A Comparative Study of Bare Frame, Open Ground Story and Infill Walls in the Alternate Stories using Spectral Acceleration, Spectral Displacement and Time

Shishir Kumar Mishra[1] Rahul Satbhaiya[2]
[1]M. Tech Scholar [2]Assistant Professor
[1,2]IMEC, Sagar, India

Abstract— In this paper a Comparative study of three different cases of framed structures has been made. Bare frame structure, Open ground story frame structure and structure with infill walls in alternate story are considered for comparing different parameters such as Spectral Acceleration with time, Spectral Displacement with time, Spectral Acceleration with Spectral Displacement (Capacity Curve). The graphs of each have been plotted and results have been compared. The results have been found to be quiet interesting proving the frame with open ground story to give better results than the other two.

Keywords: Seismic Evaluation, Pushover Analysis, Reinforced-Concrete Buildings

I. INTRODUCTION

In general, the term infill frame is used to denote a composite structure formed by the combination of a moment resisting plane frame and infill walls [1]. It can be comprehended that if the impact of infill is considered in the analysis and design of frame, the subsequent structures may be altogether diverse. In this manner, a study is attempted which will include the limited component analysis of the conduct of reinforced concrete (RC) frame with brick masonry infill [2]. Again when a sudden change in stiffness happens along the building stature, the story at which this uncommon change of stiffness happens is known as a soft storey [3]. A soft story is the one in which the lateral stiffness is under 70% of that in the story above or under 80% of the normal stiffness of the three stories[4] above. Social and functional needs like vehicle parking, shops, reception etc. are compelling to provide soft storey in high-rise building[5].

In the present study comparative study of three different cases of framed structures has been made. Bare frame structure, Open ground story frame structure and structure with infill walls in alternate story are considered for comparing different parameters such as Spectral Acceleration with time, Spectral Displacement with time, Spectral Acceleration with Spectral Displacement (Capacity Curve). The graphs of each have been plotted and results have been compared. The results have been found to be quiet interesting proving the frame with open ground story to give better results than the other two.

II. PROBLEM FORMULATION

S.NO	CONTENT		DESCRIPTION
1	Type Of Structure		Multi story High Raised Frame (Moment Resisting Frame)
2	Seismic Zone		4
3	Zone Factor		0.24
4	Number of Storey		G+9
5	Floor Height		3.00m
6	Base Floor Height		3.3m
7	Wall Thickness		External-230mm Internal- 115mm
8	Materials		Concrete (M25for beams) and (M30for columns) reinforcement Fe500
9	Size of Column(Rectangular)		450*600mm
	Size of the Beam in all Floors and Roof		450*600
	Depth of Slab		125mm
	Specific Weight of RCC		25KN/m3
10	Type of Soil		Medium

Table 1: Preliminary assumed data for G+9 RCC framed building

III. OBJECTIVES

Seismic behavior of a frame building has been analyzed by using push over analysis in this study. Three different types of frames has been used for performing the seismic performance evaluation of the building. Static type of pushover analysis is to be used in this research work where the loads consist of permanent gravity loads and incremental horizontal forces at each storey level. Capacity curves (base shear versus story total drift) obtained from static pushover analysis using commercially available software called Etabs 2015 are used for the calculation of some seismic demand parameters.

Three different types of frame are taken namely:

1) Bare frame structure Fig 1.
2) Frame with infill walls in alternate stories. Fig 2
3) Open ground story frame. Fig 3.

The structural members are modeled with the aid of commercial software ETABS v 9.7.1 in compliance with the codes IS 456-2000 and IS 1893-2002. The frame members are modelled with rigid end conditions. The floor slabs were assumed to act as diaphragms, which ensure integral action of all the lateral load-resisting elements. The floor finish on the floors is taken to be 1.0 kN/m2. The live load on floor is taken as 3.0 kN/m2 and that on the roof to be 1.5 kN/m2. In seismic weight calculations, 25 % of the floor live loads are considered in the analysis. For an infill wall located in a lateral load-resisting frame, the stiffness and strength contribution of the infill has to be considered. Non-integral infill walls subjected to lateral load behave like diagonal struts. Thus an infill wall can be modelled as an equivalent ‘compression only’ strut in the building model. Rigid joints connect the beams and columns, but pin joints connect the equivalent struts to the beam-to-column junctions. The length of the strut is given by the diagonal distance (d) of the panel and its thickness is equal to the thickness of the infill wall. The elastic modulus of the strut is equated to the elastic modulus of masonry (Em). Smith (1966) proposed a formula to calculate the width of strut based on the relative stiffness of the frame and the infill walls.

IV. RESULTS

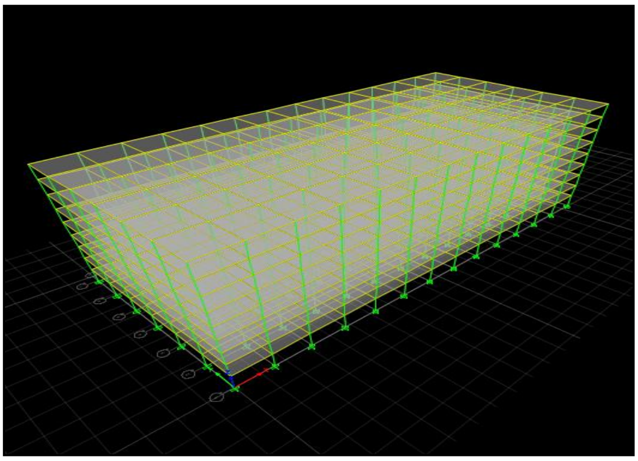

Fig. 1: 3D figure of the bare frame to be analyzed using different combinations of columns.

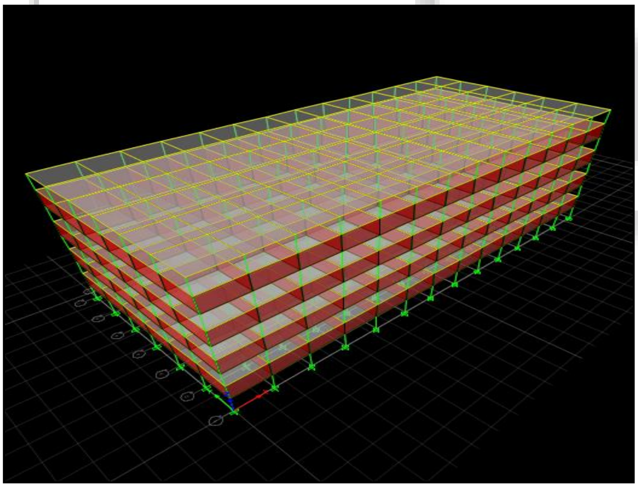

Fig. 2: 3D figure of the alternate story frame to be analyzed using different combinations of columns.

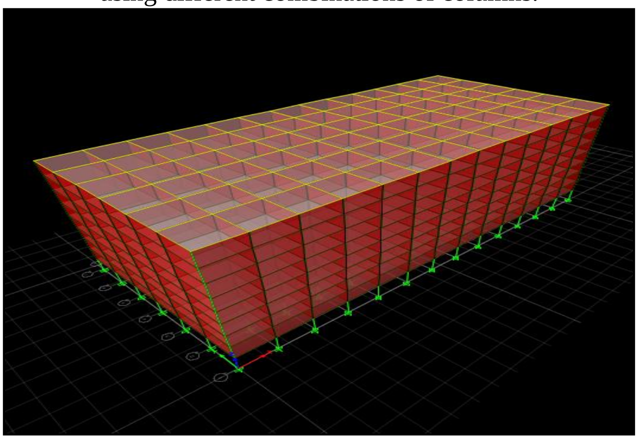

Fig. 3: 3D figure of the open ground frame to be analyzed using different combinations of columns.

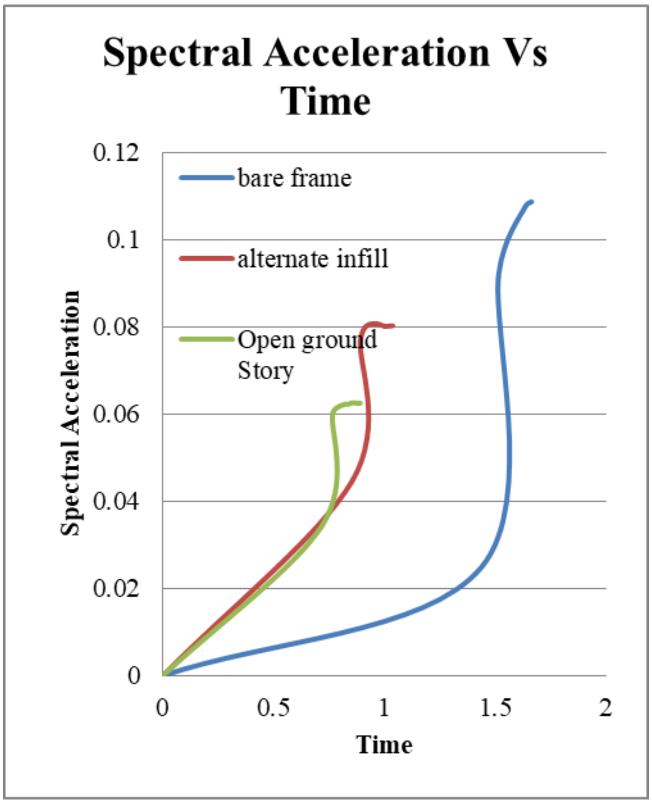

Fig. 4: Spectral acceleration Vs time curve

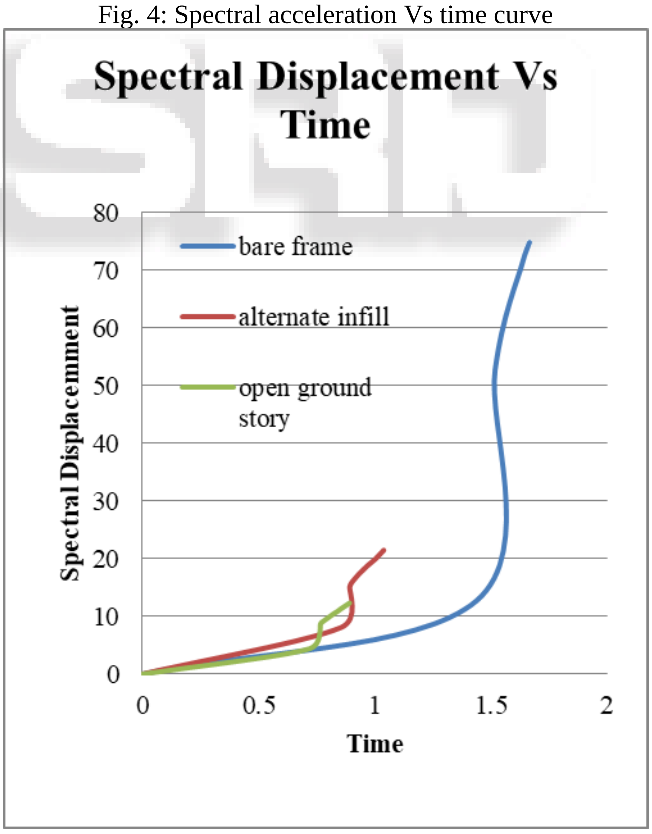

Fig. 5: Spectral Displacement Vs time curve

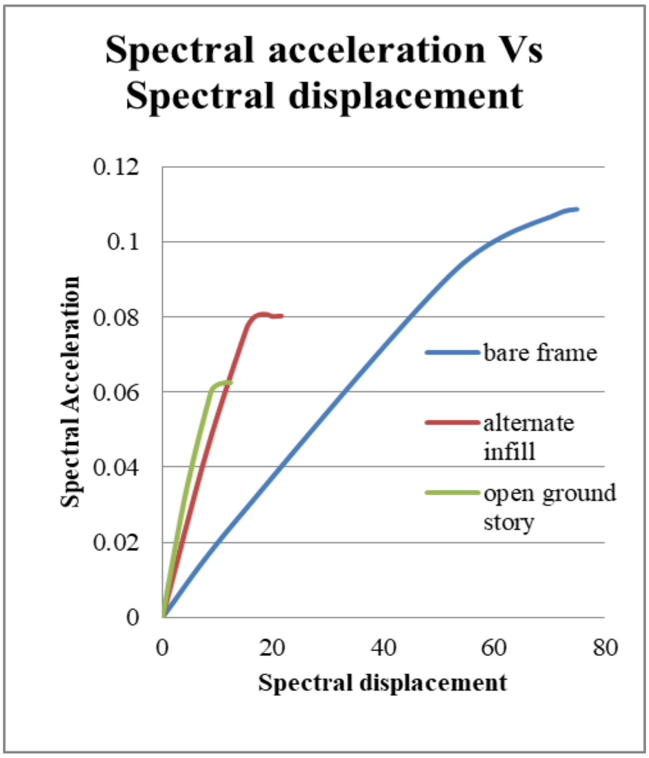

Fig. 4: Spectral acceleration Vs Spectral Displacement

Sd	Sa	Period
mm	g	sec
0	0	0
12.767	0.024856	1.438
52.775	0.092292	1.517
71.567	0.107625	1.636
74.896	0.108768	1.665

Table 2: Showing the Spectral displacement, Acceleration and Time period of a bare frame

Sd	Sa	Period
mm	g	sec
0	0	0
8.088	0.044595	0.854
15.172	0.076841	0.892
16.291	0.079609	0.908
17.363	0.080589	0.931
17.986	0.080765	0.947
18.767	0.080771	0.967
19.938	0.080177	1.001
19.939	0.080177	1.001
21.494	0.080315	1.038
21.51	0.080316	1.038

Table 3: Showing the Spectral displacement, Acceleration and Time period of an Alternate infill frame

Sd	Sa	Period
mm	g	sec
0	0	0
4.396	0.034366	0.718
8.729	0.059943	0.766
9.091	0.060976	0.775
9.426	0.061494	0.786
10.003	0.062041	0.806
10.551	0.062334	0.825
10.94	0.062336	0.841
11.287	0.062584	0.852
12.259	0.062523	0.888
12.345	0.062569	0.891

Table 4: Showing the Spectral displacement, Acceleration and Time period of an Open ground story

V. CONCLUSION

Spectral Acceleration with time, Spectral Displacement with time, Spectral Acceleration with Spectral Displacement (Capacity Curve) has been compared in this study. The seismic performance evaluation has been carried out using ETABS software. From the results it can be concluded that: Maximum spectral acceleration with time was observed in the bare frame model whereas the least was observed in the model with the open ground story.

The least Spectral displacement was observed in the open ground story frame model on the other the maximum was in the bare frame structure.

Spectral displacement versus spectral acceleration graphs (Capacity curves) show that the performance of the open ground story frame has a better performance as compared to the other two.

From the above stated observations it can be clearly stated that frames with the open ground story has a better seismic stability as compared to the bare frame and the frame with infill in alternate stories.

VI. REFERENCES

[1] Fajfar, P., (2000), "A Nonlinear Analysis Method for Performance Based Seismic Design", Earthquake Spectra, 16:573-592.
[2] Lee, D.G., Choi, W.H., Cheong, M.C., and Kim, D.K., (2006), "Evaluation of Seismic Performance of Multistory Building Structures Based on the Equivalent Responses", Engineering Structure, 28:837-856.
[3] ATC (1996), "Seismic Evaluation and Retrofit of Concrete Buildings", ATC-40 Report, Applied Technology Council, Redwood City, California.
[4] FEMA (1997), "NEHRP Guidelines for the Seismic Rehabilitation of Buildings (FEMA 273)", Federal emergency Management Agency, Washington D.C.
[5] Seneviratna, GDPK., and Krawinkler, H.,(1997), "Evaluation of Inelastic MDOF Effects for Seismic Design", John A. Blume Earthquake Engineering Center, Standford University.

