Effect of Staircase on the Seismic Performance of Buildings

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***Abstract* - In this paper, the effect of different staircase location during earthquake have been studied in design of building, the staircase is generally not a primary part & considered secondary Structural member in the RC frame building. So, its negligence in Analysis & design causes vulnerable damage in the structure. Here the staircase model in different location is compared to check how it affects the seismic performance of the building.**

Key words: Stair case, Story Drift, Base Shear, Earthquake, Location

I. INTRODUCTION

Earthquake is an impulsive event and acts quite differently. The force generated by seismic action of earthquake is different than other types of loads, such as, gravity, Dead load, Live load and wind load. It strikes the weakest spotin the whole Structural frame building. Ignorance in structural design and poor quality & maintenance of construction result many weaknesses & faults in the structure member and Structural Building also, thus cause vulnerable damage to life and Structural property of building.

In RC frame structural buildings, the primary structural system to resist Lateral & Gravity load are beams and columns. Besides, primary frame structural system, some structural member also contributes to lateral load resistance. These elements fall in the category of secondary systems. Secondary system can be structural secondary like staircase, structural partition etc and non-structural secondary like storage tanks, machinery etc. A special case of structural secondary members which are normally designed for non-seismic force; are concrete staircase.

In the present study, the effects of staircase on the seismic performance of the RC frame structural buildings of different plans have been studied in this paper with different structural seismic parameter e.g. Story displacement, Story drift & storey Shear.

II. METHODOLOGY

In this paper, linear dynamic analysis (response spectrum analysis) is performed using ETABS software. This analysis considers dynamic forces which are applied to thestructuresaspercode-baseddesignspectrum.Ithelpstodeterminetheeffectofthehighermodesofvibrationanddistributionofforces.Inresponsespectrumanalysis,multiple mode shapes are taken in to consideration. Depending upon the modal mass and modal frequency, a response is read from the design spectrum for each mode.Later,theseresponsesarecombinedtodeterminethetotalresponseofthestructurebymodalcombinationmethods.Thismethodisperformedforthestructureswhosemodes,exceptthefundamentalone,influencetheresponseofastructure.Responsespectrumistheestimationofmaximumresponses.

A. Geometrical Properties

Table 1: Geometrical Parameters

Height of Building	24m
Column Size	400mmX500mm
Beam Size	300mmX400mm
Slab Thickness	150mm
Staircase Slab Thickness	200mm
Story Length in X & Y Direction	24m
Each Story Height	3m
No of bays in X&Y direction	5nos each

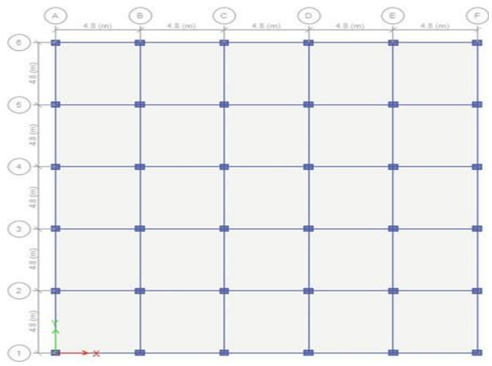

Fig.1 Plan of the building.

B. Load Parameters

The seismic parameters considered in dynamic analysis of all the models are assumed as per IS 1893 (Part 1): 2002. The buildings are assumed to be in Zone IV&V with the peak ground acceleration value of 0.36g. The importance factor, I is taken as 1.5 (for important building). Also, the response reduction factor R taken as 5 for SMRF system of the buildings. The soil strata beneath the foundation is assumed as medium soil. The gravity and imposed loads are taken as per IS 875 (Part 1 and 2): 1987, self-weight of the structure is calculated and imposed load is assumed to be 3 kN/m2 for a typical residential building.

Since, the lateral load due to earth pressure on foundation columns does not take part in the seismic weight of the structure, thus its effect is neglected in the analysis to observe only the effect of lateral forces due to seismic loads. However, for design purposes, the effect of lateral earth pressure should be considered. All the models are analysed, designed and checked for any failure of members and hence the size of the columns are varied accordingly as the height of the structure increases.

III. RESULTS AND DISCUSSION

In this paper, models with staircase locations at center & corner positions of the buildingat two severe seismic zones IV &V is considered for seismic performance of building. To check seismic performance of building with different staircase location Story displacement, Story drift & Story shear.

ZONE-IV

Case1: Stair at centre

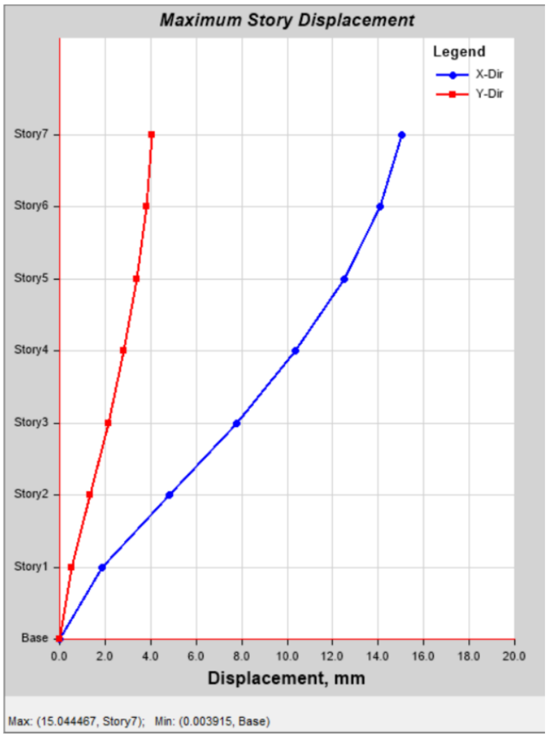

Fig.2 Maximum Storey Displacement

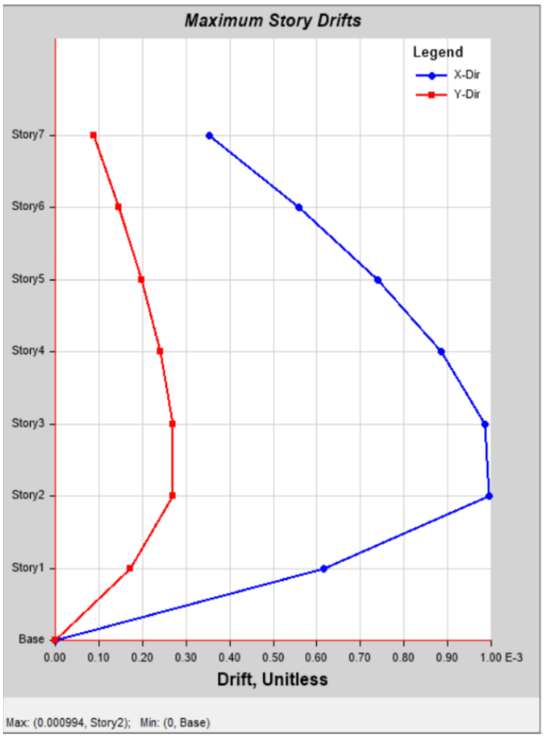

Fig.3 Maximum Storey Drift

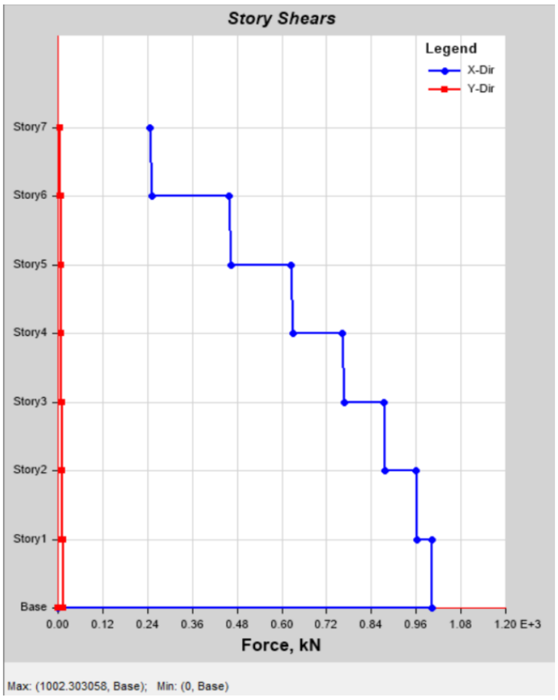

Fig.4 Maximum Storey Shear

ZONE-V

Case2: Stair at corner

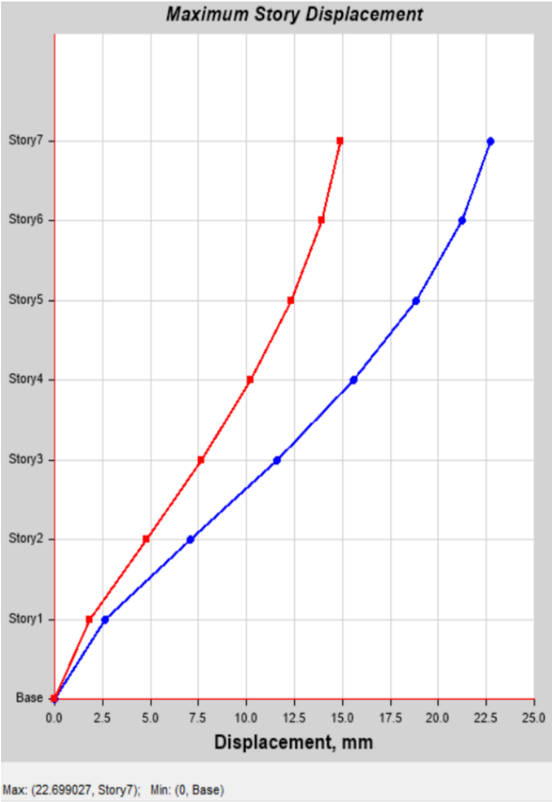

Fig.5 Maximum Storey Displacement

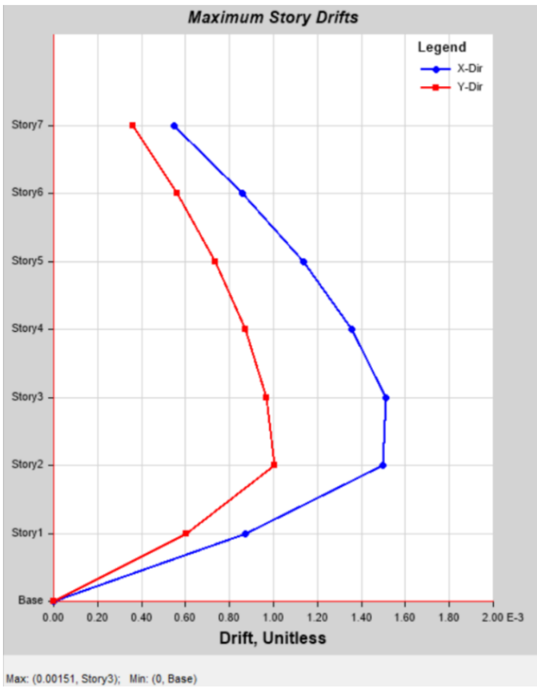

Fig.6 Maximum Storey Drift

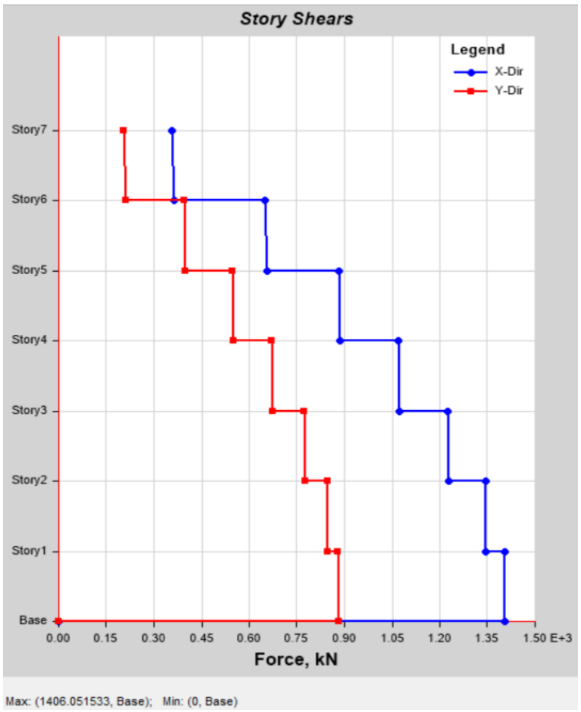

Fig.7 Maximum Storey Shear

A. Comparative Study

Table 2: Comparative Study

Models		Max storey displace-ment		Max storey drift		Storey shear	
		RSX	***RSY***	***RSX***	***RSY***	***RSX***	***RSY***
Zone 4	At center	15.044	13.489	0.000994	0.000909	1002.303	933.978
	At corner	15.132	19.658	0.001007	0.001333	937.367	864.219
Zone 5	At center	22.580	20.234	0.001492	0.001363	1502.991	1401.025
	At corner	22.699	29.488	0.00151	0.001999	1406.051	1296.328

IV. CONCLUSION

It is clear from the comparative study that the center position of the staircase yields better seismic performance compared to that of the other;

* The maximum storey displacement that, the dog-legged stair models yield less displacement at the center position rather than the corner ones in both the seismic zones in the study.

*Similarly while considering the case of maximum storey drift, greater values are evolved for corner positions of stair in both the zones which implies that the structure could be stiffer by assigning the staircases at centre positions rather than corner.

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