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Non-linear dynamic analysis on stepped RCC building considering P-delta effect

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ABSTRACT
From past earthquakes, it is observed that if the structures are not properly analyzed and constructed with required quality, then it may lead to loss of lives and property. Reinforced concrete frame buildings with different types of irregularities are most common type of constructions in urban India,which are subjected to several types of forces. Earthquake load mainly induce lateral forces which causes lateral displacement of the structure. The effect of gravity load acting on the structures lateral displacement is called the P-delta effect. Due to P-delta effect, geometric nonlinearity induces in the building which creates additional moment and shear. Hence, In the present study, modelling and design of G+14 RCC building with irregularities is carried out in SAP2000V16 considering P-delta effect using Time history analysis. Various parameters such as base shear, storey drift and overturning moment are obtained. It is found that p delta effect in building needs to be considered and controlled.

Keywords **:** P-delta effect, SAP, Time history analysis, vertical & mass irregularities.

I. INTRODUCTION

The performance of a building during an earthquake depends on many factors including the structure's configuration and proportions, its dynamic characteristics, the hysteretic behaviour of the elements and joints, the type of non structural components employed the quality of the materials and workmanship, adequacy of maintenance, the site conditions, the intensity and dynamic characteristics of the earthquake ground motion experienced. In the common linear elastic "first order" analysis P-delta effects are neglected. Whenever secondary effects due to structural deformations, such as delta, are included in the elastic analysis, it is no longer linear and reference is made to a "second order" analysis.

P-Delta effect, also known as geometric nonlinearity, involves the equilibrium and compatibility relationships of a structural system loaded about its deflected configuration of particular concern. It is the application of gravity load on laterally displaced multi-storey building structures. This condition magnifies story drift and certain mechanical behaviours while reducing deformation capacity. In structural engineering, the P-Delta effect refers to the abrupt changes in ground shear, overturning moment, and the axial force distribution at the base of a sufficiently tall structure or structural component when it is subjected to a critical lateral displacement.

Time history analysis refers to dynamic response of the structure at each increment of time, when its base is subjected to a specific ground motion time history. Alternatively, recorded ground motions database from past natural events can be a reliable source for time histories but they are not recorded in any given site to include all seismological characteristics suitable for that site. Recorded ground motions are randomly selected from analogous magnitude; distance and soil condition category are the three main parameters in time history generation.

Several researchers have presented their study in area of effect of p-delta analysis on various structures in several papers. Akshay Gupta and Helmut Krawinkler investigated the inelastic response of steel moment resisting frame. P-delta effect induces negative post yield storey stiffness as seen from pushover curve. The results lead on to the belief that P-delta problem is indeed a potential collapse hazards that needs to be considered in the present design process. EF Black introduced and evaluated two stability coefficients that can be used to quantify the P-delta effect during elastic and inelastic lateral displacement of regular steel SMRF. The study shows that the combined use of these two coefficients permit the accurate prediction of the load deformation curve of the SMRF affected by P-delta phenomena. H. Scholz studied a novel method to allow for the P-Delta effect of steel sway frames

analyzed by elastic methods. A numerical example suggests that more economical designs may be obtained, but a further comprehensive parametric study will be required to confirm this for the general case.

II. FRAME STRUCTURE DETAILS AND PROBLEM STATEMENT

In the present study, effect of nonlinearity on the response of G+14 stepped RC building has been investigated. Nonlinearity is considered in terms of P-delta effect. The structure has 2 bays in X direction and 4 bays in Y direction in the 1st step, 3 bays in X direction and 4 bays in Y direction in the 2nd step and 4 bays in X direction and 4 bays in Y direction in the 3rd step from top to bottom. Width of bay is 4 m with constant storey height of 3.0m.

III. FIGURES AND TABLES

Table no.1. Specification of the RCC model

Type of structure	G+14 storied (RC moment
Seismic zone	V, As per IS 1893 Part I, Z=0.36
Importance Factor	1
Damping Ratio	0.05
Imposed load for residential floor	2 KN/m2
Imposed load for commercial floor	3.5 KN/m2
Storey Height	3.0m
Specific Weight of RCC	25KN/m3
Specific Weight of Brick infill	20 KN/m3
Infill Wall	230mm
Column size	300X600
Beam size	230X600

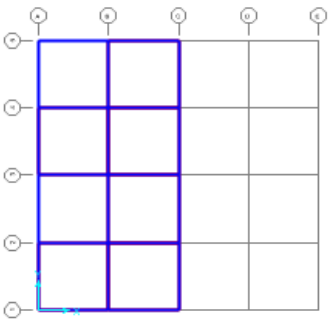

Fig.no.1. Plan of the building at step1

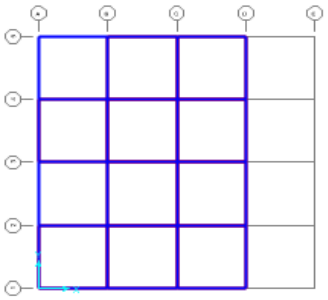

Fig.no.2. Plan of the building at step2

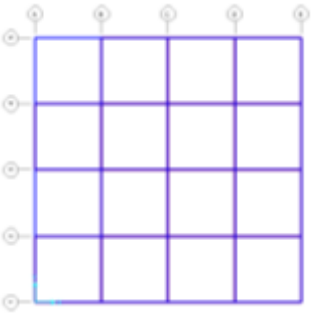

Fig.no.3. Plan of the building at step3

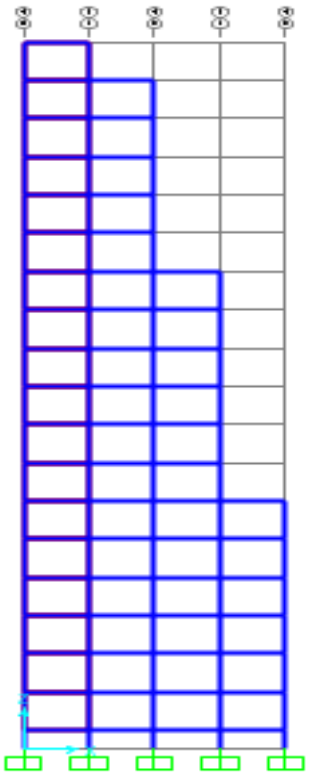

Fig.no.4. Front elevation of the building

IV. METHODOLOGY

In this paper, fourteen storied building frame is under the action of Imperial Valley (El-Centro) (1940) earthquake. The irregular stepped

RCC building is considered with the provision of lift and staircase for performing time history method of dynamic analysis. The building is analyzed for two combinations such as i) Without P-delta effect and ii) with P-delta effect modeled and designed in SAP2000 v16 using time history analysis and response quantities viz. displacement, base shear, overturning moment are obtained under considered earthquake.

V. RESULTS

The following table no.2 represents the value for Base shear for the two cases, i) Without P-delta effect and ii) with P-delta effect

Table No 2: Represents the Base shear values (KN)

Base shear (KN)		
Base shear value for RCC stepped building	Without p-delta	With p-delta
	98378.236	103116.358

The following table no.3 represents the Overturning moment values for the two cases i) Without P-delta effect and ii) with P-delta effect

Table No 3. Represents the Overturning moment values (KN-m)

Overturning Moment (KN-m)		
Overturning moment value for RCC stepped building	Without p-delta	With p-delta
	6436.884	7762.86

The following table no.4 represents the joint displacement values for each step of the stepped RCC building for the two cases i) Without P-delta effect and ii) with P-delta effect

Table No 4. Represents the joint displacement values in (m)

Step no	Without p-delta	With p-delta
1	0.5844	0.7112
2	0.4385	0.5319
3	0.2350	0.2750

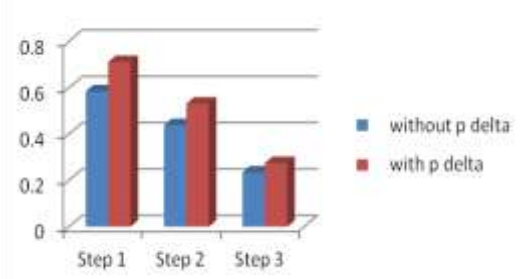

Fig No. 5. Shows the difference between the joint displacement values for each step for the two cases i) Without P-delta effect and ii) with P-delta effect

V. CONCLUSION

1) The drift in the storeys are large for the building with p-delta effect and irregularities.
2) Effect of non-linearity due to p-delta is predominant than that of the normal effect.
3) Maximum Base shear is observed in case of P-delta.
4) It can be concluded that the performance of the building under P-delta effect should be considered and remedial measures should be taken.
5) As the floor level increases, displacement increases, with maximum displacement is observed in P-delta case.

REFERENCES

[1]. A. Gupta and H. Krawinkler, "Dynamic P-delta effect for flexible inelastic steel structure," *Journal of Structural Engineering*, Vol. 126, No. 1, January 2000, pp 145-154.

[2]. E. F. Black, "Use of stability coefficient for evaluating the P-delta effect in regular steel moment resisting frames," *Engineering Structures*, Vol. 33, February 2011, pp 1205-1216.

[3]. H. Scholz, "P-delta effect in elastic analysis of sway frames," *Journal of Structural Engineering*, Vol. 113, No. 3, March 1987, pp 534-545.

[4]. H. Kwak, and J. Kim, "P-delta effect on slender RC column under seismic load," *Engineering Structures*, Vol. 29, April 2007, pp 3121-3133.

[5]. M. Aschheim, and E. H. Montes, "The representation of P-delta effect using yield point spectra," *Engineering Structures*, Vol. 25, April 2003, pp 1387-1396.

[6]. R. Gaiotti, and B. S. Smith, "P-delta analysis of building structures," *Journal of Structural Engineering*, Vol. 115, No. 4, April 1989, pp 755-770.

[7]. K. Patel, S. Thakkar, "Analysis of CFT, RCC and steel building subjected to lateral loading," *3rd Nirma University International Conference on Engineering, Nirma University, Ahmedabad*, 2013, Paper No. 51, pp 259 – 265.