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A REVIEW ON COMPARATIVE ANALYSIS OF A BUILDING WITH AND WITHOUT P-DELTA EFFECT

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Abstract — *In heavily populated cities the supply of land is becoming less and value of land is becoming higher. In sight of recognition & less availability of land, tall structures are only solutions for overcoming the issues. A tall structure should be designed to resist the lateral load like Earthquake force within the permissible limits set by Standards. Combination of rigid frame with RC structure get 30 storey as maximum storey and liable to collapse under severe displacement, axial force and moment, if the P-Delta effects doesn't include in analysis and style phase. Because of complexity and low knowledge of P-Delta analyses designers, engineers and architectures are liable to perform Linear Static analysis which can eventually become a reason behind catastrophic collapse of the high-rise. The study has been administrated for 15, 20 and 25 story structure with and without P-delta effect. Our study is predicated on "P-Delta" analysis which includes geometric nonlinearity within the analysis. The study has been performed on structural software ETABS.*

Keywords-*P-delta effect, High rise structure, Non-linear analysis, Lateral load, ETABS software, Story drift ratio*

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I. INTRODUCTION

1.1 General

Generally, the analysis of buildings is completed by using linear elastic methods, which is first order structural analysis. In a very first order analysis displacements and internal force are evaluated in relevancy the geometric undeformed structure. It doesn't consider buckling and material yielding. Within the case of first order elastic analysis, the deformations and internal forces are proportional to the applied loads. However, in some cases, the deflection of the structure can have a geometrical second order effect on the behavior of the structure, which cannot be evaluated by the linear first order analysis. This kind of geometric non-linearity will be analyzed by performing through iterative processes which is just practicable by using computer programs. It's generally called second order analysis. During this kind of analysis, the deformations and internal forces are not proportional to the applied loads.

1.2 P-delta effect

The movement of the structural mass to a deformed position within the analysis of building systems subjected to lateral displacements generates second-order overturning moments that are normally not accounted for static and dynamic analysis. This second-order behavior has been termed the P-Delta effect since the extra overturning moments on the building are adequate the sum of story weight "P" times the lateral displacements "Delta". The effect of P-Delta is especially addicted to the applied load and building characteristics. Additionally, to the present it also depends upon the peak, stiffness and asymmetry of the building.

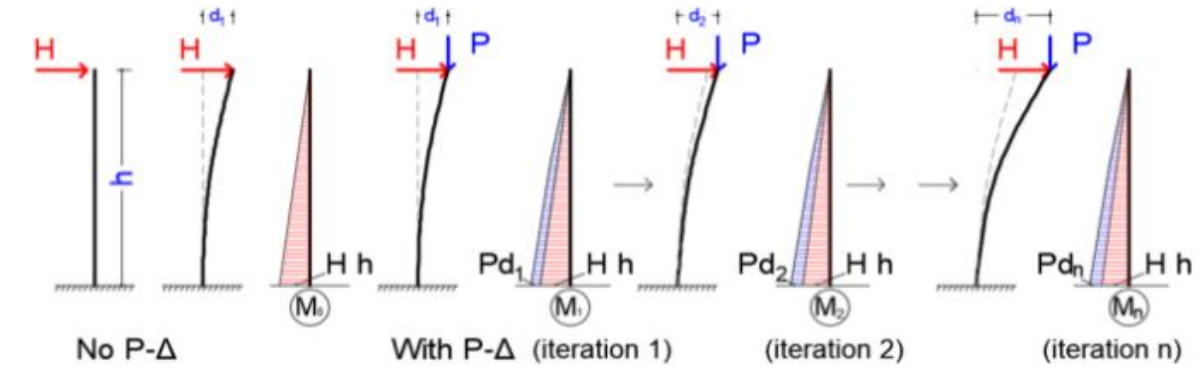

Figure-1 P-delta effect

Now- a-days many software has the potential to analysis and style with P-Delta effects. All must be that the variation of outcomes like axial, moment and deflection, between P-Delta and Linear Static analysis to spot when the P-Delta analysis are performed, possible differences, performing procedure and designing techniques, and this the purpose from which the thought of this study evolves.

II. LITERATURE REVIEW

2.1 Yousuf Dinar, Samiul Karim, Ayan Barua, Ashraf Uddin "P-Delta Effect in Reinforced Concrete Structures of Rigid joint." (IOSR Journal of Mechanical and Civil Engineering, 2013) Popularity of High-Rise structures of rigid joint frame system are increasing day by day to accommodate growing people in metropolitan city and to construct the structures with none special structural component. However, combination of rigid frame with RC structure gets 30 storey as maximum storey and susceptible to collapse under severe displacement, axial force and moment, if the P-Delta effects doesn't include in analysis and style phase. Because of complexity and low knowledge of P-Delta analyses designers, engineers and architectures are vulnerable to perform Linear Static analysis which can eventually become a reason behind catastrophic collapse of the high-rise. 12 cases and a pair of different analysis are performed to grant a light-weight on the P-Delta effect in RC Structures of Rigid Joint which is able to aware and suggest concerning person to grasp, make experience and perform P-Delta analysis of the high-rise for safety using numerical modelling which can accelerate the method and reduce the complexities.

2.1.1 Introduction

P-Delta effect may be a major issue which affects the structural response severally, neglected for its complexity in analysis phase of the planning. Although the event of data and advancement of technology is kind of advanced today, there are an awfully few practical experimental studies on the P- Delta effects of the structure. The foremost used structural analysis for concrete design is linear static analysis, where P-Delta effect is omitted which is incredibly important to incorporate in analysis and style phase. Thanks to that, high rise structures may show potential vulnerability against lateral loads.

2.1.2 Methodology

In the traditional first order analysis of structures, the results of change within the structure actions because of structure deformations are neglected. However, when a structure deforms, the applied loads may cause additional actions within the structure that are called second order or P-Delta effects. The P-Delta effect relies on the applied load and building characteristics. In step with A.S. Moghadam and A. Azimine ad, parameters like height and stiffness of a building, the degree of its asymmetry may additionally be of importance.

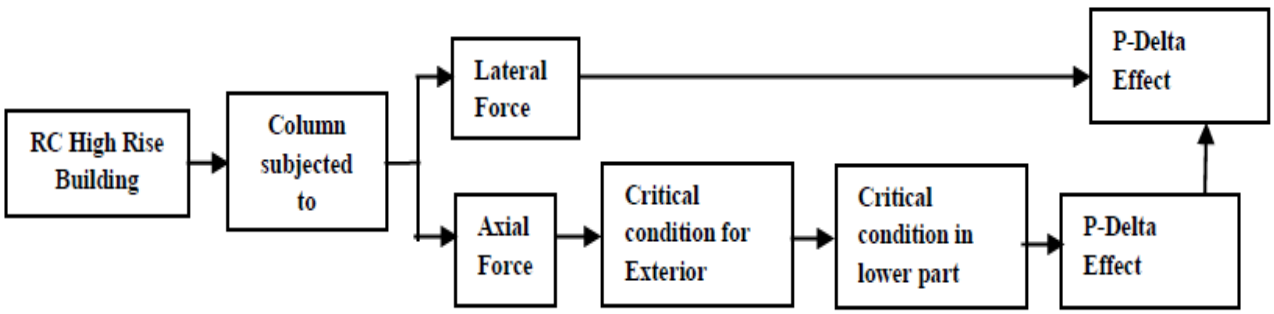

Figure-2 P-Delta effects to total loads

So, it's necessary to perform P-Delta during analysis of high-rise structures as those are at risk of damage under various reason for faulty analysis and style which can happened by not considering any of the parameters. So, P-Delta and other analysis associated with high-rise should be performed exactly in line with code.

2.1.3 Experimental study

To investigate P- Delta Effect in Reinforced Concrete Structures of Rigid joint six story group in two different analyses is performed. During study, total 24 models was analyzed and 12 cases, or geometrical possibilities, were simulated through both Linear Static and P-Delta analysis. The load deformation responses of the numerical model specimens were followed through to failure by means of the deflection in each story of each case of a particular column. A particular frame, in each and every case with two different analysis procedure, in crucial side of the structure is observed and value taken from it to meet the objectives of the study. A specific column is used for getting axial and moment in each floor.

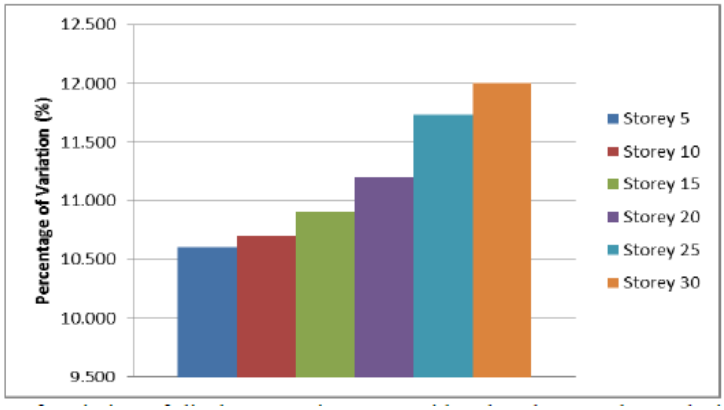

Figure-3 Percentage of variation of displacement in top considered under P-Delta analysis

2.1.4 Summary and conclusion

In Conclusion, it can be summarized that analyzing and designing RC high-rise structure needs expert observation and understanding. Analysis found was versatile in characteristics but it may be said, displacement varies exponentially under P-Delta analysis with increasing height or increment in storey and then the axial force too. Axial force changes in positive side rapidly over the Linear Static analysis, if P-Delta is performed to seek out it. Moments shows different tendency which is decreasing in value with increment of story or increasing height push to contemplate axial and displacement most. So, Linear Static and P-Delta both are necessary for RC structures and should use after proper understanding to stop any catastrophic. Axial and displacement might be observed by P-Delta analysis while keeping the instant section to the Linear Static analysis. However how the bracing, infill, shear wall and composite section influence the consequences of P-Delta might be studied to search out the overall trend of these frame system.

2.2 A.S. Moghadam and A. Aziminejad, "Interaction of torsion and p-delta effects in tall buildings." (13th World Conference on Earthquake Engineering, 2004) studied the importance of asymmetry of building on the P-Delta effects in elastic and inelastic ranges of behavior are evaluated. The contribution of lateral load resisting system, number of stories, degree of asymmetry and sensitivity to ground motion characteristics is assessed. Four buildings with 7, 14, 20 and 30 story are designed supported typical design procedures, then their elastic and inelastic static and dynamic behavior with and without considering P-Delta effects, are investigated. Each building is taken into account for 0%, 10%, 20% and 30% eccentricity levels. The results indicate that the kind of lateral load resisting system plays a vital role in degree that torsion modifies the P-Delta effects. It's also shown that although within the elastic static analyses, torsion always magnifies the P-Delta effects, but the identical is not always true for dynamic analyses. The results of dynamic analyses also show high level of sensitivity to ground motion characteristics.

2.3 T.J. Sullivan, T.H. Pham and G.M. Calvi, "P-delta effects on tall RC frame-wall buildings." (The 14th World Conference on Earthquake Engineering, 2008) studied Current international design codes impose limits on the P-delta ratio, which appear to possess been set to make sure a minimum reloading stiffness during cyclic response and with due consideration for the likely ductility demands imposed on structures. Whilst the present code limits are also reasonable for normal height structures, it is argued that the code limits should be reconsidered for tall buildings thanks to limited displacements that real earthquake ground motions impose on such buildings. During this paper, the look of a 45-storey ferroconcrete frame-wall case study structure is employed to focus on the importance of the p-delta limit within the modal response spectroscopy procedure of the Euro code 8. It's found that the strength of the structure is dictated by the P-delta limit for seismic actions, despite anticipated storey drifts and ductility demands being relatively low. A series of non-linear time-history analyses employing a suite of spectrum-compatible real and artificial accelerograms, indicate that P-delta effects don't have a major influence on displacements or storey drifts of the tall building. The likely causes of this behavior are identified, making relevance earlier investigations into P-delta behavior and considerately of substitute structure concepts. To research the importance of the P-delta ratio further, a series of SDOF studies are undertaken for systems designed with P-delta ratios of up to 0.85. The results demonstrate that the p-delta ratio has little influence on the behavior of long-period systems subject to real earthquake records and thus it doesn't appear appropriate to impose strict limits on the P-delta ratio. Instead, it's recommended that the P-delta effects be evaluated for tall-building systems as a part of an overall assessment of their response, using advanced non-linear time-history analyses with real records and within a large-displacement analysis regime.

2.4 Nikunj Mangukiya, Arpit Ravani, Yash Miyani and Mehul Bhavsar, "Study of "P-Delta" Analysis for R.C. Structure." (Global Research and Development Journal for Engineering, 2016) studied regarding the P-delta analysis. During this era of 21st century the urbanization increases worldwide, in heavily populated cities the supply of

land is becoming less and value of land is becoming higher. Seeable of recognition & less availability of land, tall structures are only solutions for overcoming the issues. A tall structure should be designed to resist the lateral load like Earthquake force within the permissible limits set by Standards. Loads are mainly of two types that are Gravity Loads & Lateral Loads likes Earthquake load. Earthquake forces are further two types, Static Forces & Dynamic Forces. It might be linear and Non-linear also. Linear static analysis is performed for Low Rise Structure & law earthquake zones only. For tall structure it's necessary to think about nonlinearity, which is mostly observed in geometry & materials. Our study is predicated on "P-Delta" analysis which contains geometric nonlinearity within the analysis. The study is going to be performed on structural software ETABS.

2.5 M. M. El-Hawary, "Effect of horizontal diaphragm flexibility on the P-delta analysis" (ELSEVIER science Ltd.-1994) This paper investigates the importance of including the consequences of the flexibleness of the horizontal diaphragms when using the P-delta method of research, especially when considering the hundreds applied to intermediate frames on trusses that aren't a part of the lateral force resisting system. Analyses were conducted for structural systems with a variable number of stories, number of bays and diaphragm stiffness's and supported by rigid jointed plane frames or vertical trusses. The effect of the consideration of the diaphragm's flexibility on the second order P-delta shear forces depends on the relative flexibility of the diaphragms compared to the supporting system. For concrete diaphragms, which are generally considered to be rigid, the effect of the consideration of diaphragm flexibility on the second order shear forces may also be considerable depending on the stiffness of the LFRS.

III. CONCLUSION

The main results of this study are as following

1. 1.Within the elastic static analyses, effect of P-Delta always is increasing, as number of stories of buildings or their eccentricity increases.
2. Within the elastic or inelastic dynamic analyses, the consequences of P-Delta sometimes increase the responses and sometimes decrease the responses. The rationale is that implementing P-Delta effects in analysis causes change in stiffness matrix of building, thus the natural periods and other dynamic properties of the building will change. If acceleration response equivalent to the new natural period of building, in response spectrum of the earthquake, is a smaller amount than acceleration response adores the first natural period, then reduction in building responses for the case with P-Delta are often expected.
3. It might be summarized that analyzing and designing RC high-rise structure needs expert observation and understanding. Analysis found was versatile in characteristics but it can be said, displacement varies exponentially under P-Delta analysis with increasing height or increment in storey and then the axial force too.
4. It shows that the planning strength of a tall RC frame-wall building is also governed by the P-delta ratio limit of 0.3 when using the Eurocode 8. Non-linear time-history analyses suggested that the behavior of a case study building subject to real records might not, in fact, be very sensitive to P-delta effects.
5. A hypothesis was then made that for very long period systems, the height displacements are limited by the height spectral displacement demands of the bottom motion, regardless of whether P-delta effects are active or not.

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