P-delta effects on non-linear static analysis

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Abstract: Nowadays, the factors affecting the stability of control structures, is one of the striking cases to design different structures. One of the pivotal factors is the P-delta effect. Effect of P-delta, by definition, is the interaction between axial load and lateral shift on each other. In static analysis, this effect was due to the multiplicity of research in the field of tangible and in most cases is to be calculated. However, dynamic analysis, due to the changing nature of the dynamic forces exerted on the structure we can say is unpredictable due to various factors. However, research has shown that non-linear static analysis the dynamic characteristics of the structure is able to calculate a little time and results in nonlinear dynamical analysis is most consistent with the frequency. Using non-linear static analysis because the structure is applied at different stages, the evolution of the structural behavior under load can be precisely studied. In this paper, to investigate the behavior of frames under lateral load with due consideration of P-delta, non-linear static analysis was used. Using non-linear static analysis, P-delta effects on joint arrangement paste and structural capacity curves is discussed. The software used in this context is SAP2000.

1. Introduction

P-delta effects in non-linear static analysis due to the preponderance of research has been done in the field of tangible and in most cases is to be calculated. However, dynamic analysis, due to the changing nature of the dynamic forces exerted on the structure we can say is unpredictable due to various factors. To consider this effect carefully, and to solve the equation of motion of nonlinear dynamical analysis used in this case, should assuming that all the parameters of this equation are a function of time. The usefulness of applying this method is the accuracy of the results. But solving the equation of motion in this case, it is difficult and time consuming. However, research has shown that non-linear static analysis with less time to calculate the dynamic characteristics of the structure and results in nonlinear dynamical analysis is most consistent with the frequency. Using non-linear static analysis because the structure is applied at different steps, one can see the evolution of the structural behavior under load to accurately be studied. Another advantage of this method is that you can paste the structure of the joint arrangement up to the first joint failure can be studied. Reasons listed in this article to examine the behavior of frames under lateral load with due consideration of P-delta, non-linear static analysis was used. The software used in this context is SAP2000.

2- Nonlinear static analysis

Plastic analysis of static non-linear is possible by non-linear version of SAP2000 software.

Applying this analysis to consider the time and great care is required. Then consider how these programs are offered by different non-linear.

3- Nonlinear Materials

Frame element nonlinear material model is assigned by the joints. This joint can be inserted in any position of an element. There is no limit to the number of joints assigned to the element. In SAP2000, allowing a detailed definition of the types of features anchor, tensional, axial and shear independently carried on. The detailed features of the label M_3-M_2-P is formulated by contrast axial forces and moments around the other two axes. View detailed properties of the steel are determined according to FEMA-273 [1].

4- Geometric nonlinear

In SAP2000, there is the possibility of considering geometric nonlinear effects. P-delta effect of the change in the stiffness matrix elements is created. In particular, a complex structural constructs that are highly uncertain degree, P-delta axial forces in Germany may be specified. Common examples of such structures, building structures is a P-delta effect is that due to gravity load. In such circumstances, the application can be based on a combination of axial forces P-delta specified static load calculations. Render combined P-delta, an arbitrary combination of static loading conditions. Program based on a specified load combination using trial and error

process, P-delta axial forces in Germany is calculated. It is important to note that the strain and rotation during this process remain small. Otherwise, significant results can not be achieved [2].

Two types of P-delta effect of the regulations are intended. First, due to the lateral shift of the second type of deformation structures and Germany between the end nodes is investigated. Typically, the first type is more important than taking the total vertical force due to gravity loads (no side loads) at the level of a class, it can be assumed with reasonable accuracy. Second, only thin columns and the columns are simple curvature effect. In the second case, the effects of gravity loads and lateral loads simultaneously on the axial force members considered.

P-delta analysis option in SAP2000, has expressed both cases. However, it is recommended that when analyzing structures of Type I and Type II due to the effects to be considered, when designing and using resonance anchor, according to regulations are examined.

5- Control procedures Times

The nonlinear static methods to control the load on the structure, there are two methods:
1- Power control: in this way the dough mix time is assumed to be known.
2- Control shift: In this method, a component is controlled by a shift in the structure. In this case, the composition of the dough enough time to rise or fall structural shift to the desired amount is reached. In this paper, the method used to control the shift and the shift limit is calculated based on FEMA-273 guidelines [1].

6- P-delta effects on the nonlinear static analysis of steel building frames

In previous research, whenever the P-delta effects are discussed in building frames, the height of the building as a major factor in exacerbating this effect is considered. It is accepted in linear static analysis. But this simply can not be treated in the dynamic analysis of structures predicted. Therefore, in this study, in addition to height and width of the two options have been considered in the frame construction is considered. All frames have been analyzed in two stages in the P-delta effect intended and are not considered further. Then by comparing the results of the two analyze, the effect of each of these factors is evaluated. The dough joint arrangement of structures in both species analyzed, assessed and compared.

Then, after introduction of frameworks and assumptions considered in the analysis, interpretation of results is discussed.

7– Introduce of analyzed frames

At this stage of the analysis were two-dimensional structural frames 140. The selection criterion covers a variety of classes, number and width of their mouths. Since the height of each storey residential buildings were assumed fixed values of 3 m were considered. Width from 3 meters to 6 meters and spans of one to five, with the addition of one is variable. Numbers of floors is 1, 3, 6, 9, 12, 15 and 20. Flexural rigid frames of the tonnage within 4 meters were considered. Considering the variation in parameters was performed according to the following reasons:
1- Detailed comparison of the results of two different types of frames to reach a definite conclusion regarding the effectiveness of each of these factors on the difference in results.
2- Check the joint arrangement of baguette dough, once the P-delta effect and once applied regardless of the effectiveness and thereby determine the amount of P-delta effect on the time and place and rotate the dough in structural joints.

8- Analysis of Frames

At this point, all of the frames were modeled using SAP2000 program. After the initial analysis, design and design control, set and type were classified sections. The primary analysis was performed under gravity load and selected sections of rolled steel profiles are standard. The initial analysis and other results are based on 2800 code shift control Iran earthquake has occurred. Thus, 140 frames were used to perform nonlinear static analysis. Some of the assumptions are:
1- To distribute the load side of the triangular load distribution, according to Iranian Earthquake 2800 code has been used.
2- In the analysis methods used to control the shift and the shift targets according to FEMA-273 guidelines have been set.
3- Detailed paste type P- M_3-M_2 is chosen.

4- Plastic hinges at both ends of the member are considered.
For each of these frames, the analysis is conducted twice in a P-delta effect and other actions, not actions.

9- Analysis of results

The results are taken from the output of the program include:
Basic cut, shift roof, floor shift, rotating joints dough, place and time of the plastic hinges. Now to review the application or the output nonlinear static analysis results are discussed. The effects of different cutting

on the roof of the base and the shift points are discussed. The formation of plastic hinges is examined.

10- Control of base shear and lateral displacement

To control the P-delta effect on cutting rate base and shift for all frames in both analyzes,

building capacity curve is prepared. Capacity curve, the relationship between the base shear versus top displacement is building. The analysis is presented in the following graph Capacity number of frames and the changes that occurred in the results of the analysis are discussed.
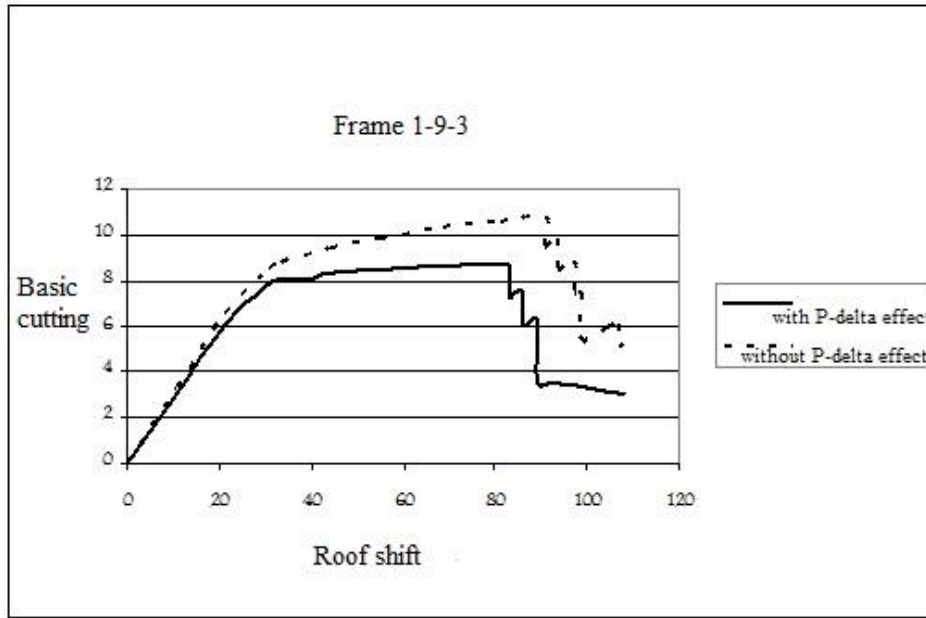
Figure 1- Curved Frame 9 floors with a capacity of 1 to 3 meters from the crater, which is obtained from nonlinear static analysis
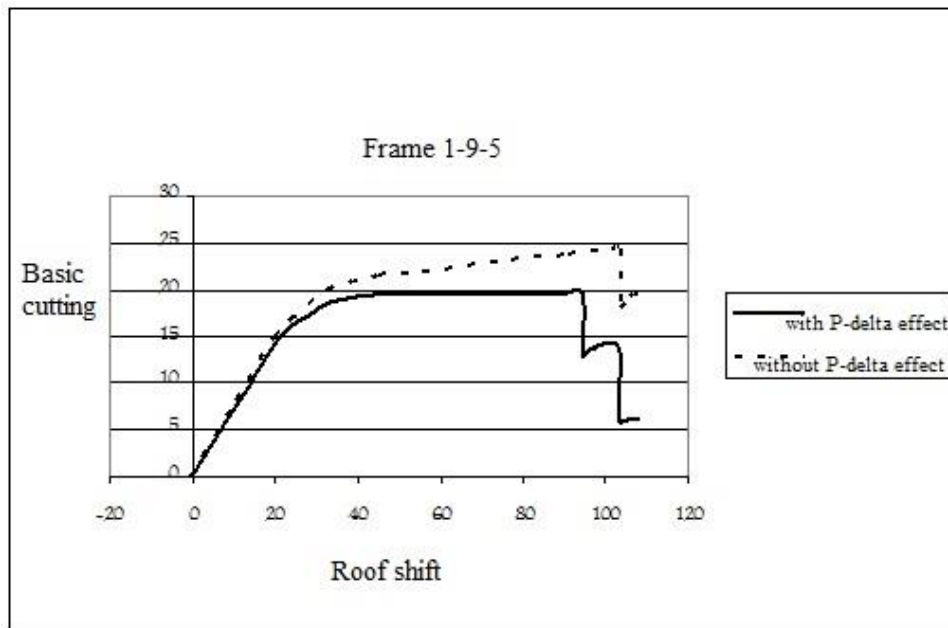
Figure 2 - Curved Frame 9 floors with a capacity of 1 to 5 meter span
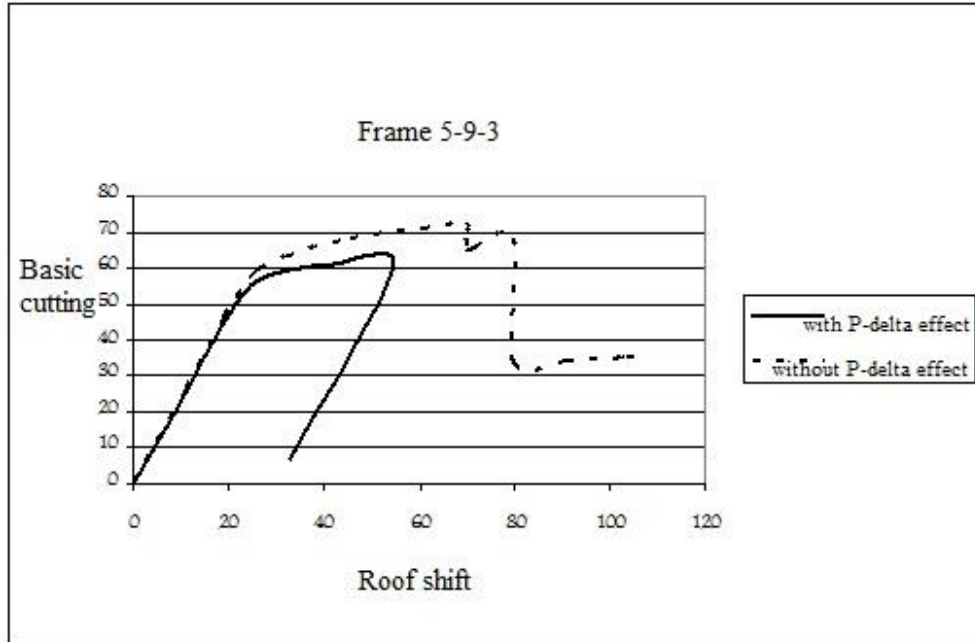
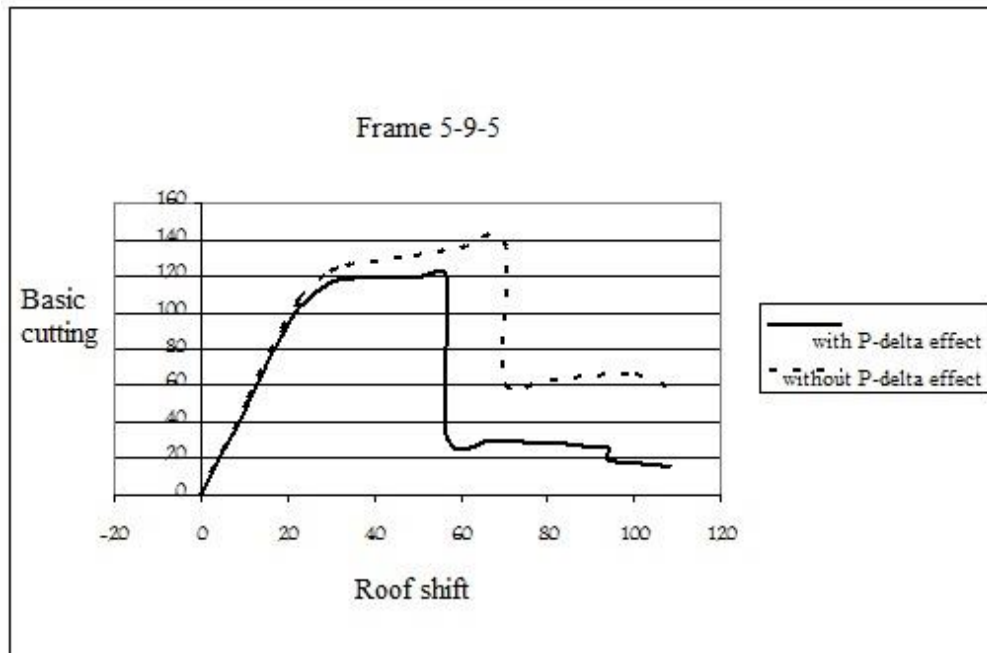Figure 3- 9 floors with a five-span curved frame capacity for 3 yards

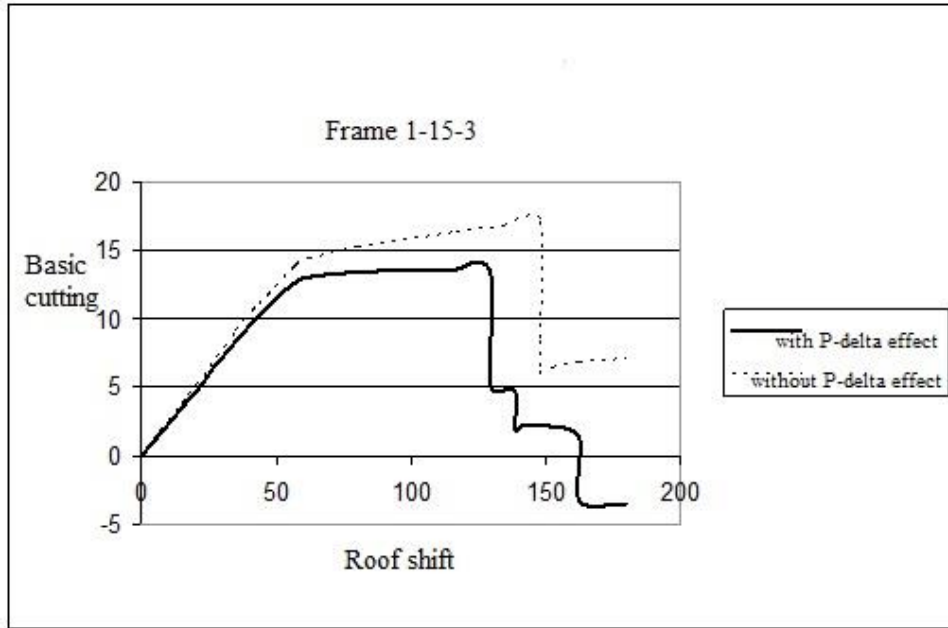Figure 4- 5 nozzles 5-foot 9-story frame capacity curve

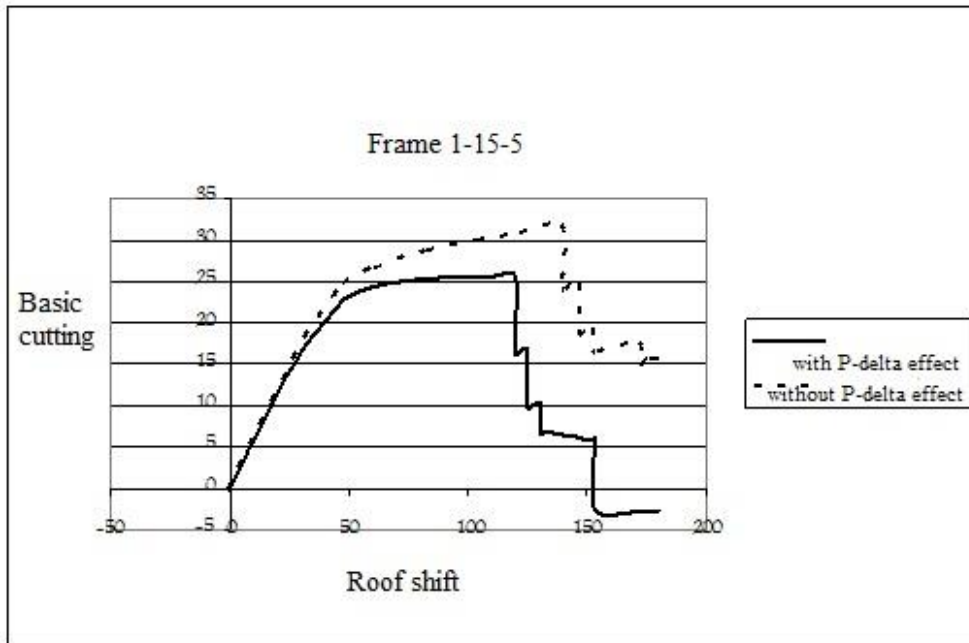Figure 5- Capacity curve frame spans 15 floors with 1 to 3 meters

Figure 6- Curved Frame capability spans 15 floors with 1 5 m
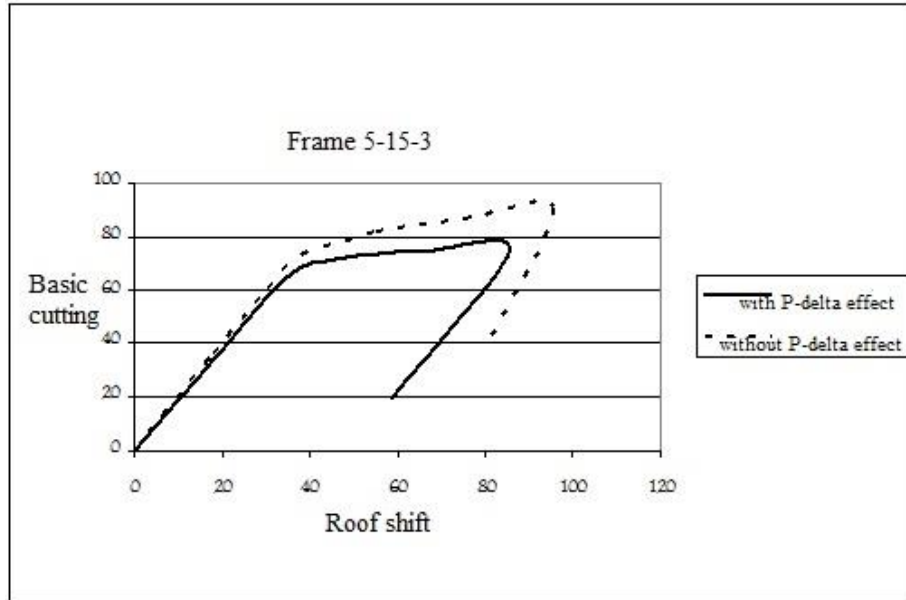
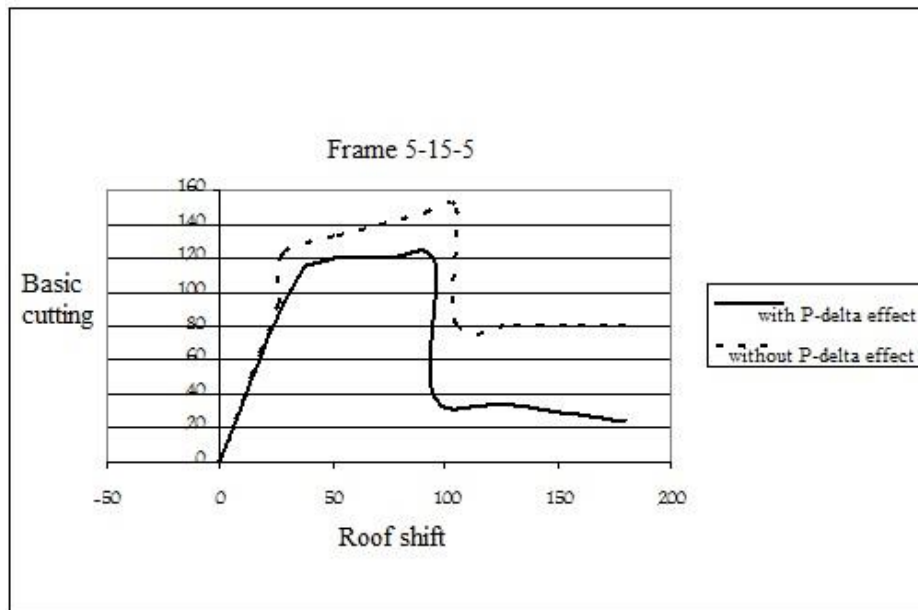Figure 7- curved frame capacity 15 storey with 5 spans 3 meters

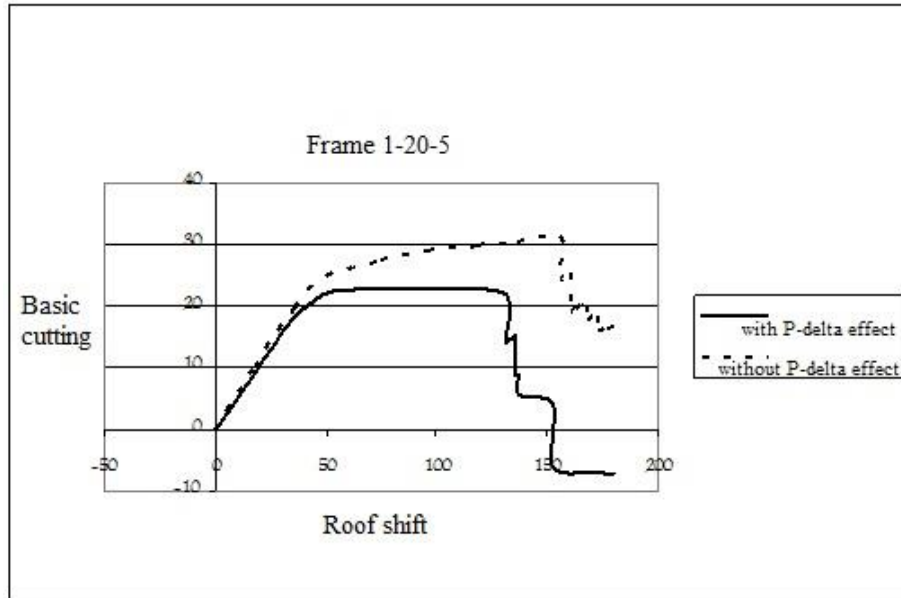Figure 8 - curved frame capacity 15 storey with 5 spans 5 meters

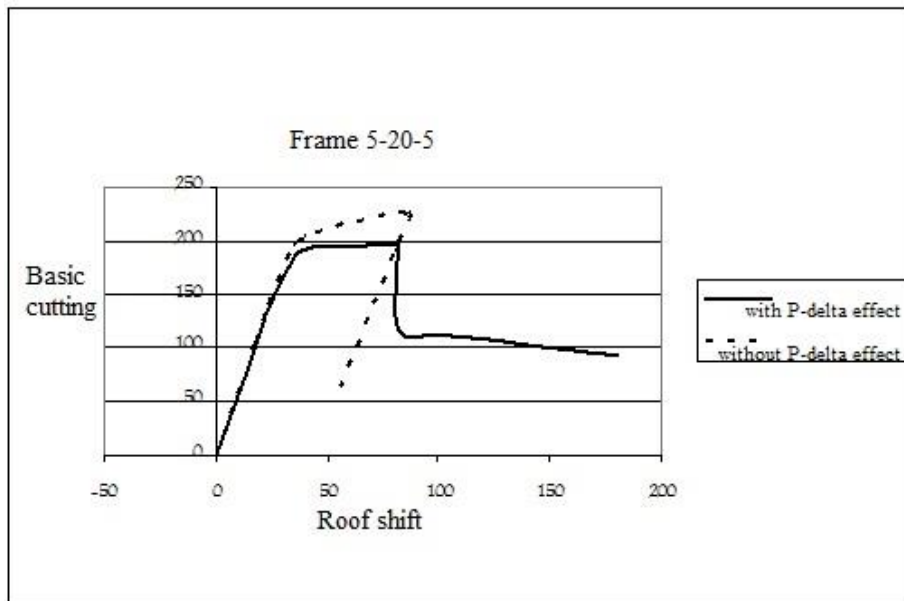Figure 9 - Frame-capacity curve spans 20 floors with 1 span 5 meters

Figure 10 - Curve capacity 20 floors with 5 nozzles 5-foot frame

As expected, these curves can be seen by visiting P-delta effects caused by the weaker performance of the structure can cope with the load. In all curves extracted structure apply to P-delta effects on the operation of the shift is much smaller.

According to Figures 1 to 10, we can say with high levels of structural differences between the two modes of applying the P-delta effect and without the effect of increased. Structures such as this case when the width increases, also was occurred. The state variable is assumed that the number of openings, increasing the number of openings, by cutting the amount of difference between the two analyzes has gone up but the amount of lateral shift of the roof has been reduced.

If the results of the capacity curve in Figures 1 to 10 are presented in a logarithmic curve to be displayed, the above seem clearer. Thus, the results in Figures 11 and 12 all offer a collection.

In Figure 11, the vertical axis and the horizontal axis represents the cutting base product of three factors: the number of classes, number of openings and the width of the powers to be calculated.

Draw this diagram This is done by first cutting of all results obtained from the analysis of approximately 140 frames in the graph, assuming a set of all elements of the horizontal axis, is entered. This analysis is performed for both cases. Then enter any two points on the graph of a line drawn which could act as an alternative to all these places. After trial and error and changed it with the powers of the three factors mentioned above, we have tried the correlation coefficient of the line is completed to the highest extent possible.

After doing all the above things, it can be seen that the curves of Figure 11, the results confirm the capacity. Given that the three factors are positive, both charts are ascending. This represents a sharp increase in the difference between the two modes by applying the P-delta effect and without any of these factors work in terms of the show.

All of the above work, the results obtained from the analysis of the shift, the roof is done. As seen in Figure 12, the results confirm the capacity curves.
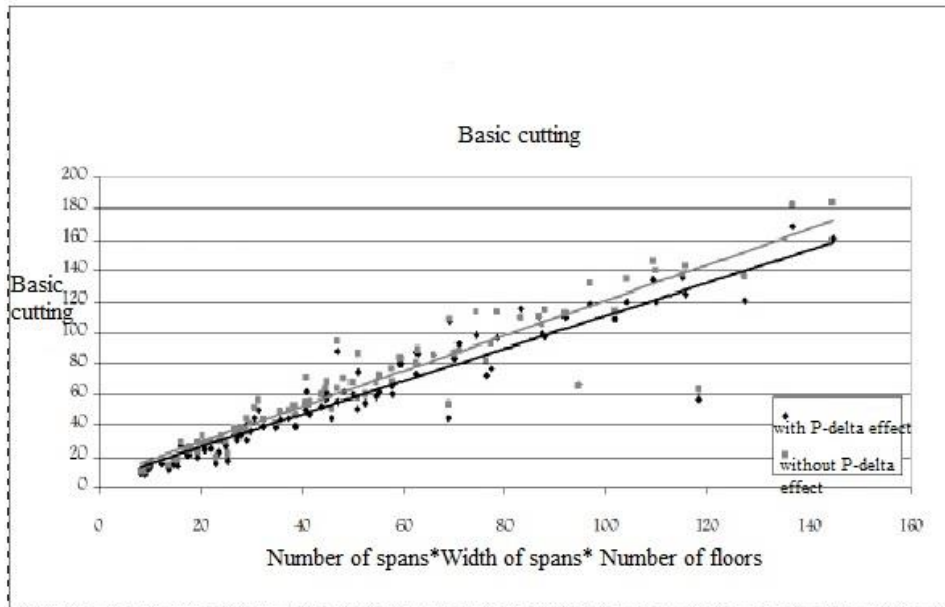

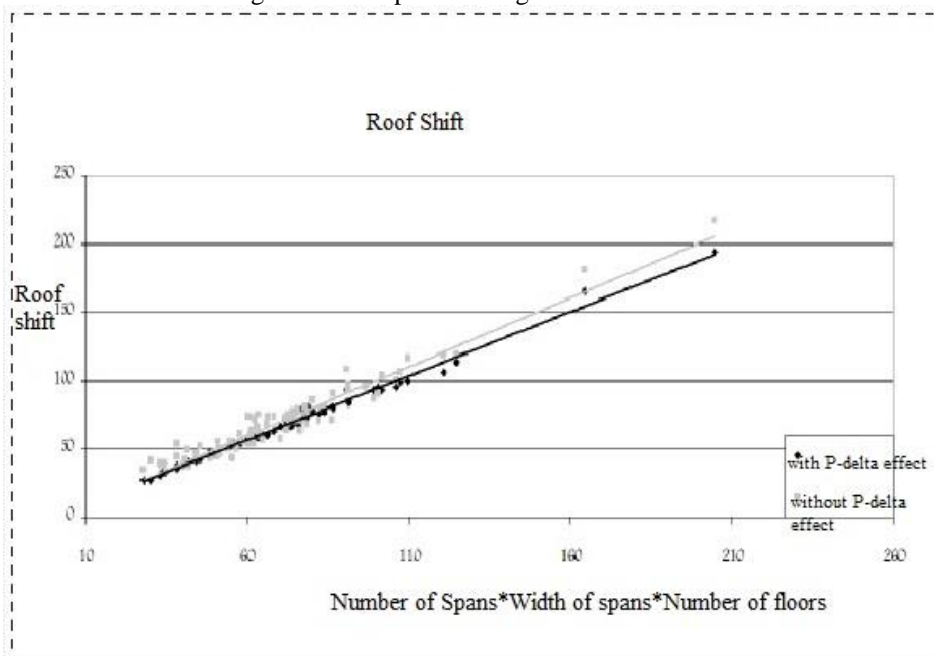Figure 11 - Graph of the logarithmic basis cuts

Figure 12 - Graph of the logarithmic shift roof

11- Joints dough control

How to form a paste description for all frames studied both with and without P-delta effect of applying this effect to be fully investigated.

Based on the analysis results, we can say P-delta effects structure does not significantly affect the makeup of the plastic joints. If no change was observed in some cases, the change was non-significant and very random and did not state a definite conclusion that could be reached.

In all frames, the nonlinear static analysis case load gradually and step by step how to control the formation of plastic hinges at each stage of loading, P-delta was observed that the effect of the time and place not get affected by plastic joints leaves.

It also controls the rotation of the plastic hinges are formed; we can say that P-delta effects on the rate of rotation does not affect the plastic joints. This suggests that a P-delta effect in the analysis of detailed shaping dough is important not play a decisive role in such a case can be made regardless of the P-delta effect.

12- Conclusion

The results of the survey conducted in the context of P-delta effects on the nonlinear static analysis can be summarized in a few sentences below:

1- P-delta effects in non-linear static analysis of structures not involved cosmetic plastic joints. The stepwise formation of plastic hinges in the frame of the analysis, it became clear that the effect of axial load on the time and place of any structure, does not affect the first joint paste and if there are some differences in the results observed in random order so that it can not reach a definite conclusion.

The first detailed characterization of the structure of the dough is too fatality outside the P-delta effect is not related.

2- P-delta effects on the rate of joint rotation does not affect the paste is formed.

3- According to the results obtained from the analysis of the capacity curve upon the roof of the shift, it could be said:

- Difference between baseline cut in two by applying P-delta effect and without the effect of increasing the number and width rises.

- The height difference between the base shear in both cases with and without P-delta effect of applying this effect is negligible at the lower limit increases.

- Variations in roof displacement, both with and without P-delta effect of applying this effect does not depend on the width and decreases with increasing number of openings.

References:

1- Applied Technology Council.Guidelines for the Seismic Rehebilitation of Buildings.Volume I : Guidelines ; Volume II : Comentary. FEMA 273/274- Ballot Version . (Prepared by the Applied Technology Council for the building Seismic Safety Council). Washington DC : Federal Emergency Managment Agency. 1996.

2 - Lawson.R.S & Vance.V & Krawinkler.Helmut , "Nonlinear Static Pushover Analysis : Why , When and How ?",Proceedings 5th US National Conference on Earthquake Engineering , Chicago , Illinois. Vol, 1994,pp.283-292.