

Performance of P-Delta Analysis of Flat Slab and R C Framed Buildings



Kanchan Gupta, Md. Tasleem

Abstract: Two-way slab directly rests on column known as flat plates, in flat slab building formwork is simple as compare to normal slab (that means slab rest on beam column frame building) and reinforcement layout are also simple and storey height decreases. In flat slab building check second order effect (second order effect known as p-delta effect). P-delta analysis means laterally displacing structures (for high rise building) with gravity loads will deflect. In P-delta analysis when lateral force act on member then it will deflect at delta distance and create secondary moments. For stability design of a building P-delta analysis is required. In the present work seismic analysis (consider zone V & soft soil) of a multi storey flat slab building with and without P-delta effects is analysed by using ETAB software. The seismic zone factor of 0.36 is considered. From the analysis check displacement and drift of flat slab building at different storey (G+9, G+19, and G+ 29) of flat slab building.

Keywords: P-delta analysis (second order effect), flat slab, drop, seismic zone (V), zone factor 0.36, soil type (soft).

I. INTRODUCTION

It is the slab that directly rest on columns, some times drop panel and column capital or combination may also be used to prevent punching failure. Its behaviour is as two-way slab and thickness is invariably higher than thickness of slab of beam slab system. For better aesthetic view we can provide flat slab. flat slab also provided for better light dispersion. In flat slab building AC ducts, firefighting and electric ducts easily provided. Storey Hight is lesser in flat slab buildings. According to IS456 minimum thickness should not be less than 125mm. longer span should be used in the slab in the calculation of the span /depth ratio according to IS456 and critical failure is punching shear failure or two-way shear failure. Critical section for punching shear is at a distance d/2 from face of column, d/2 from face of drop panel and also from column capital. Reducing negative moment reinforcement over a column or reducing the shear force around the column supports provided drop panel.

II. OBJECTIVE

To study on P-delta effect on R.C.FRAMED and FLAT SLAB building with different storey height (G+9, G+19, and G+ 29) and analysis that performance of displacement in R.C framed and flat slab building.

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Building Data

| Type of structure | R.C FRAMED BUILDING | FLAT SLAB BUILDING |
|---------------------------------------|-----------------------------------------------------|-----------------------------------------------------|
| Size of beam | 350*300mm | No beam |
| Size of column | (500*500)mm,(600*600)mm, (750*800)mm,(900*900)mm | (500*500)mm,(600*600)mm, (750*800)mm,(900*900)mm |
| Earthquake zone | V | V |
| Zone factor | 0.36 | 0.36 |
| Types of soil | Soft soil(III) | Soft soil(III) |
| Thickness of slab | 125mm | 210mm |
| Response reduction factor | 5.0 | 5.0 |
| Imposed load | 3kn/m ² | 3kn/m ² |
| Floor finish | 1.5kn/m ² | 1.5kn/m ² |
| Density of masonry wall | 20kn/m ² | 20kn/m ² |
| Density of reinforcement bar | 7850kg/m ³ | 7850kg/m ³ |
| Density of concrete | 2400kg/m ³ | 2400kg/m ³ |
| Grade of concrete | M30 | M30 |
| Grade of steel | Fe500 | Fe 500 |
| Description | Conventional slab | Flat slab |
| Plan size | (30X30)m | (30X30)m |
| Number of storey's above ground level | 10,20,30 | 10,20,30 |



The Flat Slab As Well As R.C Framed Building Models Has Shown Below

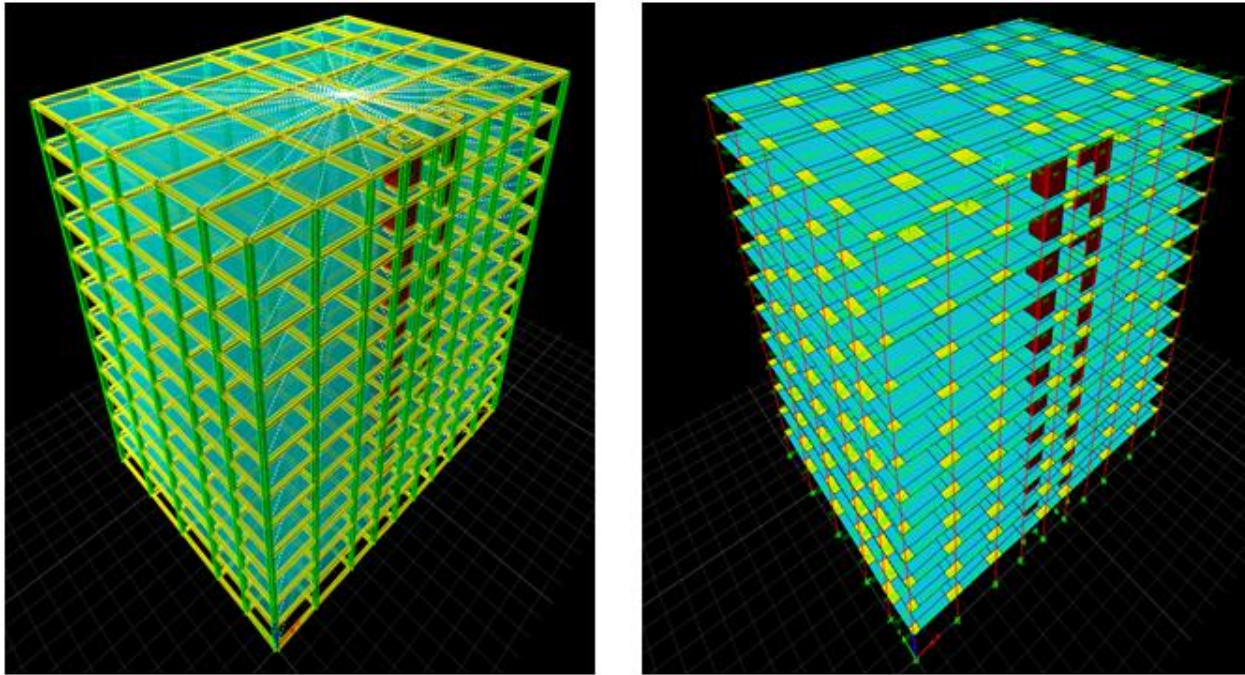
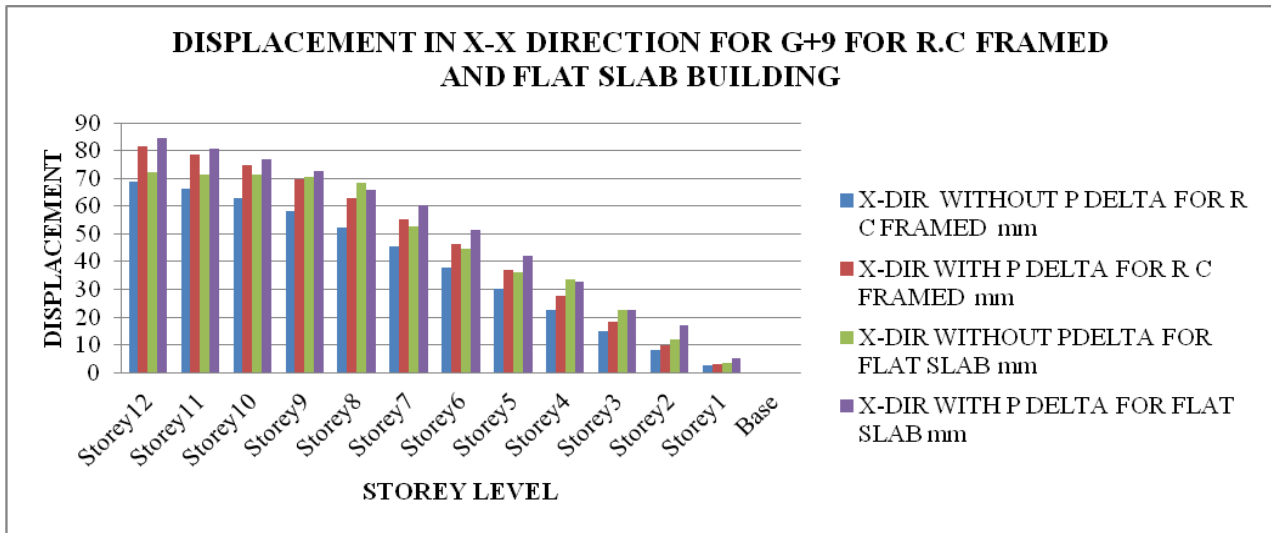


Figure 3: 3D View R.C Framed Building and Flat Slab Building

III. ANALYSIS AND RESULT

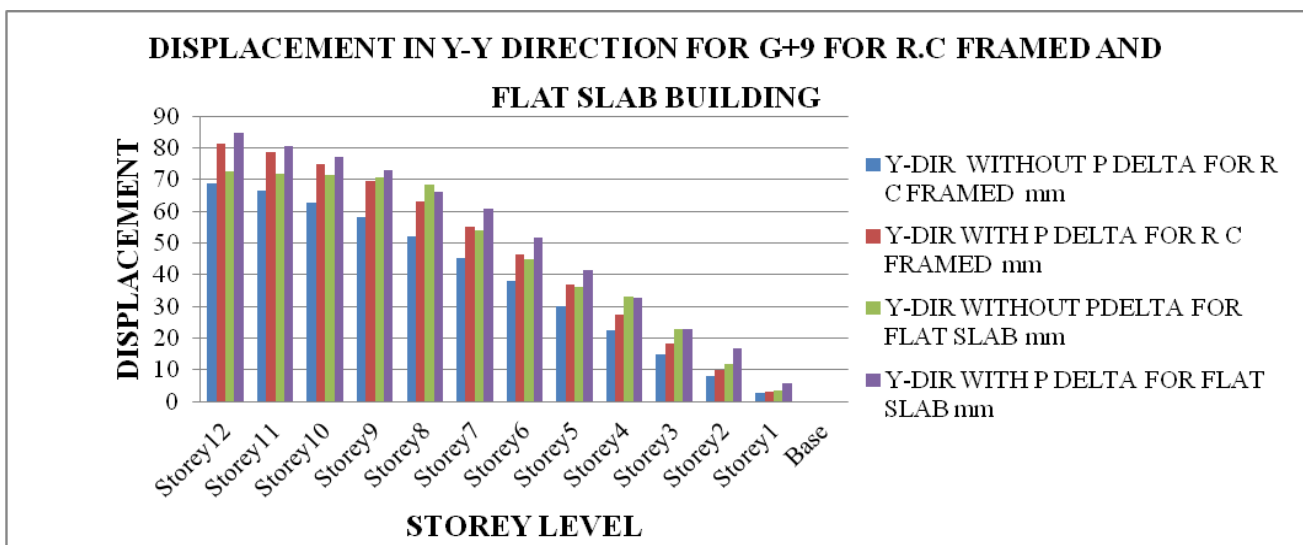
DISPLACEMENT IN X-X DIRECTION FOR G+9 FOR R.C FRAMED AND FLAT SLAB BUILDING

| STOREY | X-DIR WITHOUT P DELTA FOR R C FRAMED | X-DIR WITH P DELTA FOR R C FRAMED | X-DIR WITHOUT PDELTA FOR FLAT SLAB | X-DIR WITH P DELTA FOR FLAT SLAB |
|----------|--------------------------------------|-----------------------------------|------------------------------------|----------------------------------|
| | mm | mm | mm | Mm |
| Storey12 | 68.909 | 81.379 | 72.44 | 84.379 |
| Storey11 | 66.469 | 78.776 | 71.415 | 80.776 |
| Storey10 | 62.871 | 74.891 | 71.385 | 76.891 |
| Storey9 | 58.066 | 69.6 | 70.345 | 72.6 |
| Storey8 | 52.19 | 62.982 | 68.253 | 65.982 |
| Storey7 | 45.439 | 55.192 | 52.919 | 60.192 |
| Storey6 | 38.026 | 46.426 | 44.828 | 51.426 |
| Storey5 | 30.183 | 36.946 | 35.965 | 41.946 |
| Storey4 | 22.548 | 27.592 | 33.824 | 32.592 |
| Storey3 | 15.081 | 18.386 | 22.412 | 22.386 |
| Storey2 | 8.204 | 9.912 | 11.89 | 16.912 |
| Storey1 | 2.69 | 3.197 | 3.541 | 5.197 |
| Base | 0 | 0 | 0 | 0 |



Displacement in Y-Y Direction for G+9 for R.C Framed and Flat Slab Building

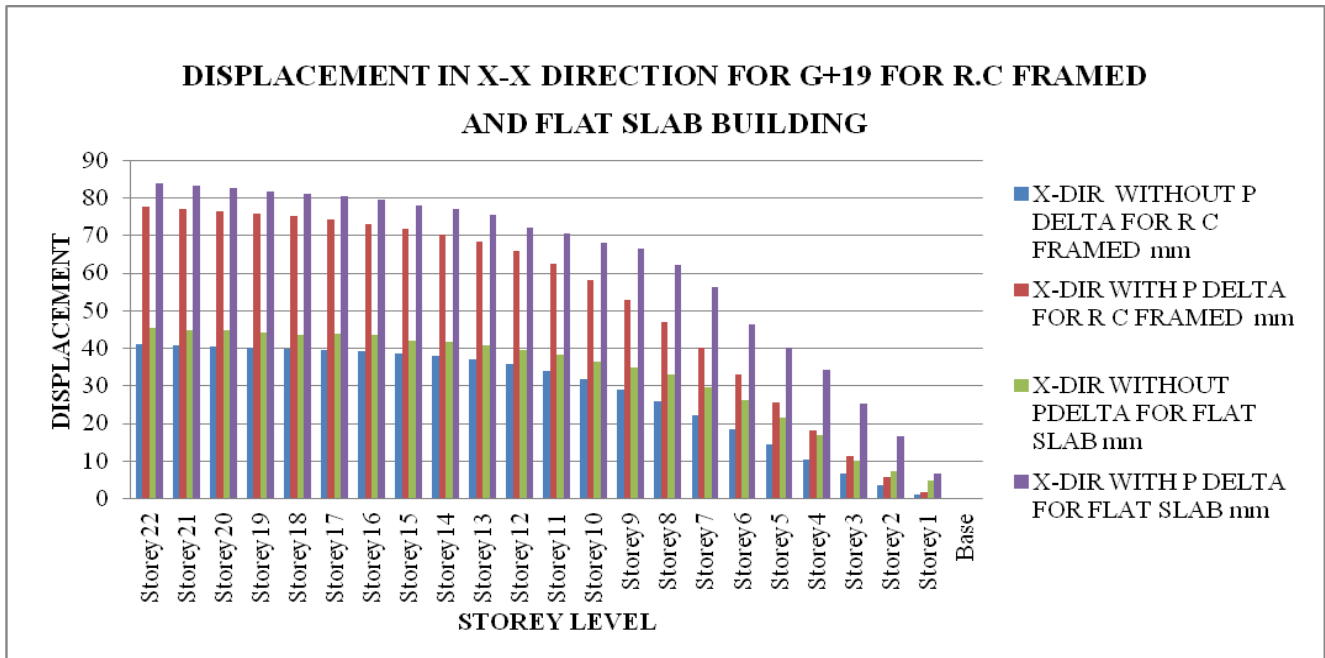
| STOREY | Y-DIR WITHOUT P DELTA FOR R C FRAMED mm | Y-DIR WITH P DELTA FOR R C FRAMED mm | Y-DIR WITHOUT P DELTA FOR FLAT SLAB mm | Y-DIR WITH P DELTA FOR FLAT SLAB Mm |
|----------|--------------------------------------------|-----------------------------------------|-------------------------------------------|----------------------------------------|
| Storey12 | 68.93 | 81.425 | 72.546 | 84.875 |
| Storey11 | 66.489 | 78.82 | 71.952 | 80.669 |
| Storey10 | 62.889 | 74.93 | 71.485 | 76.992 |
| Storey9 | 58.08 | 69.634 | 70.545 | 72.865 |
| Storey8 | 52.201 | 63.01 | 68.557 | 66.21 |
| Storey7 | 45.448 | 55.214 | 53.919 | 60.685 |
| Storey6 | 38.032 | 46.442 | 44.938 | 51.56 |
| Storey5 | 30.187 | 36.958 | 36.354 | 41.566 |
| Storey4 | 22.551 | 27.6 | 33.254 | 32.689 |
| Storey3 | 15.083 | 18.391 | 22.812 | 22.786 |
| Storey2 | 8.204 | 9.915 | 11.999 | 16.922 |
| Storey1 | 2.691 | 3.198 | 3.654 | 5.877 |
| Base | 0 | 0 | 0 | 0 |



Displacement in X-X Direction for G+19 for R.C Framed and Flat Slab Building

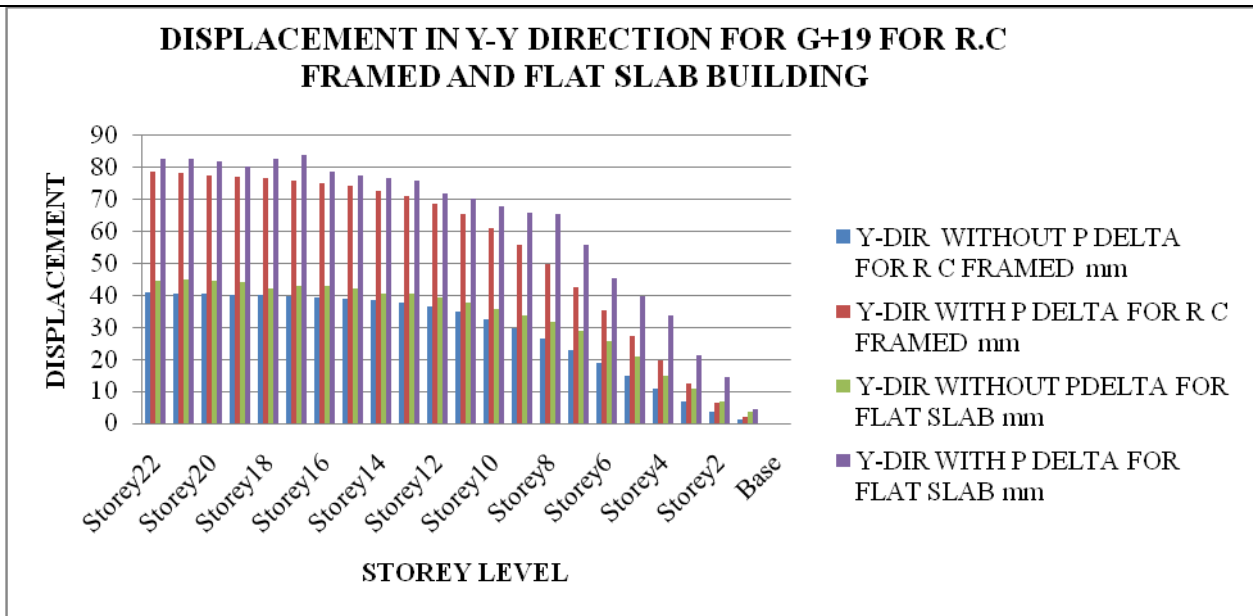
Performance of P-Delta Analysis of Flat Slab and R C Framed Buildings

| STO REY | X-DIR WITHOUT P DELTA FOR R C FRAMED | X-DIR WITH P DELTA FOR R C FRAMED | X-DIR WITHOUT PDELTA FOR FLAT SLAB | X-DIR WITH P DELTA FOR FLAT SLAB |
|-----------|--------------------------------------|-----------------------------------|------------------------------------|----------------------------------|
| | mm | mm | mm | Mm |
| Store y22 | 41.047 | 77.729 | 45.487 | 83.745 |
| Store y21 | 40.772 | 77.135 | 44.756 | 83.122 |
| Store y20 | 40.489 | 76.51 | 44.687 | 82.641 |
| Store y19 | 40.19 | 75.832 | 44.125 | 81.785 |
| Store y18 | 39.865 | 75.076 | 43.698 | 81.124 |
| Store y17 | 39.501 | 74.207 | 43.765 | 80.354 |
| Store y16 | 39.074 | 73.178 | 43.553 | 79.587 |
| Store y15 | 38.552 | 71.923 | 42.145 | 78.125 |
| Store y14 | 37.885 | 70.355 | 41.785 | 77.147 |
| Store y13 | 36.997 | 68.351 | 40.857 | 75.475 |
| Store y12 | 35.774 | 65.747 | 39.475 | 72.154 |
| Store y11 | 34.073 | 62.349 | 38.187 | 70.465 |
| Store y10 | 31.834 | 58.057 | 36.542 | 68.145 |
| Store y9 | 29.068 | 52.867 | 34.875 | 66.451 |
| Store y8 | 25.835 | 46.849 | 33.059 | 62.154 |
| Store y7 | 22.228 | 40.142 | 29.748 | 56.254 |
| Store y6 | 18.358 | 32.946 | 26.345 | 46.452 |
| Store y5 | 14.362 | 25.53 | 21.456 | 40.254 |
| Store y4 | 10.401 | 18.231 | 16.951 | 34.245 |
| Store y3 | 6.675 | 11.47 | 10.158 | 25.254 |
| Store y2 | 3.441 | 5.756 | 7.347 | 16.45 |
| Store y1 | 1.052 | 1.697 | 4.854 | 6.541 |
| Base | 0 | 0 | 0 | 0 |



Displacement in Y-Y Direction for G+19 for R.C Framed and Flat Slab Building

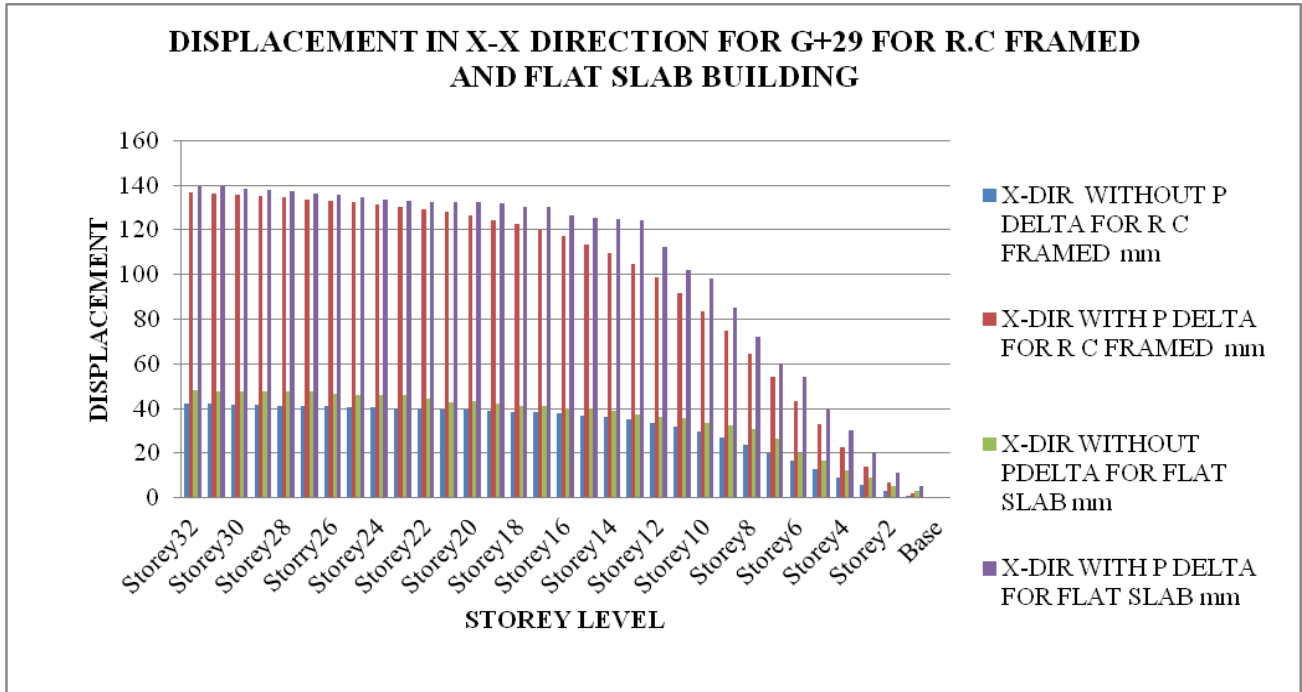
| STOREY | Y-DIR WITHOUT P DELTA FOR R C FRAMED | Y-DIR WITH P DELTA FOR R C FRAMED | Y-DIR WITHOUT P DELTA FOR FLAT SLAB | Y-DIR WITH P DELTA FOR FLAT SLAB |
|----------|--------------------------------------|-----------------------------------|-------------------------------------|----------------------------------|
| | mm | mm | mm | Mm |
| Storey22 | 40.658 | 78.214 | 44.587 | 82.255 |
| Storey21 | 40.466 | 77.816 | 44.656 | 82.352 |
| Storey20 | 40.266 | 77.392 | 44.587 | 81.741 |
| Storey19 | 40.053 | 76.921 | 44.025 | 8085 |
| Storey18 | 39.817 | 76.378 | 42.198 | 82.224 |
| Storey17 | 39.543 | 75.729 | 42.785 | 83.554 |
| Storey16 | 39.211 | 74.926 | 42.653 | 78.287 |
| Storey15 | 38.788 | 73.902 | 42.165 | 77.278 |
| Storey14 | 38.222 | 72.56 | 40.485 | 76.257 |
| Storey13 | 37.435 | 70.769 | 40.357 | 75.455 |
| Storey12 | 36.304 | 68.346 | 39.245 | 71.784 |
| Storey11 | 34.674 | 65.074 | 37.787 | 69.965 |
| Storey10 | 32.479 | 60.835 | 35.642 | 67.785 |
| Storey9 | 29.731 | 55.614 | 33.575 | 65.451 |
| Storey8 | 26.491 | 49.476 | 31.459 | 65.354 |
| Storey7 | 22.853 | 42.558 | 28.688 | 55.564 |
| Storey6 | 18.93 | 35.066 | 25.455 | 45.362 |
| Storey5 | 14.86 | 27.278 | 20.656 | 39.454 |
| Storey4 | 10.803 | 19.555 | 14.751 | 33.455 |
| Storey3 | 6.964 | 12.35 | 10.788 | 21.254 |
| Storey2 | 3.61 | 6.22 | 6.987 | 14.452 |
| Storey1 | 1.111 | 1.84 | 3.424 | 4.4541 |
| Base | 0 | 0 | 0 | 0 |



Displacement In X-X Direction For G+29 For R.C Framed And Flat Slab Building

| STORE Y | X-DIR WITHOUT P DELTA FOR R C FRAMED mm | X-DIR WITH P DELTA FOR R C FRAMED mm | X-DIR WITHOUT P DELTA FOR FLAT SLAB mm | X-DIR WITH P DELTA FOR FLAT SLAB Mm |
|----------|--------------------------------------------|-----------------------------------------|-------------------------------------------|----------------------------------------|
| Storey32 | 42.207 | 136.856 | 48.457 | 139.45 |
| Storey31 | 41.994 | 136.289 | 47.854 | 139.334 |
| Storey30 | 41.781 | 135.706 | 47.785 | 138.425 |
| Storey29 | 41.567 | 135.1 | 47.685 | 138.025 |
| Storey28 | 41.351 | 134.461 | 47.582 | 137.485 |
| Storey27 | 41.133 | 133.778 | 47.421 | 136.487 |
| Storey26 | 40.911 | 133.04 | 46.425 | 135.487 |
| Storey25 | 40.685 | 132.231 | 46.215 | 134.465 |
| Storey24 | 40.452 | 131.335 | 46.112 | 133.452 |
| Storey23 | 40.21 | 130.329 | 46.012 | 133.124 |
| Storey22 | 39.955 | 129.187 | 44.125 | 132.487 |
| Storey21 | 39.681 | 127.877 | 43.0147 | 132.241 |
| Storey20 | 39.383 | 126.358 | 43.085 | 132.475 |
| Storey19 | 39.05 | 124.581 | 42.451 | 132.014 |
| Storey18 | 38.669 | 122.49 | 41.245 | 130.245 |
| Storey17 | 38.223 | 120.015 | 41.147 | 130.147 |
| Storey16 | 37.685 | 117.076 | 40.225 | 126.241 |
| Storey15 | 37.023 | 113.58 | 40.014 | 125.142 |
| Storey14 | 36.187 | 109.419 | 39.147 | 125.012 |
| Storey13 | 35.114 | 104.471 | 37.452 | 124.247 |
| Storey12 | 33.715 | 98.602 | 36.145 | 112.247 |
| Storey11 | 31.884 | 91.682 | 35.487 | 102.245 |
| Storey10 | 29.579 | 83.676 | 33.245 | 98.251 |
| Storey9 | 26.816 | 74.652 | 32.254 | 85.241 |
| Storey8 | 23.653 | 64.773 | 30.568 | 72.124 |
| Storey7 | 20.178 | 54.287 | 26.254 | 60.245 |

| | | | | |
|---------|--------|--------|--------|--------|
| Storey6 | 16.503 | 43.524 | 20.145 | 54.124 |
| Storey5 | 12.763 | 32.891 | 16.784 | 39.245 |
| Storey4 | 9.117 | 22.86 | 12.458 | 30.254 |
| Storey3 | 5.756 | 13.967 | 8.785 | 20.245 |
| Storey2 | 2.911 | 6.788 | 5.345 | 11.254 |
| Storey1 | 0.87 | 1.931 | 3.254 | 5.245 |
| base | 0 | 0 | 0 | 0 |

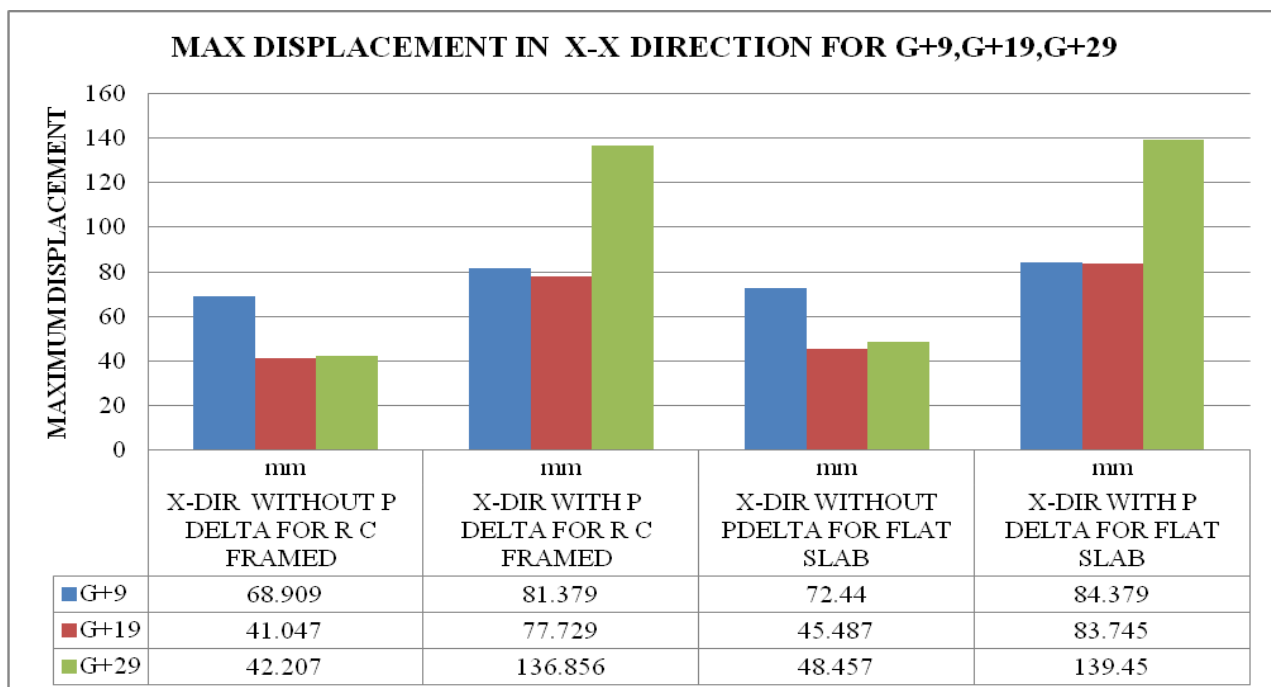
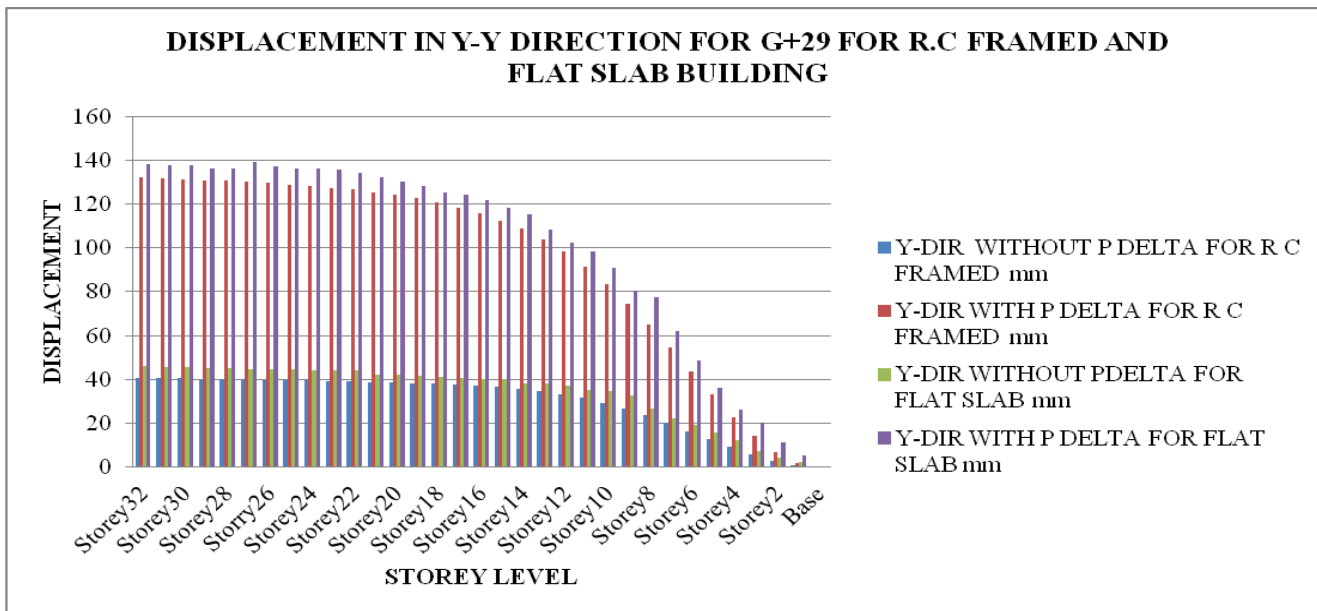


Displacement In Y-Y Direction For G+29 For R.C Framed And Flat Slab Building

| STO REY | Y-DIR WITHOUT P DELTA FOR R C FRAMED mm | Y-DIR WITH P DELTA FOR R C FRAMED mm | Y-DIR WITHOUT P DELTA FOR FLAT SLAB mm | Y-DIR WITH P DELTA FOR FLAT SLAB Mm |
|-----------|--------------------------------------------|-----------------------------------------|-------------------------------------------|----------------------------------------|
| Storey 32 | 40.7 | 132.142 | 45.874 | 138.245 |
| Storey 31 | 40.55 | 131.761 | 45.675 | 137.785 |
| Storey 30 | 40.4 | 131.368 | 45.354 | 137.542 |
| Storey 29 | 40.249 | 130.954 | 45.245 | 136.245 |
| Storey 28 | 40.096 | 130.511 | 45.125 | 136.124 |
| Storey 27 | 39.941 | 130.029 | 44.754 | 139.078 |
| Storey 26 | 39.782 | 129.496 | 44.662 | 137.245 |
| Storey 25 | 39.619 | 128.897 | 44.552 | 136.124 |
| Storey 24 | 39.448 | 128.216 | 44.321 | 136.087 |
| Storey 23 | 39.268 | 127.431 | 44.214 | 135.754 |

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| | | | | |
|-----------|--------|---------|---------|---------|
| Storey 22 | 39.074 | 126.514 | 44.142 | 134.254 |
| Storey 21 | 38.861 | 125.433 | 42.124 | 132.241 |
| Storey 20 | 38.623 | 124.146 | 41.895 | 130.245 |
| Storey 19 | 38.349 | 122.604 | 41.557 | 128.451 |
| Storey 18 | 38.027 | 120.749 | 41.225 | 125.425 |
| Storey 17 | 37.638 | 118.508 | 40.654 | 124.125 |
| Storey 16 | 37.157 | 115.799 | 40.254 | 121.875 |
| Storey 15 | 36.549 | 112.526 | 40.078 | 118.124 |
| Storey 14 | 35.766 | 108.578 | 38.145 | 115.243 |
| Storey 13 | 34.744 | 103.83 | 38.0147 | 108.425 |
| Storey 12 | 33.393 | 98.142 | 37.245 | 102.125 |
| Storey 11 | 31.609 | 91.382 | 35.247 | 98.452 |
| Storey 10 | 29.348 | 83.511 | 34.784 | 90.784 |
| Storey 9 | 26.626 | 74.595 | 32.745 | 80.451 |
| Storey 8 | 23.501 | 64.794 | 26.451 | 77.245 |
| Storey 7 | 20.059 | 54.358 | 22.178 | 62.245 |
| Storey 6 | 16.414 | 43.619 | 18.981 | 48.365 |
| Storey 5 | 12.701 | 32.986 | 15.754 | 36.245 |
| Storey 4 | 9.077 | 22.941 | 12.451 | 26.354 |
| Storey 3 | 5.733 | 14.022 | 7.412 | 20.128 |
| Storey 2 | 2.9 | 6.817 | 4.125 | 11.274 |
| Storey 1 | 0.867 | 1.939 | 2.125 | 5.241 |
| Base | 0 | 0 | 0 | 0 |



IV. CONCLUSION

In the present study of the R.C framed building and flat slab building for G+9, G+19, G+29 was modeled and analyzed for without p-delta effect(linear static analysis) and with p-delta effect(non linear analysis) by Etabs. The structure was analyzed for seismic zone V for soft soil type.

The results obtained from various analyses are comparing and concluded as below:

Maximum displacement occurs in flat slab building as compare with normal slab building and when applied p-delta (second order effect) on building than displacement is increases approx more than 10% as compare with linear statics analysis. And storey drift is maximum at mid storey height and overturning moment is also increases when p-delta effect applied on building. After analysis base shear is increase as the number of storey increases.

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