# Study of behaviour of wind evaluation of multi-storey building with and without floating columns structures in STAAD- PRO

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***Abstract-*** *Over the past few years, the structure has experienced effects from these gusts in both directions. These designs aim to enhance the visual perspective of the projects they undertake. The variability in floor height causes a discontinuity in the stiffness of the structure at the level of the soft story. This phenomenon is caused by floor height fluctuations. In the even If winds expose this discontinuity, it could potentially cause buildings to This study aimed to perform a static analysis of three-dimensional building frames, which included G+7 storeys, floating columns, and soft storey elements. elements. The other sixty-four examples feature floating columns at a single level, with the soft storey varying directly from the ground (G) story to the G+7 storey. Eight of the instances include Centre floating columns on any one of the storeys, while sixty-four of the other cases have floating columns at a certain level. This instance considers a total of seventy-three instances. Furthermore, we construct a simple example where neither the storeys nor any of the column's float, adhering to the previously stated conditions. In addition to the previously stated conditions, we construct a simple example where neither the floors nor any of the columns float. We have adjusted the floor heights to achieve the desired appearance. We conducted the analysis using the maximum node displacements (resultant), maximum moments, maximum shear force, maximum axial force, and maximum storey drift. It is necessary to do an analysis of the findings in order to arrive at technical conclusions.*

## I. INTRODUCTION

The most fundamental factor that differentiates the design of high-rise structures from low- to medium-rise buildings is the potential lateral loading from wind or earthquakes. However, this is not the only factor that causes these differences. This situation arises due to the transfer of lateral loads by wind and earthquakes. To be more specific, this is because high-rise structures are built to withstand higher heights than other types of buildings. Wind loads have a minimal influence on the design of buildings that are up to about ten stories tall and have proportions that are typical of the structure. There are certain exceptions to this rule. However, when elevating the building to a height exceeding this limit, the structural sections' size will increase, necessitating structural reorganization to withstand wind loads.

**BUILDING FRAMES**:

A mix of beams, columns, and slabs construct a frame structure to withstand the forces of gravity and lateral acceleration. We refer to this type of construction as a frame structure. Most of the time, we use these structures to maintain resistance against the massive moments created by the tension.

**RIGID FRAME STRUCTURE**

The term "rigid" refers to the ability to withstand deformation with ease. We refer to these constructions as rigid frame structures because they feature monolithic beams and columns that collaborate to withstand the moments generated by the applied load. We refer to these structures as rigid frame structures.

**BRACED FRAME STRUCTURE**

In this frame construction, the gaps between the beams and columns often serve as bracing. We take this action to fortify the beams and columns against the lateral forces and side sway forces generated by the applied load, thereby bolstering the building's structural integrity. This action strengthens the structure. It is common practice to place the diagonal pieces in the space between the beams and the columns to ensure effective bracing.

**FLOATING COLUMNS**

The load transmission channel is interrupted in buildings that feature columns that hang or float on beams at an intermediate level and do not run all the way to the foundation. These kinds of buildings are referred to as multistory buildings. The reason behind this is that the beams are unable to reach the base during construction. According to the field of architecture, these kinds of constructions are referred to as "discontinuities." Due to the fact that this is the case, the weight is transferred to the columns that are located underneath the beams.

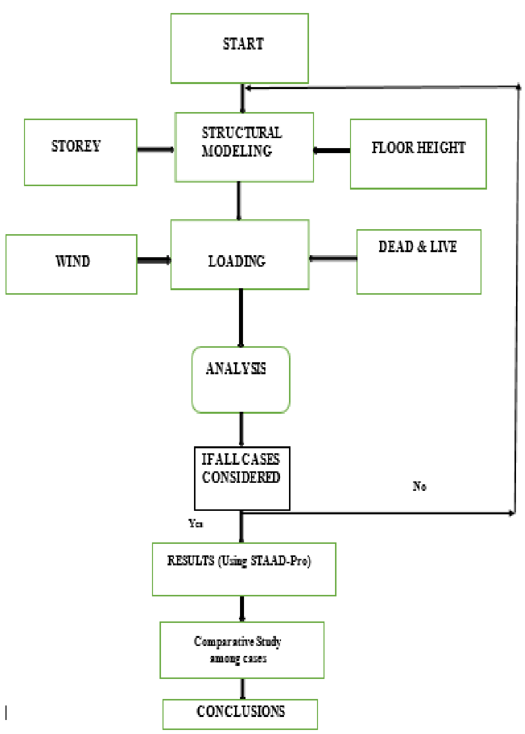
## II. OBJECTIVE OF STUDY

The main objective of this work is to analyze the building frames with floating columns and soft storeys under wind loads. The structures, under which conditions are relatively more secure, is to be determined. The building frames are analyzed using software STAAD.Pro.

Following are the considerations on basis of which we will analyze the results-

1. Maximum node displacements,
2. Maximum moments,
3. Maximum shear force,
4. Maximum axial force,
5. Maximum storey drift.

**FLOW CHART OF METHODOLOGY**




## III. STRUCTURALANALYSIS

**IMPLEMENTATIONWORK**

For analysis of building frames with floating columns and soft storeys under wind loads, we have made use of software called STAAD.Pro. Details about the above mentioned software are discussed in following sections.

Bentley System Inc., the firm responsible for its creation, created the software application known as STAAD.Pro for structural analysis and design. Mr. Keith A. Bentley and his brother, Mr. Barry J. Bentley, founded the business that would eventually be known as The Bentley System Inc. in 1984. Together, they named the corporation after themselves. The version of STAAD.Pro that is currently available is version 8i. This software is highly anticipated in the field of structural analysis and design. This document specifically includes requirements for concrete design and steel design activities. It can be used to perform a wide range of studies, including static analysis, P-delta analysis, buckling analysis, and other types of analyses. These are only some of the types of analyses that exist.

1. Standard MS windows functionality with state of art graphical environment.
2. Full range of analysis such as Push-over analysis, P-Delta analysis, Seismic analysis, stress analysis, steel design, timber design, buckling analysis, concrete design.
3. Model generation is through Object-oriented 2D/3D patterns in graphical style.
4. It supports curvilinear beams, frame members, plate elements, solids, non- linear cables.
5. Automatic load generation facility is also available for wind, hydrostatic, seismic, rolling loads etc.
6. It also displays loads, support conditions, joints, member's properties etc.

**Model Creation**: The simple geometry of the structure using members is generated. Plates, solids, beams etc. can be the type of member.

- Sectional Properties: Defining the member sizes.
- Material Properties: Specification of materials such as concrete or steel to define Poisson's ratio, Young's Modulus of Elasticity, Density of material etc.
- Member specification: Defining member specification, offsets, releases etc.
- Supports: Defining the location of support and various boundary conditions.

- Loads such as self-weight of structure, dead, live, impact, wind, seismic loads as well as load combinations.
- Analysis type must be defined with help of associated options.
- Post processing command option helps in review and extraction of results.
- Design can be done by suitable codes for concrete or steel design etc.

Versions of STAAD Pro

- An older version called STAAD-III for windows.
- Latest version: STAAD.ProV8i (SELECT Series 6).

As per the methodology discussed in previous chapter, a total of 73 cases of building frames are analyzed subjected to wind loads. The final process of the structural analysis is the post- processing of the cooling tower analysis.

## IV. RESULTS WITH DISCUSSION

The following sections offer a discussion of the structural analysis results in relation to the categories mentioned earlier in the paragraph.

a)Group-1

In this situation, the structure does not have floating columnsor soft floors. This is the standard scenario. This structure stands at a height of twenty-four metres. Table 2's information highlights the axial force as the characteristic with the largest quantity.

| Max. Node disp. (Res.) (mm.) | Max. B.M. Mz (kNm) | Max. Axial Force Fx (kN) | Max. S.F. Fy (kN) |
|---|---|---|---|
| 17.299 | 51.537 | 883.648 | 44.372 |

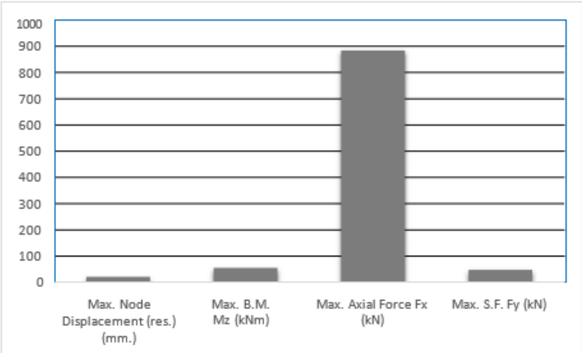



Figure. 5.1: Various analysis parameters in Group 1

b)Group- 2

We refer to these buildings as "floating columns." A typical building's height is at least 24 meters. At ground level, where the central floating columns are, the largest nodal displacement, maximum bending moment, maximum shear force, and maximum axial force all happen (Table 3). This is because the ground grade is the lowest point in the structure.

| Floating column at | Max. Node disp. (Res.) (mm.) | Max. B.M.: Mz (kNm) | Max. Axial Force: Fx (kN) | Max. S.F.: Fy (kN) |
|---|---|---|---|---|
| G | 19.363 | 130.945 | 1192.881 | 108.099 |
| G+1 | 19.125 | 54.291 | 112.327 | 62.307 |
| G+2 | 18.956 | 47.416 | 103.829 | 57.816 |
| G+3 | 18.724 | 41.432 | 96.377 | 53.958 |
| G+4 | 18.383 | 36.191 | 90.899 | 50.627 |
| G+5 | 17.985 | 35.210 | 87.784 | 47.606 |
| G+6 | 17.694 | 35.111 | 86.029 | 44.683 |
| G+7 | 17.429 | 35.112 | 85.400 | 30.325 |

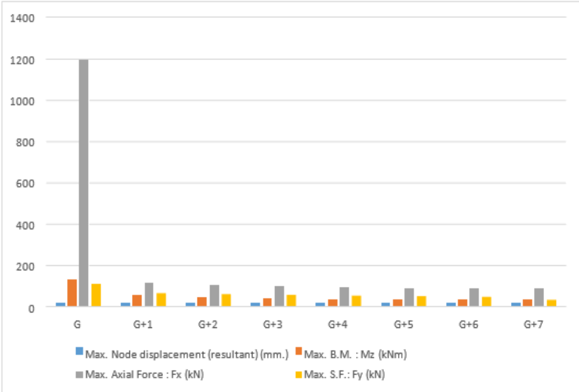



Figure 5.2: Values of analysis parameters in Group 2

Group-3

These structures feature floating columns on a specific level, with the soft floor extending from the ground floor all the way up to G+7. Each of the structures stands at a height of 25 metres

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**Table-1**Values of analysis parameters for Group 3: CASE 1-8:when the columns are at ground(G)storeyandsoftstoreybeingvariedfromGtoG+7.

| Soft Storey at | Max. Node disp. (Res.) (mm.) | Max. B.M.: Mz (kNm) | Max. Axial Force: Fx (kN) | Max. S.F.: Fy (kN) |
|---|---|---|---|---|
| G | 22.844 | 127.811 | 1179.706 | 106.459 |
| G+1 | 20.559 | 60.112 | 697.324 | 55.255 |
| G+2 | 22.483 | 82.236 | 695.789 | 69.182 |
| G+3 | 22.449 | 81.440 | 697.94 | 68.646 |
| G+4 | 23.365 | 81.02 | 699.166 | 68.351 |
| G+5 | 22.899 | 80.764 | 699.858 | 68.173 |
| G+6 | 22.331 | 80.613 | 700.205 | 68.067 |
| G+7 | 21.882 | 80.610 | 700.840 | 68.066 |

Group 3 achieves the maximum node displacement when the soft storey reaches G+4, as indicated by the CASE 1-8 notation in Table 4. When it comes to the soft storey, which is the ground level, the maximum axial force, maximum axial moment, and maximum axial force are all at their highest points (Table 4).

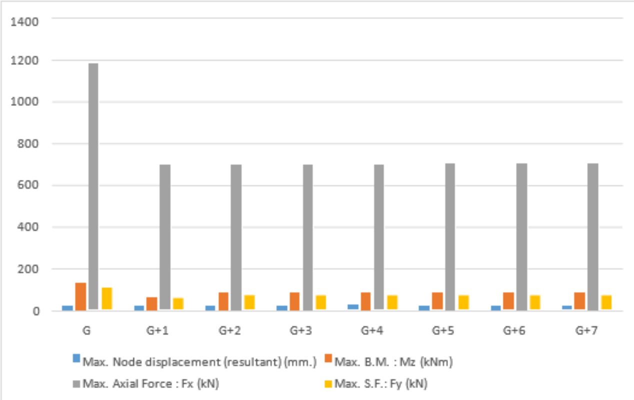



Figure. 5.3: Values of analysis parameters in Group 3: CASE 1-8

**Table-2** Values of analysis parameters for Group 3: CASE 9-16: when the floating columns are at G+1 storey and soft storey being varied from G to G+7.

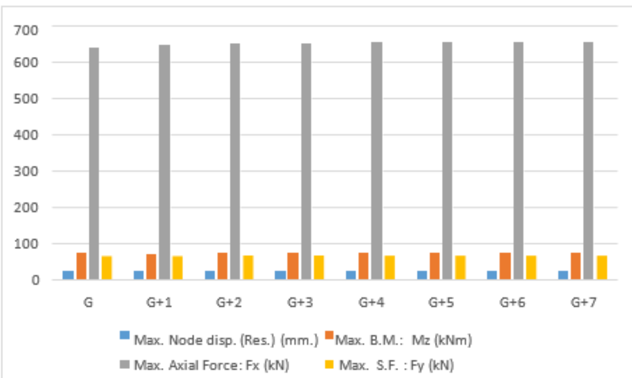



Figure. 5.4: Values of analysis parameters in Group 3: CASE 9-16

**Table-3**Values of analysis parameters for Group 3: CASE 17-24: when the floating columns are at G+2 storey and soft storey being varied from G to G+7

| Soft Storey at | Max. Node disp. (Res.) (mm.) | Max. B.M.: Mz (kNm) | Max. Axial Force: Fx (kN) | Max. S.F.: Fy (kN) |
|---|---|---|---|---|
| G | 21.861 | 64.772 | 598.082 | 57.505 |
| G+1 | 22.325 | 64.716 | 604.271 | 57.487 |
| G+2 | 22.970 | 64.406 | 608.360 | 57.143 |
| G+3 | 22.461 | 66.390 | 611.699 | 58.863 |
| G+4 | 23.339 | 66.706 | 612.967 | 58.799 |
| G+5 | 22.864 | 66.084 | 613.792 | 58.381 |
| G+6 | 22.299 | 65.763 | 614.203 | 58.156 |
| G+7 | 21.850 | 65.705 | 614.844 | 58.117 |

Regarding Group 3, the following scenarios are applicable: When the soft layer is at G+4, it is possible to gain the maximum node displacement amount. The Max.B.M. assigns a G+4 rating to the soft tale level. To produce the highest possible axial force, one must reach the G+7 soft-story level. There is a maximum square footage achievable at the G+3 soft story level.

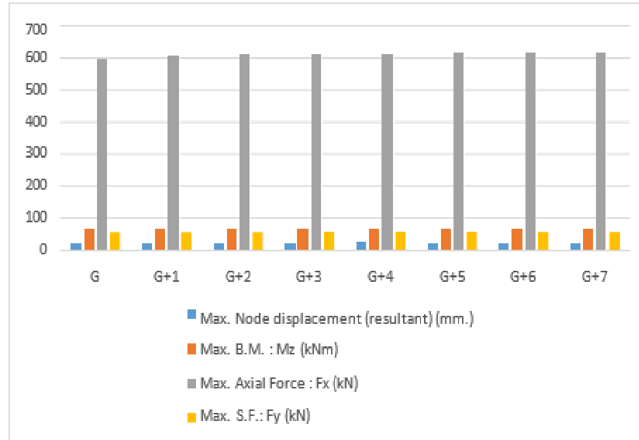



Figure. 5.5: Values of analysis parameters in Group 3: CASE 17-24

**Table-4**ValuesofanalysisparametersforGroup3:CASE25-32:columnsareat G+3 storey and soft storey being varied from G to G+7

| Soft Storey at | Max. Node disp. (Res.) (mm.) | Max. B.M.: Mz (kNm) | Max. Axial Force: Fx (kN) | Max. S.F.: Fy (kN) |
|---|---|---|---|---|
| G | 21.850 | 65.705 | 614.844 | 58.117 |
| G+1 | 21.608 | 53.319 | 564.618 | 53.730 |
| G+2 | 22.050 | 59.356 | 569.919 | 53.755 |
| G+3 | 22.095 | 59.779 | 573.230 | 53.719 |
| G+4 | 22.711 | 60.075 | 575.847 | 53.397 |
| G+5 | 22.607 | 61.135 | 578.861 | 54.761 |
| G+6 | 23.103 | 61.761 | 578.117 | 54.788 |
| G+7 | 22.037 | 60.457 | 579.335 | 54.402 |

In the case 25–32 investigation, the third group has achieved the maximum nodal displacement when the soft storey is at G+6. At the point when the soft storey is at ground level, we are able to ascertain the maximum axial force, maximum shear force, and maximum bending moment.

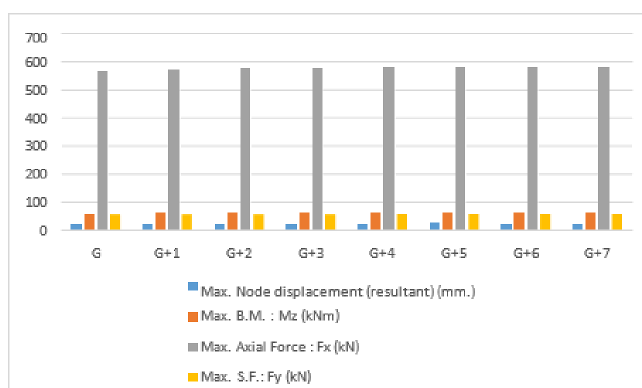



Figure. 5.6: Values of analysis parameters in Group 3: CASE 25-32

**Table-5** Values of analysis parameters for Group 3: CASE 33-40: when the floating columns are at G+4 storey and soft storey being varied from G to G+7.

| Soft Storey at | Max. Node disp. (Res.) (mm.) | Max. B.M.: Mz (kNm) | Max. Axial Force: Fx (kN) | Max. S.F.: Fy (kN) |
|---|---|---|---|---|
| G | 21.254 | 54.665 | 538.818 | 50.458 |
| G+1 | 21.695 | 54.692 | 543.615 | 50.476 |
| G+2 | 21.719 | 54.707 | 546.320 | 50.487 |
| G+3 | 21.724 | 57.414 | 548.429 | 50.450 |
| G+4 | 23.149 | 60.221 | 550.019 | 50.161 |
| G+5 | 22.248 | 55.490 | 551.579 | 51.258 |
| G+6 | 21.661 | 55.841 | 551.956 | 51.252 |
| G+7 | 21.212 | 55.620 | 552.614 | 51.113 |

When the soft storey is at G+4, the third group, CASE 33–40, reaches its maximum nodal displacement and its maximum basal mass. This is in accordance with the previous statement. Table 8 illustrates that the soft layer creates the highest axial force when it reaches the G+7 level. Conversely, the soft floor at the G+5 story level produces the maximum shear force.

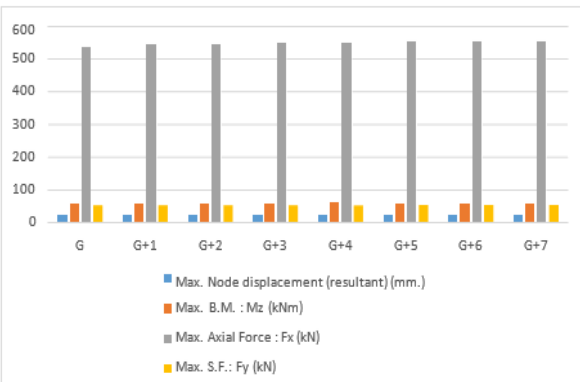



Figure. 5.7: Values of analysis parameters in Group 3: CASE 33-40

**Table-6** ValuesofanalysisparametersforGroup3:CASE41-48:whenthefloating columns are at G+5 storey and soft storey being varied from G to G+7.

| Soft Storey at | Max. Node disp. (Res.) (mm.) | Max. B.M.: Mz(kNm) | Max. Axial Force: Fx(kN) | Max. S.F.: Fy(kN) |
|---|---|---|---|---|
| G | 20.849 | 50.456 | 519.877 | 47.476 |
| G+1 | 21.289 | 53.065 | 524.323 | 47.492 |
| G+2 | 21.312 | 53.830 | 526.752 | 47.499 |
| G+3 | 21.299 | 53.686 | 528.442 | 47.504 |
| G+4 | 22.144 | 54.126 | 529.737 | 47.474 |
| G+5 | 22.116 | 50.789 | 530.664 | 47.230 |
| G+6 | 21.138 | 50.995 | 531.713 | 48.065 |
| G+7 | 20.779 | 51.624 | 532.239 | 48.280 |

Group3acquiresfourvalues:themaximumnodaldisplacement,themaximumaxialforce,themaximumaxialforce,andthemaximumaxialforce.WhenthesoftstoreyisatG+4,G+4,G+7, and G+7 in the appropriate order, use the CASE 41-48 formula

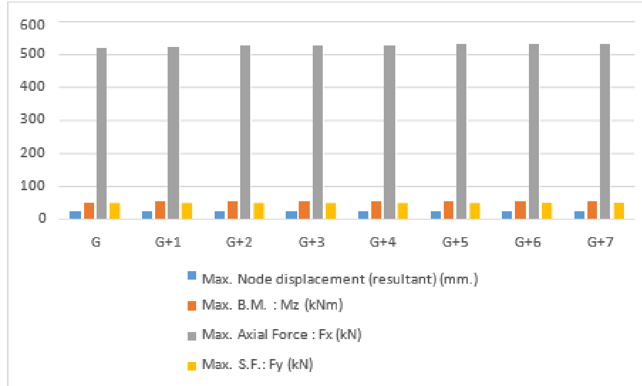



Figure. 5.8: Values of analysis parameters in Group 3: CASE 41-48

**Table-7**Values of analysis parameters for Group 3: CASE 49-56: when the floating columns are at G+6 storey and soft storey being varied from G to G+7

| Soft Storey at | Max. Node disp. (Res.) (mm.) | Max. B.M.: Mz (kNm) | Max. Axial Force: Fx (kN) | Max. S.F.: Fy (kN) |
|---|---|---|---|---|
| G | 20.549 | 52.401 | 585.029 | 50.565 |
| G+1 | 20.990 | 53.175 | 510.583 | 44.594 |
| G+2 | 21.012 | 54.364 | 512.836 | 44.601 |
| G+3 | 20.998 | 54.110 | 514.376 | 44.604 |
| G+4 | 21.802 | 54.405 | 515.375 | 44.607 |
| G+5 | 21.347 | 51.423 | 516.165 | 44.587 |
| G+6 | 21.102 | 51.175 | 516.616 | 44.431 |
| G+7 | 20.460 | 51.179 | 517.676 | 45.493 |

Themaximumnodaldisplacementandthemaximumaxialforcebothoccurwhenthesoftstoreyreaches G+4ingroup3(cases49–56).Additionally,thesoftstoreyachievesthemaximumaxial forcewhenitreachesthegroundsoftstorey(Table10).Thisistruewhenthesoftsurfaceison the ground.

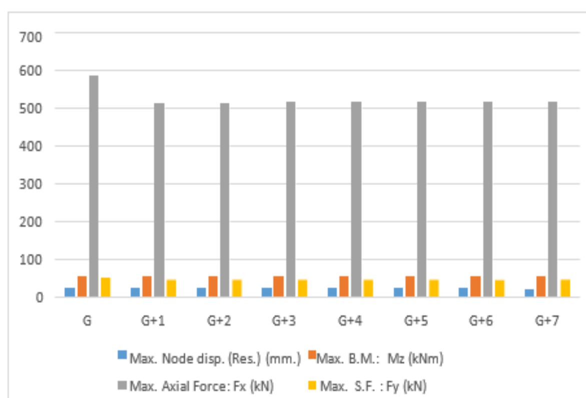



Figure.5.9: Values of analysis parameters in Group 3: CASE 49-56 |

**Table-8** Values of analysis parameters for Group 3: CASE 57-64: when the floating columns are at G+7 storey and soft storey being varied from G to G+7

| Soft Storey at | Max. Node disp. (Res.) (mm.) | Max. B.M.: Mz (kNm) | Max. Axial Force: Fx (kN) | Max. S.F.: Fy (kN) |
|---|---|---|---|---|
| G | 20.275 | 49.780 | 511.945 | 38.886 |
| G+1 | 20.714 | 53.218 | 515.120 | 40.098 |
| G+2 | 20.737 | 54.499 | 516.997 | 41.355 |
| G+3 | 20.723 | 54.217 | 518.343 | 41.032 |
| G+4 | 21.527 | 54.788 | 519.237 | 41.872 |
| G+5 | 21.066 | 51.522 | 519.769 | 40.172 |
| G+6 | 20.516 | 51.308 | 520.281 | 40.062 |
| G+7 | 20.262 | 51.303 | 519.666 | 40.038 |

When it reaches G+4, the soft layer achieves both the maximum nodal displacement and the maximumbasalmass.ThisisthesituationinGroup3:Cases57–64. However,theG+6 soft-storey level achieves the greatest axial force, while the G+4 level produces the maximum one-strength force (Table 11). Both of these forces are represented in the table.

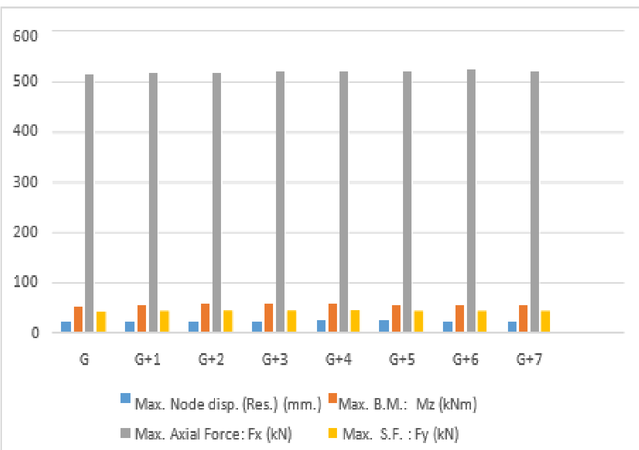


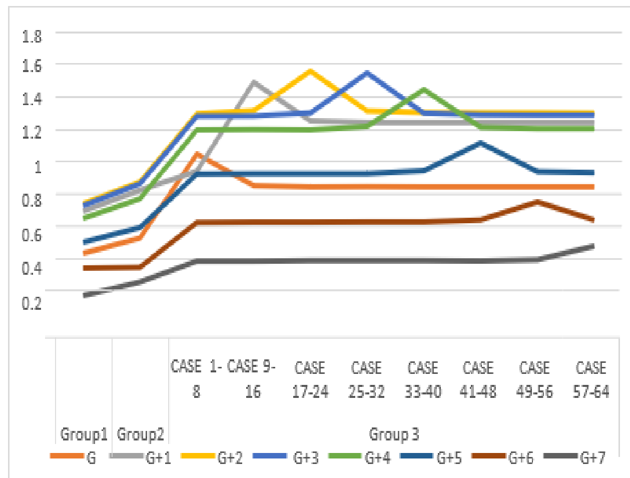
Figure.5.10: Values of analysis parameters in Group 3: CASE 57-64

**MAXIMUMSTOREYDRIFT**

One of the most significant considerations to take into account when it comes to constructions that are vulnerable to wind loads is drift. As a result, Table 12 displays values derived from instances within a specific group. We consider these values to be the highest among all values on a specific storey level, yet they remain distinct from the other values.

| Storey | Group1 | Group2 | Group 3 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | CASE 1-8 | CASE 9-16 | CASE 17-24 | CASE 25-32 | CASE 33-40 | CASE 41-48 | CASE 49-56 | CASE 57-64 |
| G | 0.436 | 0.529 | 1.049 | 0.853 | 0.846 | 0.847 | 0.846 | 0.846 | 0.846 | 0.846 |
| G+1 | 0.693 | 0.821 | 0.940 | 1.490 | 1.250 | 1.241 | 1.241 | 1.240 | 1.240 | 1.240 |
| G+2 | 0.739 | 0.874 | 1.297 | 1.316 | 1.562 | 1.315 | 1.305 | 1.303 | 1.303 | 1.302 |
| G+3 | 0.728 | 0.864 | 1.283 | 1.285 | 1.303 | 1.552 | 1.302 | 1.292 | 1.290 | 1.290 |
| G+4 | 0.647 | 0.768 | 1.195 | 1.196 | 1.195 | 1.216 | 1.445 | 1.211 | 1.202 | 1.202 |
| G+5 | 0.502 | 0.592 | 0.923 | 0.924 | 0.925 | 0.925 | 0.943 | 1.113 | 0.936 | 0.931 |
| G+6 | 0.342 | 0.347 | 0.621 | 0.623 | 0.623 | 0.625 | 0.625 | 0.638 | 0.748 | 0.636 |
| G+7 | 0.177 | 0.260 | 0.386 | 0.387 | 0.389 | 0.389 | 0.389 | 0.388 | 0.395 | 0.476 |

InGroup1andGroup2,Max.StoreyDriftisatG+2storey.InGroup3:CASE1-8,9-16,17- 24,25-32, 33-40, 41-48,49-56 and 57-64, Max.Storey DriftisatG+2,G+1,G+2, G+3,G+4,G+2 andG+2 respectively.

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## V. CONCLUSION

Following notable conclusions can be drawn from the results given above:

1) When we insert floating columns at ground floor level under the presented loading circumstances, the maximum bending moment increases by 2.54 times. This occurs immediately afterthe introduction of floating columns. For comparison, consider a typical building that experiences the same loads but lacks floating columns.

2) When floating columns are present at the highest level of a building that contains non-soft floors, the structures produce the greatest nodal displacement. This is because floating columns give Bthe building a more rigid appearance. The floating columns are the ones responsible for the most nodal displacement, which explains why this is the case.
3) Additionally, when the wind pressure is measured, there are slight variations in the value of the design wind pressure up to a height range of about 15 metres. This is the case.
4) It is possible to see a general decline in the size of the maximum shear force across all of the different occurrences. Consider the fact that the numbers in Cases 1–8 are much higher when compared to the values in Cases 9–16 of Group 3, for example.
5) Group 3: Cases 1–8 show a lower value of the maximum axial force when both the central floating columns and the soft storey are at ground level. This is true when both of these elements are present. We've drawn our attention to this situation. In Group 2, the only floating columns at ground level are those in the middle. In comparison to Group 1, this is a substantial difference.
6) The bulk of the cases that match the G+4 narrative level in Group 3 are the ones that achieve the greatest nodal displacement. This is accurate for the vast majority of situations.
7) The relocation of the central floating columns to higher levels, up to the G+6 levels, has resulted in the relocation of the maximum shear force in Group 3 to higher floors. The relocation of the columns prompted this decision.
8) We can conclude that wind loads have the greatest potential to cause storey drift based on the assumption that floating columns and soft storey are both located at the G+2 storey level.
9) Wind loads exert an influence, leading to a concentration of larger drift values up to the G+4 story level. This is due to the impact that wind loads have on the structure.

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