International Journal of Engineering Innovations in Advanced Technology
ISSN: 2582-1431 (Online), Volume-7 Issue-1, March 2025

# Study of Behavior of Wind Evaluation of Multi-storey Building with Floating Columns

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***Abstract:*** **Tall buildings often face space constraints due to the current surge in urbanization. The structure can be affected by wind gusts in both directions. These gusts have the potential to impact the structure from both directions. 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.**

***Keyword:*** **Three-dimensional building frames, Floating columns, Maximum node displacements (Resultant), Maximum moments, Maximum shear force, Maximum axial force, and Maximum storey drift**

## 1. INTRODUCTIONS

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. This is because the structural sections will expand from their original size. Towering building structures are more likely to deflect and wobble in response to wind loads. This is because tall buildings are more efficient and lighter than other buildings. Because of this increased possibility, wind loads are more likely to occur. In this specific case, the lower weight and increased efficiency contribute to this outcome. This incentivized research, leading to notable breakthroughs in comprehending the nature of wind loading and devising methods for its estimation. These findings have led to significant progress in their respective fields. This acted as a catalyst, enabling the research project to commence. Experimental and theoretical approaches have made most of these advancements in predicting the gust-induced increase in wind loading and the dynamic interaction of structure with gust forces. These methods have accounted for the majority of these achievements. Most of the breakthroughs have come from the field of wind engineering. The most recent years have seen the creation and implementation of most of these inventions.

It is often expected that the load will be transferred to the ground by way of a column, which is a vertical component that begins at the level of the foundation. The term "floating column" refers to a vertical component that is supported by a beam, which is a component that is oriented horizontally relative to the vertical component. The lowest level of the vertical element is where you will find this beam. 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 multi-story 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.

Figure. 1: A building with Floating columns at first storey

### 1.1 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.

## 2. METHODOLOGY

Following are the group's classification with detail:

- Group 1: In this group only a normal case of G+7 storey has been analysed. Normal case in which neither floating columns are present nor any soft storey is present. Height of buildings is 24 m.
- Group 2: In this group**,** buildings in which only a particular storey level has floating columns. No soft storey at any level in any case of this group. Height of buildings is 24 m.
  CASE 1: When floating columns are at G Storey. CASE 2: When floating columns are at G+1 Storey. CASE 3: When floating columns are at G+2 Storey.
  CASE 4: When floating columns are at G+3 Storey.CASE 5: When floating columns are at G+4 Storey. CASE 6: When floating columns are at G+5 Storey.CASE 7: When floating columns are at G+6 Storey.CASE 8: When floating columns are at G+7 Storey.
- Group 3: In this group, buildings in which a particular storey has floating columns with soft storey being varied from ground storey to G+7 storey level. Height of buildings is 25 m.
  CASE 1-8: In all these cases ground (G) storey has floating columns withSoft storey being varied from G to G+7.
  CASE 9-16: In all these cases G+1 storey has floating columns with Softstorey being varied from G to G+7.
  CASE 17-24: In all these cases G+2 storey has floating columns with Soft storey being varied from G to G+7.
  CASE 25-32: In all these cases G+3 storey has floating columns with Soft storey being varied from G to G+7.
  CASE 33-40: In all these cases G+4 storey has floating columns with Soft storey being varied from G to G+7.
  CASE 41-48: In all these cases G+5 storey has floating columns with Soft storey being varied from G to G+7.
  CASE 49-56: In all these cases G+6 storey has floating columns with Soft

storey being varied from G to G+7.

CASE 57-64: In all these cases G+7 storey has floating columns with Soft storey being varied from G to G+7.

Hence in whole analysis total cases (All Groups): 73 (including one normal caseof Group 1)

### 2.1 Material and Geometrical properties

Following material properties have been considered in modelling:

Specific weight of RCC: 25 kN/m$^3$

Size of Columns (Const.) = 550×250 mm.

Size of beams (Const.) = 450×250 mm.

As per IS: 875 (Part III): 1987

The code considers the following factors for all conditions, regardless of a person's group membership, in order to compute the design wind speed and design wind pressure. Calculating these values yields the design wind speed and design wind pressure K2 = to be determined as per height and Table 2 of Wind Code. Also it is When the height is at or above 10 metres, it is considered significant for Group 3. On the other hand, we have proven that the height for regular geometry instances belonging to groups 1 and 2 must be at least 12 meters. It is critical to keep in mind that the code's value also begins at ten meters. In both groups 1 and 2, we assume that wind is not particularly significant for floors up to G+2, excluding the elements. This provides the reasoning behind the assumption.

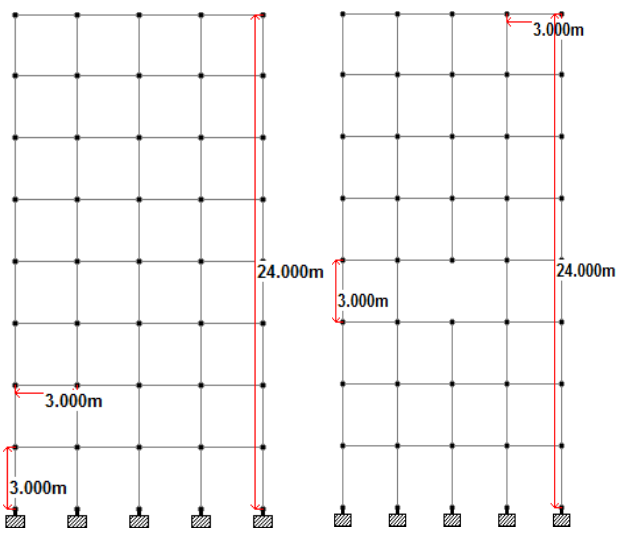


Figure 2: Group 1,2,3 Building Modelling

## 3. RESULT AND DISCUSSIONS

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 columns or soft floors. This is the standard scenario. This structure stands at a height of twenty-four meters. Table 1's information highlights the axial force as the characteristic with the largest quantity.

Table 1: Values of analysis parameters for Group 1

| 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 |

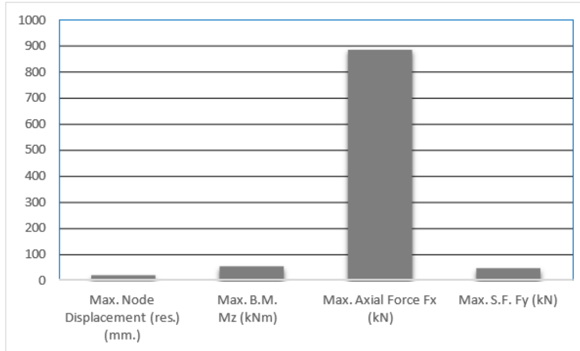


Figure 3: Various analysis parameters in Group 1

### (b). Group 2

In certain structures, floating columns are only present on a particular storey level, and there are no soft-storeys on any of the levels. 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 2). This is because the ground grade is the lowest point in the structure.

Table 2: Values of analysis parameters for Group 2

| 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 |

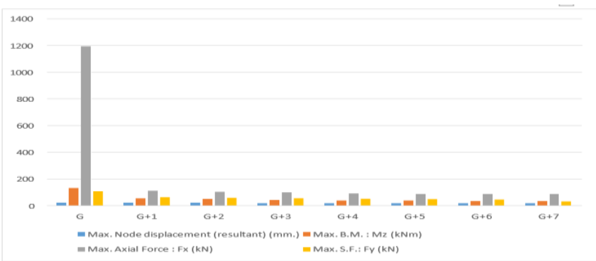


Figure 4: Values of analysis parameters in Group 2

### (c). 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

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

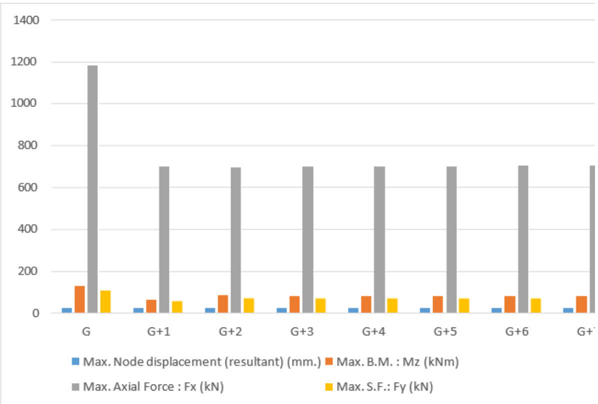


Figure. 5: Values of analysis parameters in Group 3: CASE 1-8

### (d) MAXIMUM STOREY DRIFT

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 4 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.

Table 4: Max. Storey Drift (mm.)

| 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 |

In Group 1 and Group 2, Max. Storey Drift is at G+2 storey. In Group 3: CASE 1-8, 9-16, 17-24,25-32, 33-40, 41-48 ,49-56 and 57-64, Max. Storey Drift is at G+2,G+1, G+2, G+3, G+4,G+2 and G+2 respectively.

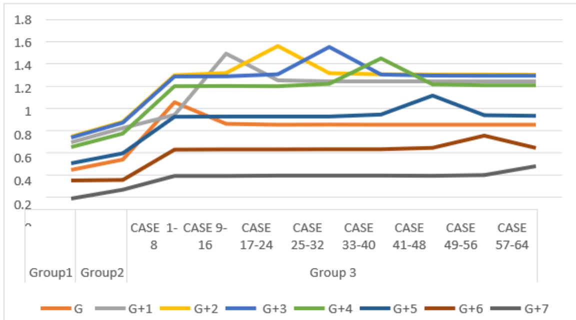


Figure 6: Values of Max. Drifts (mm.) for all groups

## 4. CONCLUSIONS

- 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 after the introduction of floating columns. For comparison, consider a typical building that experiences the same loads but lacks floating columns.
- 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 the building a more rigid appearance. The floating columns are the ones responsible for the most nodal displacement, which explains why this is the case.

- 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.
- 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.
- 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.
- 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.
- 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.
- 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.
- 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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