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# Seismic Analysis Vs Wind Analysis of Steel Frame Structure using Staad.Pro

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*Abstract*— Present investigational study reflects the comparison between seismic analysis and wind analysis of 8 story and 12 story building of steel material. The analysis and design of these buildings were done in staad.pro software in order to get the final outcome of the study. The buildings were evaluated in terms of axial force, bending moment, displacement of column. Total quantity and cost of these buildings were also calculated. For 8 story building, type A building produces more displacement (13.233 mm) in column than Type B (9.196 mm). But for 12 Story building, Type D produces more displacement (21.163 mm) than Type C building (21.288 mm). Although the variation in both the displacement is very slight.

***Keywords:*** Dynamic Seismic Analysis, Wind Analysis, Staad.Pro

## I. Introduction

Steel frame structures are often used in the following type of building:

- High rise buildings: Steel is used in high rise towers and buildings because of its high strength, light weight sections and it consumes minimal time for construction.
- Industrial building: Steel is used for Industrial buildings as it has the ability to create very large spaced frames at very reasonable rates.
- Warehouse buildings: Steel is used as intermediate floors are easily constructed in Steel Structures.
- Residential buildings: Main reason of using steel in residential building is that its dead weight is very less when compared to RCC material.
- Temporary structures: Steel is used for temporary buildings as it is easy to construct and it takes minimal time to dismantle it.

Seismic loads and wind loads are the lateral loads from which at least one must be consider while designing (load with maximum magnitude). The magnitude of seismic loads is maximum at ground level and decreases as the height increase, whereas, the magnitude of wind loads is maximum at roof level of the building and decreases as the height decreases.

When earthquake forces hit the building from soil then they push the soil and foundation away in the force direction. But the topmost portion of the building try to remain at its original place due to which cracks develop at the joints and failure occurs.

Unlike earthquake forces, wind forces hit the building from top, therefore, the topmost portion starts to sway away from its position and bottom portion (as fixed by foundation and soil) will try to resist the forces due to which structure may fail.

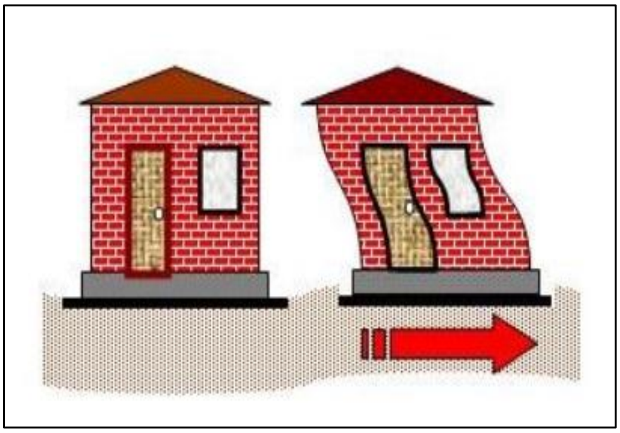

Fig. 1: Effect of shaking of ground on building.

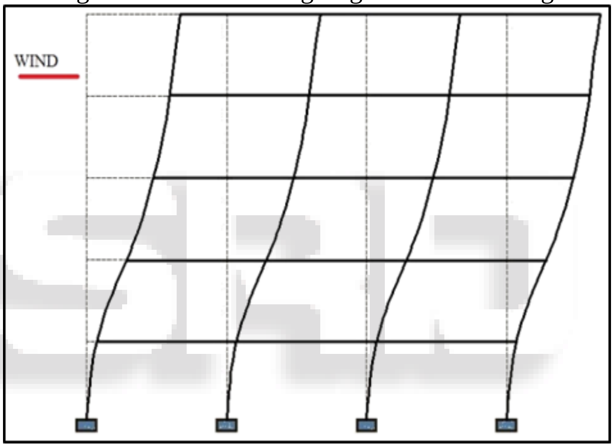


Fig. 2: Effect of Wind on building.

## II. Modelling

First step of the present work is to prepare various steel frame structures. For this purpose, bentley’s Staad.Pro software was used and different analysis and design parameters were taken as per their respective codes. Different storey buildings were modeled as mentioned below:

First step of the present work is to prepare various steel frame structures. For this purpose, bentley’s Staad.Pro software was used and different analysis and design parameters were taken as per their respective codes. Different storey buildings were modeled as mentioned below:

- 8 story building with seismic and wind loads (Type A and Type B).
- 12 story building with seismic and wind loads (Type C and Type D).

Other Modeling Data:

- No of Bays: 5
- panel size: 6 x 6 m
- floor height: 3.3 m

 

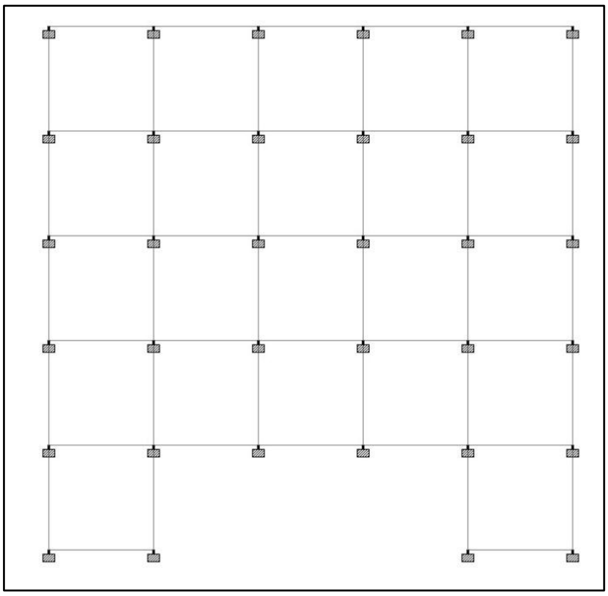

Fig. 3: Plan of the building.

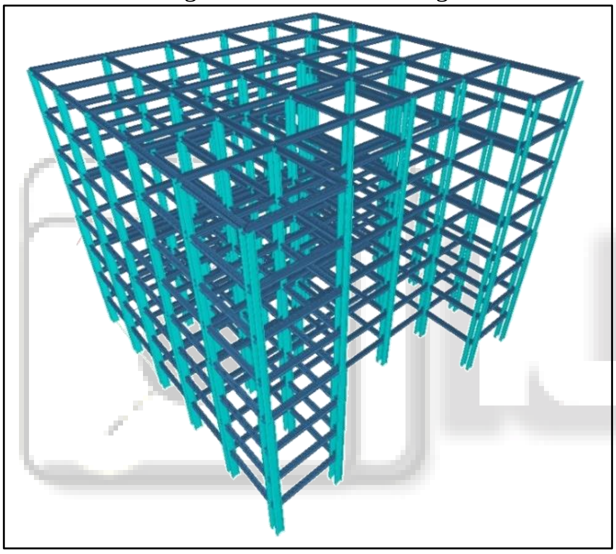

Fig. 4: Elevation of 8 Storey Building.

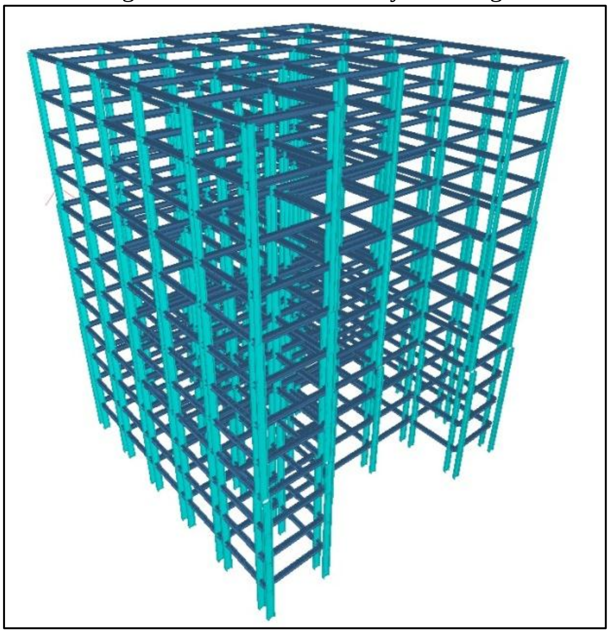

Fig. 5: Elevation of 12 Building.

| Floor | Column size | Beam size |
|---|---|---|
| 1st to 4th | 2-ISMB 600 (SP-450 mm) | ISMB 400 (2 flange plates- 300 x 10 mm) |
| 5th to 8th | 2-ISMB 400 (SP-400 mm) | ISMB 350 (2 flange plates- 300 x 10 mm) |

Table 1: Material properties for 8 story building.

| Floor | Column size | Beam size |
|---|---|---|
| 1st to 4th | 2-ISWB H 600 (SP-950 mm) | ISMB 400 (2 flange plates- 300 x 10 mm) |
| 5th to 8th | 2-ISMB 600 (SP-420 mm) | ISMB 400 (2 flange plates- 300 x 10 mm) |
| 9th to 12th | 2-ISMB 400 (SP-370 mm) | ISMB 350 (2 flange plates- 275 x 10 mm) |

Table 2: Material properties for 12 story building.

Dynamic Seismic Analysis (Response Spectrum Analysis) was performed as per new seismic code IS: 1893-2016. During the seismic analysis, different seismic parameters were taken as follows:

- Seismic Zone: IV
- Response Reduction Factor: 5
- Importance Factor: 1.2
- Damping ratio: 5
- Type of structure: Steel
- Type of soil: medium

Wind Analysis of the steel frame structure as per IS: 875 (Part 3) – 1987 and different wind factors and coefficient were chosen from the code.

## III. Results and Discussion

The present investigational study was carried out in order to compare the seismic analysis and wind analysis for the building having 8 stories and 12 stories. The various models were made in staad.pro and analyzed as per the codal provisions of Indian Standard Codes. After analyzing, the results were collected from the post-processing and output file of staad.pro software.

| Floor | Type A | Type B |
|---|---|---|
| 1 | 1500 | 1316.19 |
| 2 | 1312 | 1135.73 |
| 3 | 1109.7 | 1109.77 |
| 4 | 893.02 | 893.02 |
| 5 | 693.36 | 612.65 |
| 6 | 502.77 | 465.36 |
| 7 | 298.61 | 345.6 |
| 8 | 100.09 | 59.65 |

Table 3: Axial Force in Columns.

| Floor | Type A | Type B |
|---|---|---|
| 1 | 50.1 | 136.7 |
| 2 | 53.64 | 95.14 |
| 3 | 55.72 | 50.82 |
| 4 | 72.15 | 94.22 |
| 5 | 49.38 | 65.23 |
| 6 | 53.26 | 45.77 |
| 7 | 54.58 | 31.56 |
| 8 | 56.97 | 60.09 |

Table 4: Bending Moment in Columns.

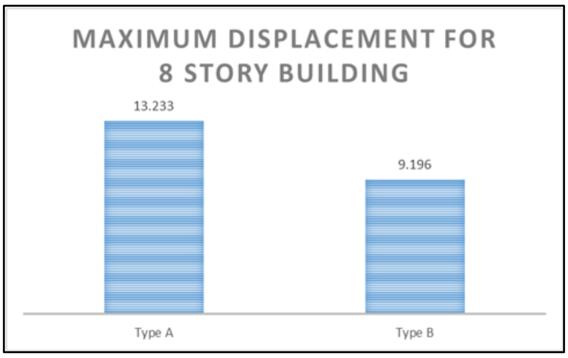


Fig. 6: Maximum displacement in Column for Type A and Type B building.

From the output file of staa.pro, total quantity was recorded. Total quantity of steel for 8 storey building in both the cases was 4292.336 Kn. Total cost of material was calculated and it comes out to be Rs. 171.7 lakhs.

| Floor | Type C | Type D |
|---|---|---|
| 1 | 2171.73 | 2190.5 |
| 2 | 1984.66 | 1998.34 |
| 3 | 2014.25 | 1796.88 |
| 4 | 1789.66 | 1653.35 |
| 5 | 1578.82 | 1566.84 |
| 6 | 1377.22 | 1265.01 |
| 7 | 1149.6 | 1098.54 |
| 8 | 931.82 | 865.45 |
| 9 | 720.33 | 799.48 |
| 10 | 522.29 | 501.05 |
| 11 | 310.91 | 389.65 |
| 12 | 105.36 | 138.95 |

Table 5: Axial Force in Columns.

| Floor | Type C | Type D |
|---|---|---|
| 1 | 176.17 | 227.60 |
| 2 | 129.51 | 145.26 |
| 3 | 56.97 | 107.008 |
| 4 | 61.52 | 94.65 |
| 5 | 61.21 | 89.74 |
| 6 | 62.44 | 62.44 |
| 7 | 67.3 | 84.51 |
| 8 | 83.64 | 98.48 |
| 9 | 55.53 | 59.15 |
| 10 | 58.67 | 48.65 |
| 11 | 61 | 60.94 |
| 12 | 65.12 | 65.12 |

Table 6: Bending Moment in Columns.

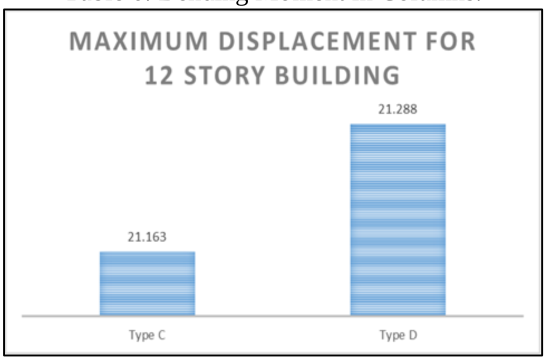


Fig. 17: Maximum displacement in Column for Type C and Type D building.

From the output file of staa.pro, total quantity was recorded. Total quantity of steel for 12 storey building in both the cases was 6921.684 Kn. Total cost of material was calculated and it comes out to be Rs. 276.9 lakhs.

## IV. Conclusion

After scrutinizing all the results of present investigational study, following inferences were made:

- When 8 story building was hit by horizontal forces such as earthquake and wind, the columns were subjected to displacement. For 8 story building, type A building produces more displacement (13.233 mm) in column than Type B (9.196 mm).
- But for 12 Story building, Type D produces more displacement (21.163 mm) than Type C building (21.288 mm). Although the variation in both the displacement is very slight.

In the gist, it can be concluded that up to 8 story building, seismic forces are dominant forces but as the building rises to 12 story wind forces becomes the dominant forces and produce more displacement values than earthquake forces.

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