# Comparison of Response of Building Against Wind Load as per Wind Codes [IS 875 – (Part 3) – 1987] and [IS 875 – (Part 3) – 2015]

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# Comparison of response of building against wind load as per wind codes [IS 875 – (Part 3) – 1987] and [IS 875 – (Part 3) – 2015]

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## Abstract

**A comparison of wind loads to make a G+11 building in staad and design the building against wind load is presented in this paper. The importance of this study is to calculate the wind load for a structure by the two different code and compare them for better analysis. In present scenario high rise structures have advantages in the populous area and to make more space to live and provide better accommodation in highly populated area around the world. To make the building cost effective and proper design should have to done for more area for living purpose and reduce the cost of structure and safety of structure should be consider in this design. In the recent times, there had been so many catastrophic damages caused by high wind speed in the coastal regions of India which prove that many buildings that are currently in use are not fully wind resistant. In this paper, we have calculated the wind load using static method by the old code [IS: 875 – (Part 3) – 1987] and as per the new code [IS: 875 – (Part 3) – 2015] for zone 4 with terrain category 3 and the building is analyzed using STAAD PRO Software.**

## I. Introduction

The wind is an important factor in the design of high-rise building. The wind is more important than the earthquake and other important loads. The terrain category is defined according to the roughness and the smoothness of the surface. The wind load is affecting many parameters like construction cost, building strength and another parameter of the building. As per the results which help in the selection of different parameter of the building. Standard codes from different countries use their different terrain categories for the calculation the wind load and they depend on the surface conditions. All the standard wind load codes have their approach to calculate the wind load. they have different formulas and conditions in their map for the calculation of the wind load. For the analysis of wind load, the terrain category 3 has taken for the different wind load and the comparative analysis. STAAD-PRO is very good software for the structure analysis and this software is using by many structural engineers now a days this software can be solved typical problem like static analysis, finite element model, wind analysis and we can also select various load combination in the design by this software to check RCC codes. For the design of beams, columns, lateral bracing and foundations wind loads on the structural frames are required. Wind load is generally taken in to account when the height of building is greater than 150m and low-rise buildings are also affected by wind load. When building is goes increasing, they become flexible and more lateral deflection occur in the building. This paper describes wind analysis of building which is located in zone IV. For the analysis of wind load a twelve-storey building is taken. In this project comparison of result from the IS:875- Part3 (2015) code and IS:875Part3 (1987) are discussed so that we can understand the applicability of wind load analysis using both codes.

## II. Review of literature

high rise structures are currently in demand because of continuously increase in population and technological enhancement as compared to past scenario. In current design practice, the lateral load resisting system of a high-rise building is considered in the design of structure. Structural components such as column, beam, shear wall is considered in the load resisting system of the high-rise building. In the lateral resisting performance of high-rise building nonstructural component are also consider in the loading. In practice building is system of structural and non-structural but the nonstructural components of the building are considered as non-load bearing component and they are not including in the design of the building.

Kawale and Joshi (2017) analyzed columns, beams, slabs by using IS code [IS: 875 – (Part 3) – 1987] and as per the new code [IS: 875 – (Part 3) – 2015). Thejaswini and Sawjanya (2018) stated the behavior of the junction tower build for the fabric handling purposes in thermal power station subjected to wind load as per IS code [IS: 875 – (Part 3) – 1987] and as per [IS: 875 – (Part 3) – 2015). Sreedharan (2016) comparative study of the seismic and wind analysis for four different structure and three different tracing system are considered for the concentrated load and analyzed. Rajesh et.al., (2016) Found that shear and lateral defection in the building at each story is more at wind load when we compare it to seismic load. higher sections are subjected to high wind so it is good to provide more reinforcement at higher sections to counter the high lateral loads. Mashalkar et al., (2017) studied the effect of wind on different shape as I, C, T and L.

# III. METHODOLOGY

RCC framed structure is a combination of beam, column, slab in which beam, column, slab and foundation are inter connected to each other. load transfer of building to soil is through foundation so the foundation must be strong. In frame structure, Load transfers from the slabs to beams, and beams to columns and finally to the foundation.
Bearing walled building is 10 to 12 percent of total framed structure. Monolithic construction is done with R.C.C framed structures. monolithic buildings can easily resist vibrations, wind loading. Load bearing walled can effectively resist earthquake.

**Assumptions in Design:**

• Using partial factor of safety for loads as 1.5 (as per clause 36.4 of IS-456-2000).
• Partial factor of safety is taken as 1.5 and 1.15 for concrete and steel respectively.
These are the load combinations, which are considered in the design of structures (as per IS 456-2000).
(i) 1.5× (Dead load+Live load)

(ii) 1.2 × (Dead laod+Live laod+Wind load)

When wind load acting in X direction, load combination is considered as 1.2(D+L+$W_{\text{in X +ve}}$) and wind load acting in Z direction load, the combination of load will be 1.2(D+L+$W_{\text{in Z+ve}}$).

Therefore, three load combination are considered in this study.

**Wind load calculation as per IS 875 part3 (1987):**

The design wind speed ($V$z) is obtained as per formula given below:

$$V_z = V_b\, k_1\, k_2\, k_3 \qquad (1)$$

where

$V_z$ = design wind speed at any height z in m/s,

$k_1$ = probability factor (risk coefficient)

$k_2$ = terrain, height and structure size factor

$k_3$ = topography factor

The design wind pressure at height z can be calculated as

$$P_z = 0.6\,(Vz)^2 \qquad (2)$$

where,

$P_z$ = design wind pressure in N/m$^2$ at height z,

$V_z$ = design wind velocity in m/s at height z.

The total Wind load (F) on particular building or structure is calculated as

$$F = C_f\, Ae\, Pz \qquad (3)$$

Where,

$A_e$ = effective frontal area

$C_f$ = force coefficient depends upon shape of element plan size & wind dir.

$P_z$ = design wind pressure in N/m$^2$ at height z,

**Wind load calculation as per I*S* 875 part3 (2015)**

The design wind speed ($V$z) is obtained as per formula given below:

$$V_z = V_b\, k_1\, k_2\, k_3\, k_4 \qquad (4)$$

where

$V_z$ = design wind speed at any height z in m/s,

$k_1$ = probability factor (risk coefficient)

$k_2$ = terrain, height and structure size factor

$k_3$ = topography factor

$k_4$ = importance factor for the cyclonic region

The basic wind pressure at height z can be calculated as

$$P_z = 0.6\,(Vz)^2 \qquad (5)$$

where,

$P_z$ = basic wind pressure in N/m$^2$ at height z,
$V_z$ = design wind velocity in m/s at height z.

The basic wind pressure at height z can be calculated as

$$P_d = K_d.\ K_a.\ K_c.\ P_z \qquad (6)$$

where,

$P_d$ =design wind pressure in N/m2 at height z,
$K_d$= wind directionally factor
$K_a$= area averaging factor
$K_c$ = Combination factor

The total Wind load (F) on particular building or structure is calculated as

$$F = C_f \times Ae \text{ x } P_d \qquad (7)$$

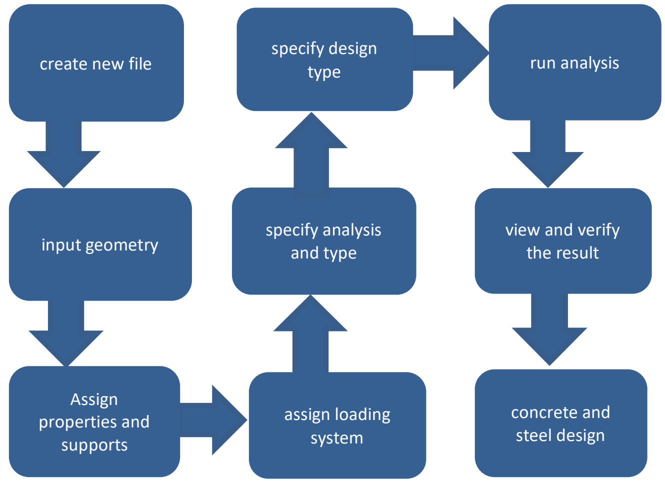
Where,

$A_e$ = effective frontal area
$P_z$ = design wind pressure in N/m$^2$ at height z,
*$C_f$ = force coefficient depends upon shape of element plan size & wind dir.*

**STEPS FOR ANALYSIS OF BUILDING USING STAAD. Pro:**

1: First, we create nodal point according the dimension, according to the plan we entered the position of plan of building in to the STAAD pro software.
2: By using add beam command we add the beam between nodes for beam and column.
3: To visualize the 3D view of structure, we simply add transitional repeat command.
4: After the completion of structure, we assign support at the bottom as a fixed support. also, we assign material and beam and column dimension.
5: Wind loads are calculated as per IS 875 PART 3 and exposure factor is taken as 1. Then wind load is added in load case details in +X, +Z directions.
7: Dead loads are calculated as per IS 875 PART 1, including self-weight of structure for external walls, internal walls.
8: Live loads are taken as per IS 875 PART 2 and assigned for each floor as 3 KN/m2.
9: After assigning all the loads, the load combinations with suitable safety factor are taken as per IS 875 PART 5.
10: After completed all the steps we have performed the analysis and checked for errors.
11: Design of concrete and steel, concrete and steel design are performed as per IS 456: 2000 after the design process, again we performed an analysis for any errors.

All the steps are shown in this figure




# IV. NUMERICAL STUDY

In this study, a G+11 story building situated in Delhi is considered for comparison of response of building against wind load. The details of building is given in Table 1.

**Table 1:** Building details:

| | |
|---|---|
| No. of storey | G+11 |
| Size of Column | 350 mm × 350 mm |
| Size of Beam | 300mm × 0.500mm |
| Size of Slabs | 150 mm |
| Live load on slab | 3 KN/m2 |
| Floor finish | 3 KN/m2 |
| Concrete grade in column | M 25 |
| Concrete grade in beam | M 25 |
| Steel grade | Fe 415 |
| Total height of building | 36 m |
| ground storey height | 3 m |
| Height of each floor | 3 m |
| Spacing of frame along length and along width | 4m |
| Thickness of external wall | 230 mm |

The building, which is considered situated in Delhi. As per IS per code, parameters are given in Table 2.

**Table 2:** Design Parameter

| | |
|---|---|
| Basic wind speed | 47 |
| zone | IV |
| city | Delhi |
| terrain category | 3 |
| class | B |

Values shown in Table 1 and Table 2 are used for input in the STAAD-Pro software for making the elevation and plan of building and design.

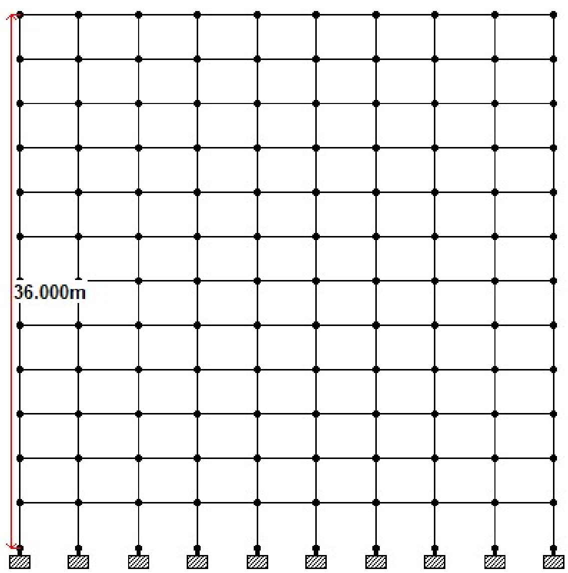



**Figure 1:** elevation

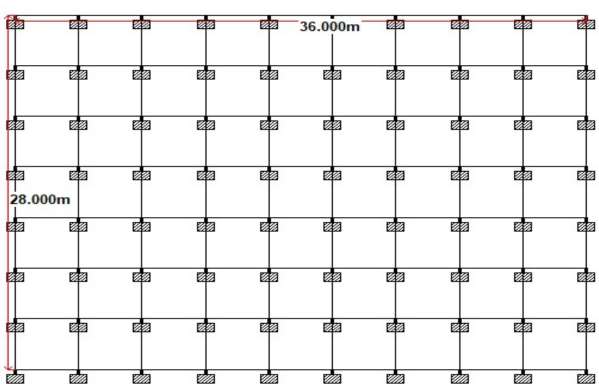



**Figure 2**: plan

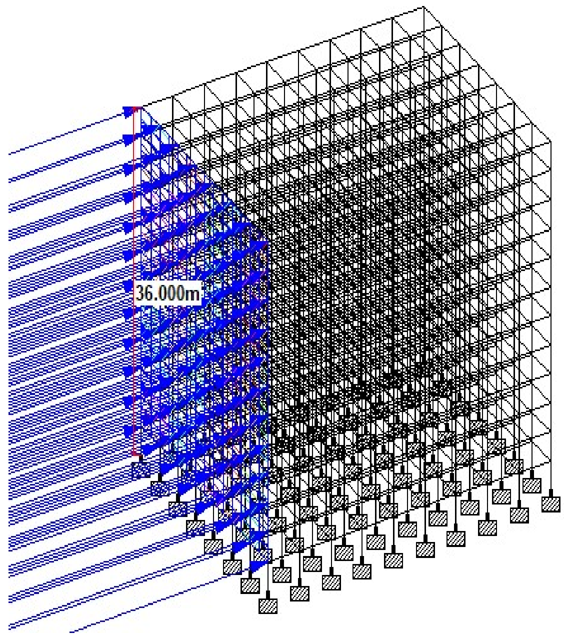



**Figure 3:** wind load acting in x direction

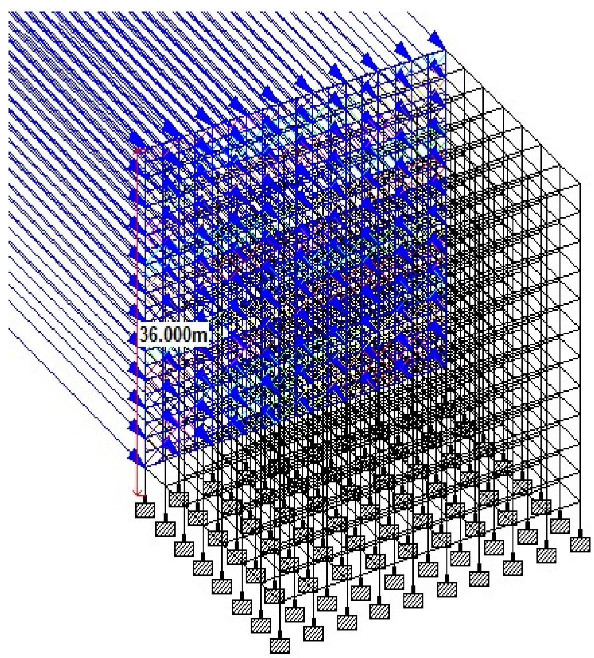



**Figure 4:** wind load acting in z direction

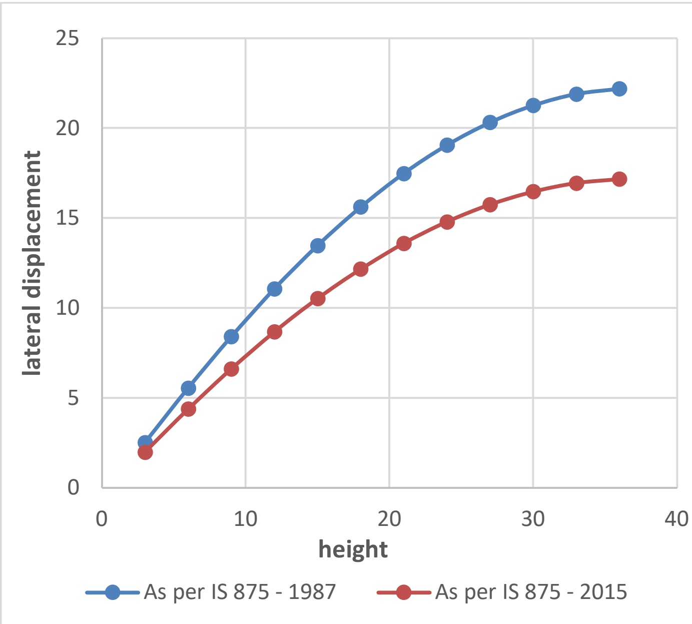



**Figure 5:** Comparison of Lateral Displacements at different height in x direction

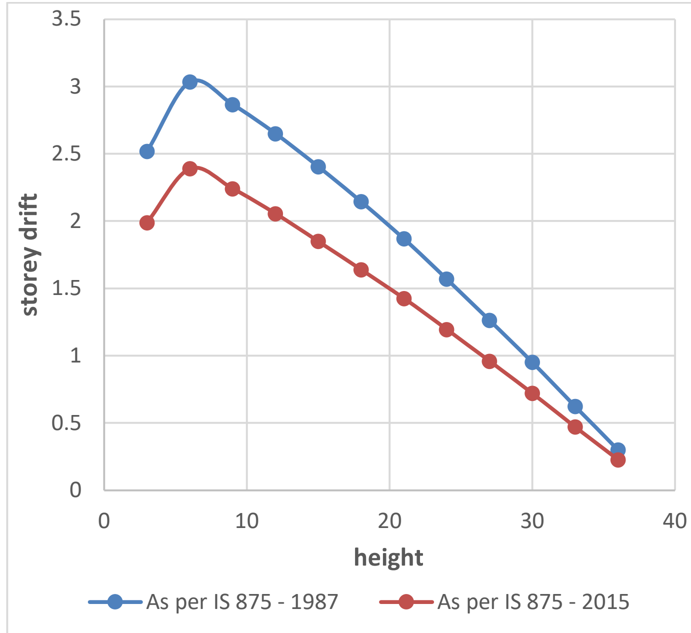



**Figure 7:** Comparison of storey drift at different height in x direction

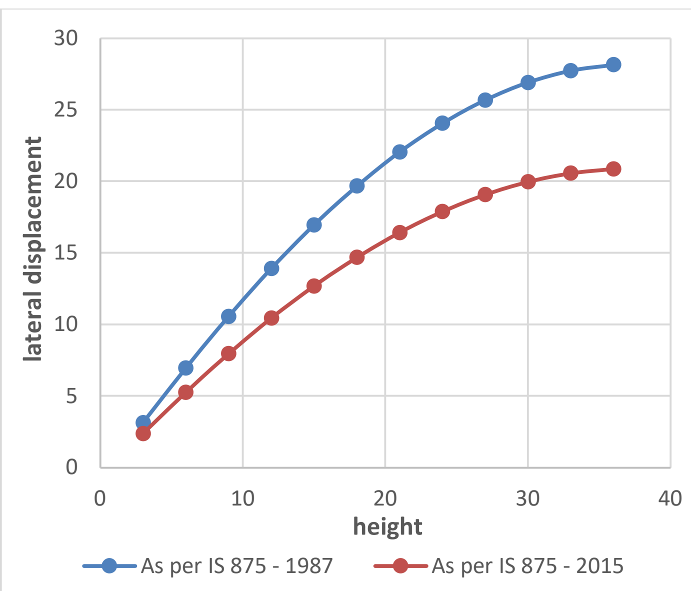



**Figure 6:** Comparison of Lateral Displacements at different height in z direction

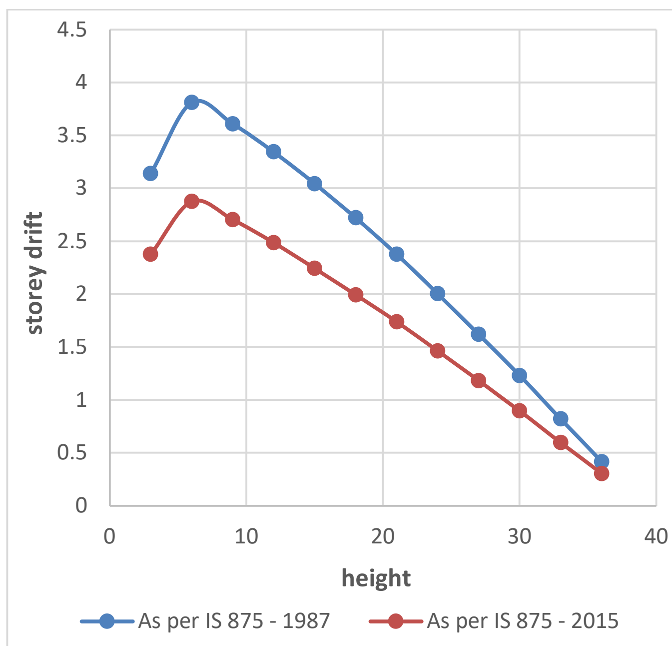



**Figure 8:** Comparison of storey drift at different height in z direction

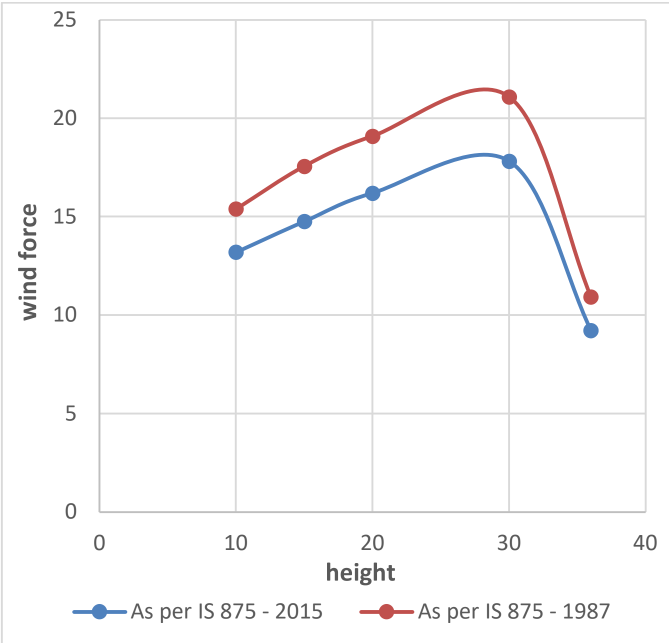



**Figure 9:** Comparison of wind force at different height in x direction

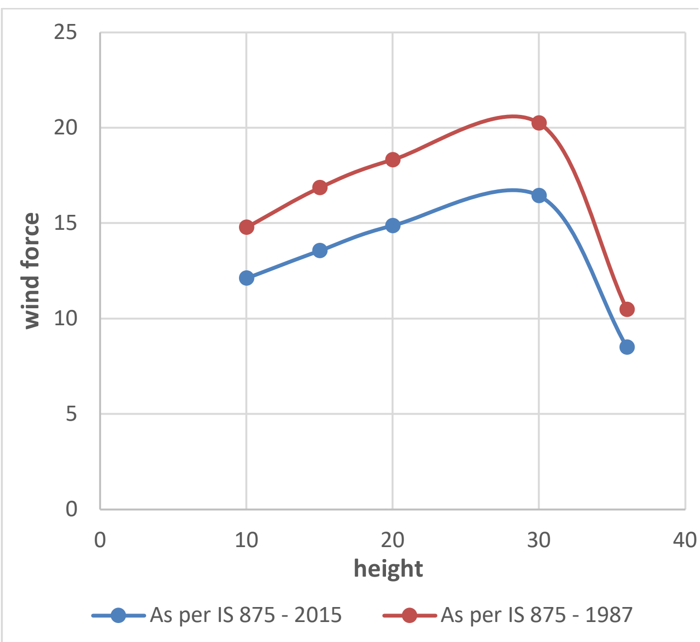



**Figure 10:** Comparison of wind force at different height in z direction

**Table3:** Comparison of Lateral Displacements at different height in x direction

| Height (m) | Deflection in mm | | |
|---|---|---|---|
| | As per IS 875 - 1987 | As per IS 875 - 2015 | % defection decrease |
| 3 | 2.518 | 1.99 | 20.96902 |
| 6 | 5.553 | 4.38 | 21.12372 |
| 9 | 8.418 | 6.622 | 21.33523 |
| 12 | 11.068 | 8.678 | 21.59378 |
| 15 | 13.473 | 10.529 | 21.85111 |
| 18 | 15.618 | 12.169 | 22.08349 |
| 21 | 17.487 | 13.596 | 22.25081 |
| 24 | 19.057 | 14.792 | 22.38023 |
| 27 | 20.32 | 15.752 | 22.48031 |
| 30 | 21.271 | 16.474 | 22.55183 |
| 33 | 21.895 | 16.946 | 22.60333 |
| 36 | 22.196 | 17.174 | 22.6257 |

In table no.3 these are Deflection at each story in x direction, as height increases wind load increases and defection at storey increases. comparison of deflection as per IS 875 – 1987 and as per IS 875 – 2015 mention in above table in x direction.

**Table4:** Comparison of Lateral Displacements at different height in z direction

| Height (m) | Deflection in mm | | |
|---|---|---|---|
| | As per IS 875 - 1987 | As per IS 875 - 2015 | % defection decrease |
| 3 | 3.14 | 2.376 | 24.33121 |
| 6 | 6.952 | 5.251 | 24.46778 |
| 9 | 10.562 | 7.956 | 24.67336 |
| 12 | 13.907 | 10.443 | 24.90832 |
| 15 | 16.951 | 12.687 | 25.15486 |
| 18 | 19.672 | 14.681 | 25.37109 |
| 21 | 22.049 | 16.42 | 25.5295 |
| 24 | 24.054 | 17.885 | 25.64646 |
| 27 | 25.674 | 19.067 | 25.73421 |
| 30 | 26.905 | 19.963 | 25.8019 |
| 33 | 27.725 | 20.56 | 25.8431 |
| 36 | 28.143 | 20.864 | 25.86434 |

In table no.4 these are Deflection at each story in z direction, as height increases wind load increases and defection at storey increases comparison of deflection as per IS 875 – 1987 and as per IS 875 – 2015 mention in above table in z direction.

# Conclusion

- The maximum deflection in the top most storey is 22.196 mm for structure which is designed as per Old IS code and 17.174 mm in case of structure which is designed as per new IS Code in x dir.
- The maximum deflection in the top most storey is 28.143 mm for structure which is designed as per Old IS code and 20.864 mm in case of structure which is designed as per new IS Code in z dir.
- Wind force has been decreased as per the new code [IS: 875 (Part 3) 2015]. Percentage decreased is 15.56% along "X" direction and 18.87% along "Y" direction.
- Displacement for the top most storey of G+11 storey building as per new code 22.62% as been decreased along "X" direction and along "Z" direction as per new code 25.86% as been decrease in new code when compared with old code.
- Storey drift for the top most storey of G+11 storey building as per new code 6.37% along "X" direction as been decreased and along "Y" direction as per new code 27.09% as been decreased in new code when compared with old code.
- From the above results it can be concluded that new IS Code [IS: 875 – (Part 3) – 2015] will provide high safety to the structure for static analysis as compared to Old IS Code also structure is economical that designed as per [IS: 875 – (Part 3) – 2015].
- Lateral deflection at each storey shall not exceed 0.002 times the storey height and all the lateral displacement at each story is under permissible limit.

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