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# A STUDY ON EFFECT OF WIND ON THE STATIC AND DYNAMIC ANALYSIS

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## ABSTRACT

Civil engineering structures are an integral part of our modern society. Traditionally, these structures are designed to resist static loads. However, they may be subjected to dynamic loads like earthquakes, winds, waves, and traffic. Wind-induced vibrations in structures increases the importance of structural design as the use of high-strength, lightweight materials, longer floor spans, and more flexible framing systems are used, results in structures that are more prone to vibrations. The diversity of structures that are sensitive to the effects of wind increases the need to improve the performance of constructed structures. For long span bridges, tall buildings and high towers or mast structures, wind load may be taken as a critical loading. The impact of wind loads are to be considered for the design of tall multistoried buildings. This study presents the wind effects on buildings with different aspect ratio using ETABS. All the frame models are idealized as 3D models. Variations of bending moment and axial force in columns are considered to study the behavior of frames. From the present study it can be concluded that wind effects are significant compared to gravity effect, when the aspect ratio is less and dynamic effect is not significant compared to static effect for symmetrical frames.

**Key words:** wind effects, aspect ratio, dynamic analysis.

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## INTRODUCTION

It is the great challenge of the engineers to reduce the wind load on the tall buildings. Now a day due to huge population pressure, emphasis on design and construction of the tall buildings is being given in many places. As the building becomes tall it is necessary to take into consideration the effect of wind on its design. The study of wind effect was first limited to loading on buildings and structures only, possibly because of its most dramatic effects are seen in their collapses. It is the task of the engineer to ensure that the performance of structures subjected to the action of wind will be adequate during their anticipated life from the standpoint of both structural safety and serviceability. To achieve this end, the designer needs information regarding (i) the wind environment, (ii) the relation between that environment and the forces it induces on the structures, (iii) the behavior of the structure under the action of forces. The knowledge of wind loading on a single tall building or on a group of tall buildings is essential for their economic design. It is the task of the engineer to ensure that the performance of structures subjected to the action of wind will be adequate during their anticipated life from the standpoint of both structural safety and serviceability.

## WIND LOADS ON TALL BUILDINGS

The wind load is the most important factor that determines the design of all buildings over 10 storeys. Buildings taller than 10 storeys would generally require additional steel for lateral system. An important problem associated with wind induced motion of buildings is concerned with human response to vibration and perception of motion. The complexities of wind loading should be kept in mind when applying a design document. Because of the many uncertainties involved, the maximum wind loads experienced by a structure during its lifetime, may vary widely from those assumed in design [1]. The structural forms used today have greater flexibility combined with less mass and damping than those used for traditional structures of the past. These factors have increased the importance of wind in design consideration. For estimations of the overall stability of a structure and of the local pressure distribution on the building, knowledge of the maximum steady or time averaged wind loads is usually sufficient.

## MODELING

The E-TABS software is used to develop 3D model and to carry out the analysis. The lateral loads to be applied on the buildings are based on the Indian standard IS-875-Part 3: 1987[2] the building consists of reinforced concrete elements.10, 15, 20, 25, and 30 storied building with different aspect ratios 0.25, 0.5, 1.0, 1.5 and 2.0 analyzed for bare frame models.

| Sl No | **Parameter** | **Type/Value** |
|---|---|---|
| 1 | Storey height | 3.5m |
| 2 | Thickness of slab | 0.15m |
| 3 | Beam size | 0.3x0.45m |
| 4 | Column size | 0.3x0.45m |
| 5 | No. of Stories considered | 10, 15, 20, 25, 30 |
| 6 | Aspect ratio | 0.25, 0.5, 1, 1.5, 2 |
| 7 | Wind speed | 50m/s |
| 8 | Terrain category | II |
| 9 | Structural class | B |
| 10 | Topography | Flat |
| 11 | Grade of steel | Fe 415 |
| 12 | Grade of concrete | M 25 |
| 13 | Young's modulus of concrete | $2.5x10^7 kN/m^2$ |

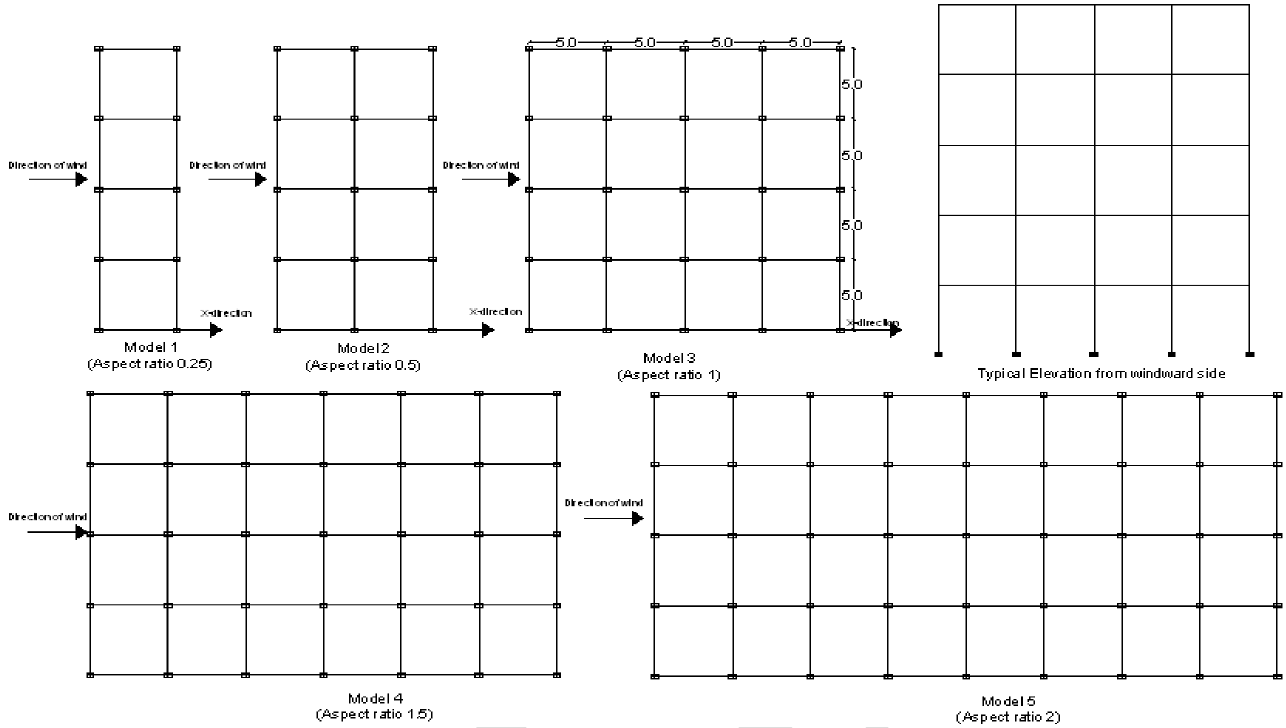



Fig 1: Models with different Aspect ratio considered for the study

## RESULTS AND DISCUSSION

In structures of ordinary height, dead and live loads are predominant. The wind loading effects are covered by the increase of permissible stresses as recommended by the I.S. code (IS 875 Part 3). Hence, for the design of buildings of low to medium height the wind effects are usually ignored. As the height of the building increases, the wind effects become gradually considerable. In the case of very tall slender frames they even become predominant compared to dead and live load effects. Very tall slender building frames are flexible in nature and as a result they interact with the wind dynamically and the safety and the stability of structure may become critical. Hence, for design of very tall frames, a thorough study of wind effects and investigation of criticality are very much necessary. This is particularly so in regions where wind is more critical than earthquakes. In order to understand the effect of wind load on the aspect ratio, 5 models with different aspect ratios (0.25, 0.5, 1, 1.5, and 2) are considered. Also 4 different load cases as per IS 875 part 5:1987[3] are considered. The load cases considered are

- 1.5(DL+LL) – Load Case-1
- 1.2(DL+LL+WL) – Load Case -2
- 1.5(DL+WL) – Load Case -3
- 0.9DL+1.5WL – Load Case -4

LC-1 is considered to study the effect of DL+LL and Load Case -2 to Load Case -4 are considered to study the effect of wind load.

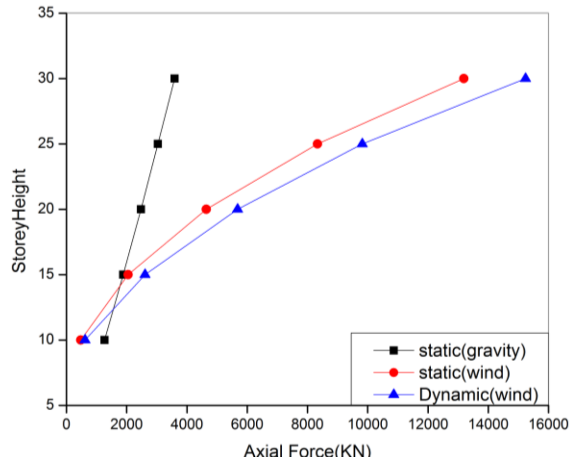



Fig. 2: Variation of axial force with Storey height in windward column (AR-0.25)

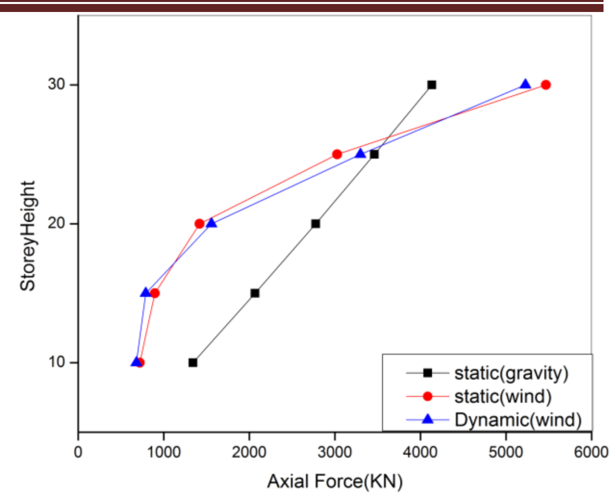



Fig. 3: Variation of axial force with Storey height in windward column (AR-0.5)

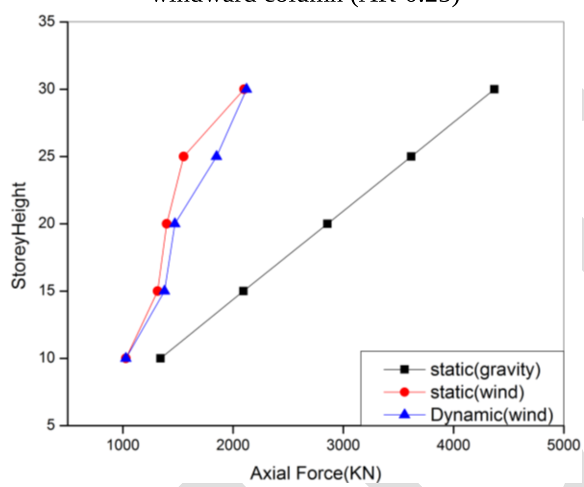



Fig. 4: Variation of axial force with Storey height in windward column (AR-1.00)

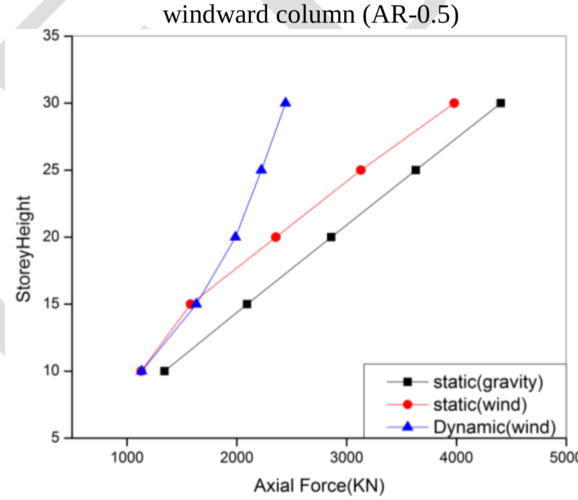
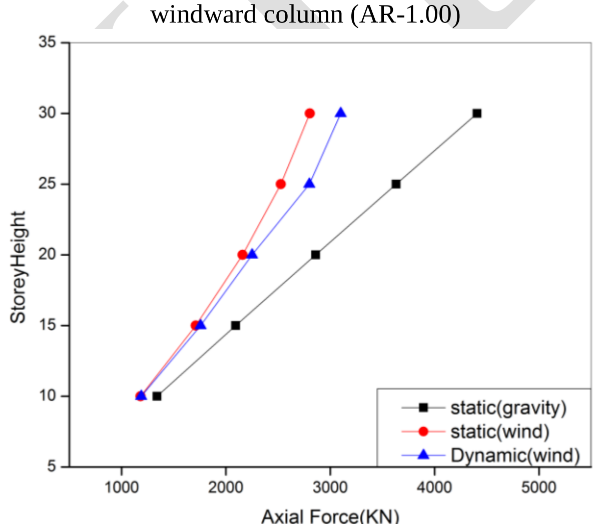
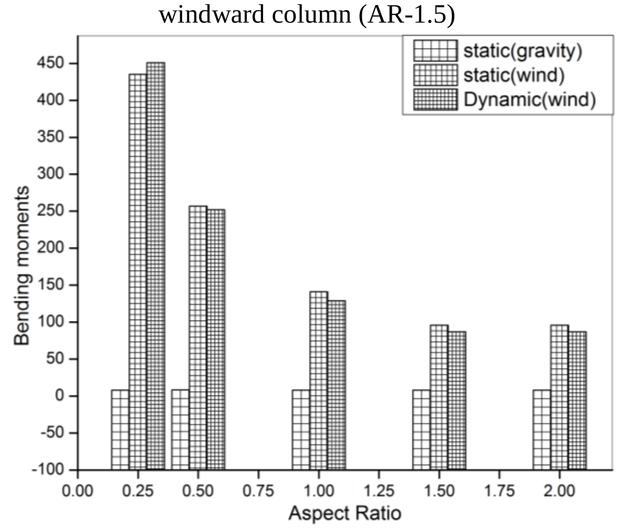



Fig. 5: Variation of axial force with Storey height in windward column (AR-1.5)



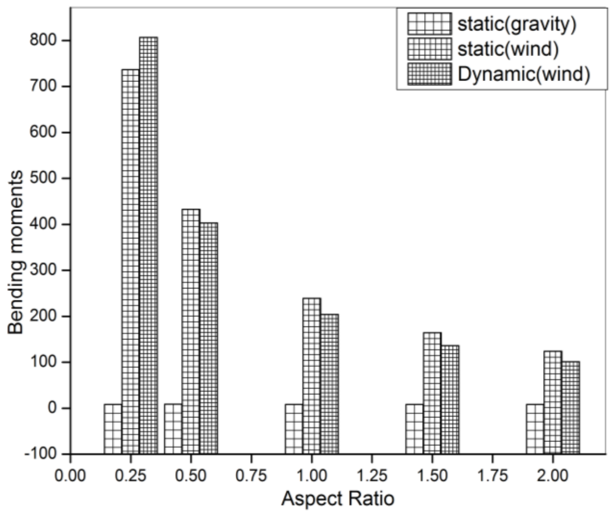



Fig. 8: Variation of BM with Aspect Ratio in windward column (storey-15)

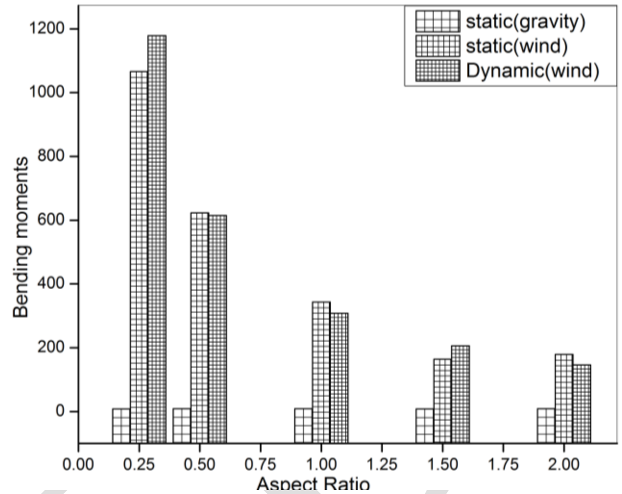



Fig. 9: Variation of BM with Aspect Ratio in windward column (storey-20)

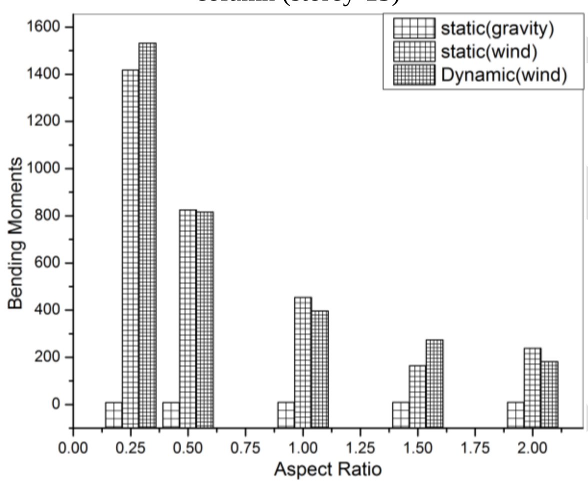



Fig. 10: Variation of BM with Aspect Ratio in windward column (storey-25)

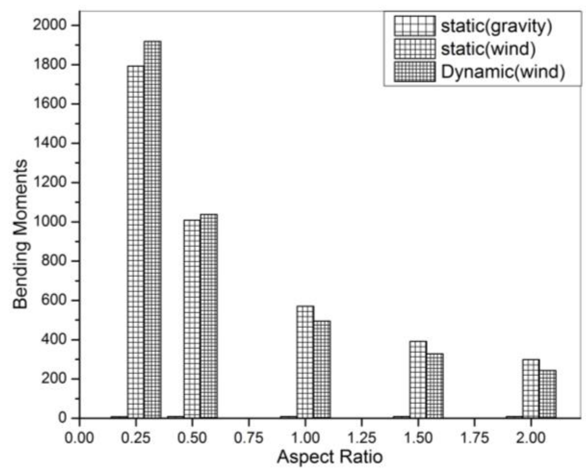



Fig. 11: Variation of BM with Aspect Ratio in windward column (storey-30)

Fig. 6: Variation of axial force with Storey height in windward column (AR-2.00)

Fig. 7: Variation of BM with Aspect Ratio in windward column (storey-10)

Effect of wind is obtained from analysis and compared with gravity loading. Fig. 2 to Fig. 6 shows the variation of axial force with storey height in all the models for gravity and wind loads at bottom storey column for different aspect ratio and different storey height.

It is observed that when the aspect ratio is 0.25, the axial force is increased by 10% in dynamic analysis compared to static analysis. However it is interestingly to see that when the aspect ratio is increased to 2.0, then the axial force is decreased by 3% in dynamic analysis compared to static analysis.

Fig. 7 to Fig. 11 shows variation of Bending Moments with Aspect ratio in windward column. In the present study it can be explained that Bending Moments due to gravity will remain same for gravity and wind cases in all aspect ratios. But the moment due to the static and wind analysis is maximum at aspect ratio 0.25 when compared to aspect ratio 2.00.

## CONCLUSION

Based on the computed results and the discussion made, the following conclusions are drawn:

1. As the building width is increased by keeping its length fixed, the GEF goes on decreases. Gust factor is more in case of building having less width dimension.
2. The dynamic response factor increases with height. This is because of the increase in the slowly varying background component of the fluctuating response.
3. From the present study it is observed that for symmetrical frames the dynamic effect is not significant compared to static effect.
4. Wind effects are significant compared to gravity effects, when the aspect ratio is less, however its effect reduces as aspect ratio increases.

## REFERENCES

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