Chapter 7

CONCLUSION AND FUTURE SCOPE

7.1 Introduction

In the earlier chapters, we explored the intricate details of our research, the influence of geometrical, structural, and wind parameters on across-wind loading in super high-rise buildings, aerodynamic adaptations for mitigating wind loads on square-plan structures, and the analysis of torsional wind loads in framed-tubed buildings. A comprehensive overview of the valuable contributions and insights that have emerged from our research are concluded in this chapter. The concluding remarks and scope for future work have been discussed separately in this chapter in the following section.

7.2 Conclusion

The brief conclusions of the present dissertation work are presented as follows:

Effect of geometrical parameters:

- Among various plan aspect ratios ranging from 0.5 to 2, it's apparent that structures with a plan aspect ratio of one (square-shaped) are more susceptible to across wind load. To reduce the impact of crosswind loads on buildings, it's advisable to avoid square-shaped floor plans.
- As the height aspect ratio of a structure escalates, there is a corresponding augmentation in the magnitude of the lateral wind load it experiences. Notably, once the height aspect ratio surpasses eight, there is a pronounced and abrupt escalation in the intensity of the lateral wind load. Therefore, it is prudent to recommend avoiding height aspect ratios exceeding eight in architectural designs as a means of mitigating the substantial increase in across-wind loads.

Effect of wind and structural parameters:

- The results clearly show that as the natural frequency changes from 0.1515Hz to 0.2619 Hz, there is a change in the across wind ESWL from 1589kN/m to 664 kN/m. It is because the background components of the building are highly responsive to the natural frequency. The across wind load of a structure is significantly influenced by its natural frequency. As the natural frequency increases the across wind load decreases.
- The exponent of mean velocity profile (α) influences the cross wind load the most compared to other parameters. As the α changes from 0.36 to 0.4, there is a 65% increase in wind load. At high wind speed, there is an intense across-wind response.
- This study has demonstrated that when the structural damping ratio increases, there is a decrease in the cross-wind load. As the structural damping ratio increases from 1% to 2%, the across-wind ESWL decreases from 975 to 746kN/m.
- Across wind load is minimally affected by the turbulence intensity of the surrounding wind. As the turbulence intensity changes from 17% to 21.71%, the across wind ESWL remained unchanged as 980kN/m.
- The peak factor for resonant response (g_R) affects the cross wind loads more in comparison to the background peak factor (g_B), and Peak acceleration is independent of the background peak factor (g_B), As the g_R changes from 2.5 to 3.2882, the cross wind ESWL, the across wind ESWL increases from 748 kN/m to 977 kN/m. The background peak factor(g_B) changes from 2.5 to 3.7, there is a small increase in across wind ESWL as 971kN/m to 976kN/m.

Corner modifications:

- In conclusion, our research findings reveal that the choice of corner reduction strategy significantly impacts the reduction of wind loads on buildings. When implementing a 5% corner reduction, chamfering emerges as the most effective approach, leading to a substantial 25.97% reduction in overall wind load and a noteworthy 13.41% reduction in across-wind load.
- For more extensive corner reductions, specifically 10%, rounded and recessed corners prove to be superior, achieving reductions of 33.85% and 32.71% in overall wind load, respectively. Meanwhile, chamfered and rounded corners continue to perform well, demonstrating commendable reductions in across-wind load, at 18.60% and 18.34%, respectively.
- Further increasing the corner reduction to 15% highlights rounded and chamfered corners as the top choices for reducing overall wind load, with reductions of 38.20% and 35.50%, respectively. Conversely, recessed corners excel in curbing across-wind load, achieving a substantial 23.03% reduction.
- Finally, with a 20% corner reduction, rounded corners exhibit exceptional efficacy in diminishing overall wind load by 40.73%, while recessed corners effectively reduce the across-wind load by 26.92%. These findings underscore the importance of selecting an appropriate corner reduction strategy in architectural design to optimize the mitigation of wind-induced loads, thereby enhancing structural performance and safety.

Torsional wind loads in framed-tubed buildings:

The results indicate that axial force distribution changes significantly with change in the loading patterns of the building. A difference in axial force distribution is observed between torsional and non-torsional load cases. Axial force in columns in the case of uniform loading is more significant as compared to partial loading cases. Due to loading on half of the face, axial force distribution becomes unsymmetrical, and a minimum axial force in corner columns is observed. Also, notable differences can be seen in the axial force distribution of load cases having both direction loadings compared to single direction loadings. Axial force distributions in cases of both face loading are unsymmetrical for the central column.

7.3 Potential avenues for future research

Like every research endeavour, there always remains scope for future work. In this context of study, the future work can be summarized as follows:

Wind tunnel experiments: In our current study, we have employed a mathematical model to investigate super high-rise buildings characterized by rectangular or square shapes. Nevertheless, there exists an opportunity for progress through the implementation of wind tunnel experiments on building shapes beyond the rectangular paradigm. This expansion is geared towards providing a more holistic comprehension of the intricate aerodynamic complexities linked to exceptionally tall structures.

Optimizing wind load mitigation strategies: An intriguing area of future research lies in the pursuit of the most effective combination of corner modifications and elevation variations to mitigate wind-induced loads. This endeavour necessitates an extensive computational fluid dynamics (CFD) analysis, followed by experimental validation through wind tunnel testing. The overarching objective is to identify and validate strategies that prove efficacious in reducing the impact of wind forces on structures.

Recommendation

The present research outcomes suggest a potential scope for enhancing IS 875 (Part 3): 2015, specifically in the realm of wind-load analysis for tall buildings. One notable recommendation for improvement involves incorporating the formulation proposed by Quan and Gu (2012) into the existing standard. This addition aims to refine the calculation of across-wind forces on super high-rise structures, introducing a more comprehensive and accurate approach. Such an enhancement has the potential to positively influence the design practices for tall buildings in India.