

Investigation Comparative Analysis of Wind Loads on Tall Buildings Derived from State-of-the-Art LES CFD with Eurocode Design Approaches

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SUMMARY

With advances in computer hardware and high-fidelity large eddy simulation (LES) software, the use of LES simulations is becoming an increasingly realistic option for wind loading assessments. This study compares the wind loads derived from the state-of-the-art Cadence Fidelity CharLES 2025.1 software with those derived from wind tunnel test data and current and emerging codes of practice, including the existing and proposed Eurocode for wind actions (EN 1991-1-4). The study evaluates the performance of the code-based provisions with those produced from the LES simulations and wind tunnel tests. The wind-induced dynamic response of the structure using the LES outputs is compared to that from the codes of practice and wind tunnel tests. The impact of discrepancies in wind loading between the compared methodologies is quantified through differences in structural massing and embodied carbon.

Keywords: wind loading, large eddy simulation, CFD, codes of practice, second generation eurocode, tall buildings

1. INTRODUCTION

Large-eddy simulation (LES) is becoming an increasingly common tool in the prediction of wind loads and cladding pressure, but widespread implementation is limited by the need for verified workflows, inflow realism, and validation. This study compares both the global peak structural loading and localised cladding pressures obtained for the Commonwealth Advisory Aeronautical Research Council (CAARC) standard tall building using LES, wind tunnel testing and the existing Eurocode and the draft of the proposed Second-Generation Eurocode (EN1991-1-4).

2. METHODOLOGY

Using the newly released Fidelity CharLES 2025.1 software, LES is performed for the CAARC building based on recent CFD best-practice recommendations for wind loading (Tsinuel N. Geleta and Girma T. Bitsuamlak, 2025; Marie Skyette Thordal *et al.*, no date). Using the findings of previous studies focused on LES of building structures, optimal inflow boundary conditions and grid resolutions are chosen for the analysis (Fan-Qing Meng *et al.*, 2018; Giacomo Lamberti and Catherine Gorle, 2020). The time series of global base reactions and localised façade pressures from the LES are analysed for the peak values and compared to those from wind tunnel test data and those calculated using the existing and proposed second generation Eurocode. Using the derived wind loads, the primary structure is designed to satisfy both ultimate and serviceability limit states. The impact of any discrepancies in wind loading is then compared through design of the primary structure and comparison of differences in the structural massing and embodied carbon.

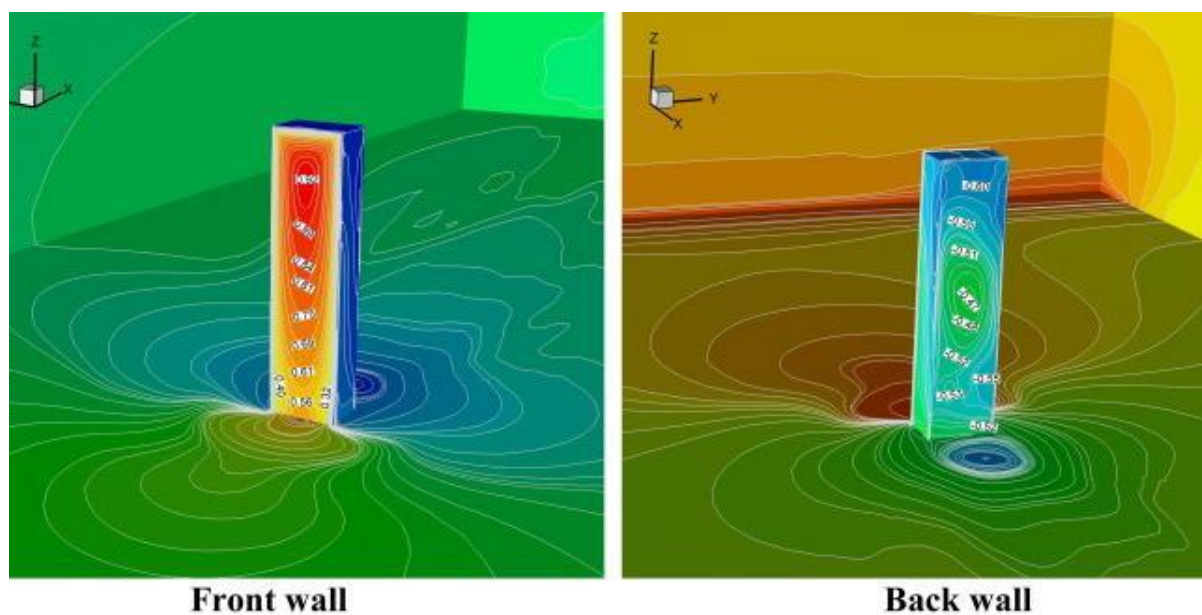


Figure 1: CAARC building (Alexandre Luis Braun and Armando Miguel Awruch, 2009).

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