How the Surrounding Multi-Scale Building Clusters Affect the Wind Loads of the Super High-Rise Building

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Many super high-rise buildings emerge in modern cities with urban development, facilitating work, accommodations, etc. However, their safety risks and accidents due to the wind are urgent problems with the complex flow field in cities. The research on wind loads of super high-rise buildings is thus crucial, but most studies tend to consider only the influence of the surrounding single-scale building clusters, rarely considering multi-scale ones. In this paper, the influence of the surrounding multi-scale building clusters on the wind loads of a super high-rise building is investigated. The wind field of a super high-rise building surrounded by four different arrangements of idealized, simplified buildings is first simulated using computational fluid dynamics (CFD) methods: RANS and Hybrid LES/RANS models. It is found that surrounding tall buildings can significantly affect the pressure distribution on the windward and leeward sides of the super high-rise building, such as fluctuating, extreme, and mean wind pressure. The vortex, formed largely due to short buildings, increases the negative pressure at the back of the super high-rise building. In addition, simulations are conducted for the wind field around the CITIC Tower in Beijing CBD, and it is found that the flow field of the actual building group is more complex due to the strong interactions between buildings, and the flow near the ground is even more complex. All simulation results are validated by the wind tunnel tests. This study can provide important guidance for the wind safety design of super high-rise buildings and the future planning of urban buildings.