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WRF-LES Simulation of Wind Flow over Rough Urban Surface during Typhoon Lan (2017)

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In an LES (Large-Eddy Simulation) to evaluate the wind load acting on buildings, the turbulent boundary layer flow is typically set as the inflow data. However, the effect of meteorological disturbances due to large-scale flow structures cannot be considered sufficiently in this method. Attempts have recently been made to generate LES inflow data that include the effect of meteorological disturbances by using meteorological models; further advancement of wind load evaluation using LES is expected. In a previous study, we indicated that the meteorological model overestimated the mean wind speed in an urban area because of an underestimation of ground surface friction (Nakajima et al., 2021). The prediction accuracy of meteorological models in urban areas needs to be improved to generate LES inflow data that include the effect of meteorological disturbances adequately.

In this study, we investigated the influence of the ground surface boundary conditions of the meteorological model on the accuracy in predicting the mean wind speed and wind speed fluctuation in an urban area. Two types of ground surface boundary conditions (Cases 1 and 2) were created. In Case 1, the roughness length for the urban area was set to 0.5 m uniformly (default setting), whereas in Case 2, the spatial distribution of roughness length for the urban area was set based on the urban geometry (Kanda et al., 2013). In Case 2, the roughness length in the central part of Tokyo was much larger than 0.5 m and ranged from approximately 4 to 20 m.

We performed wind flow simulations in the central part of Tokyo during Typhoon Lan (2017) using WRF-LES (LES mode of Weather Research and Forecasting model) with the created ground surface boundary conditions. The simulation results were compared with observation data at multiple locations. By setting the roughness length based on the urban geometry, the accuracy in predicting the mean wind speed in the urban area was improved significantly. However, in both cases, WRF-LES underestimated the turbulence intensity, especially near the ground surface.

REFERENCES

[1] Nakajima, K., Kawai, H., Kawaguchi, M., Tamura, T., Kondo, K., Itoh, Y. and Takagi, K. Numerical simulation of wind flow during typhoon No. 21 (2017) in central part of Tokyo using WRF-LES. *Summaries of Technical Papers of Annual Meeting, Architectural Institute of Japan* (2021). (in Japanese)

[2] Kanda, M., Inagaki, A., Miyamoto, T., Gryschka, M. and Raasch, S. A New Aerodynamic Parametrization for Real Urban Surfaces. *Boundary-Layer Meteorology* (2013) **148**: 357-377.