論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	Statistical methods for estimating low-occurrence strong wind speeds at the entire pedestrian level in urban areas
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出典(和文)	学位:博士(工学), 学位授与機関:東京工業大学, 報告番号:甲第12153号, 授与年月日:2021年12月31日, 学位の種別:課程博士, 審査員:大風 翼,中村 芳樹,鍵 直樹,湯淺 和博,淺輪 貴史
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Tokyo Institute of Technology, Report number:甲第12153号, Conferred date:2021/12/31, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	要約
Type(English)	Outline

（博士課程）
Doctoral Program

論 文 要 約

THESIS OUTLINE

系・コース： Department of, Graduate major in	建築学 系 都市・環境学 コース	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of （ 工学 ）
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要約（様式自由）
Thesis Outline（free format）

Statistical Methods for Estimating Low-occurrence Strong Wind Speeds at the Entire Pedestrian Level in Urban Areas

The low-occurrence strong wind speeds (LOSWSs) have caused safety and discomfort problems at the pedestrian level. There are two main difficulties limited the studies of the LOSWS distribution at the entire pedestrian level in urban areas. The first difficulty is that the computational cost of large-eddy simulations (LESs), which can directly provide the time-series data of wind speed, is significantly high. The second difficulty is that the vast amount of time-series data brought huge challenges to the storage and analysis.

The main objective of this study is to obtain the LOSWS distribution at the entire pedestrian level in urban areas using a small amount of data. To obtain this main objective, several sub-objectives need to be step-by-step realized. The first sub-objective is to find appropriate cell types and arrangements for the LES of urban areas with high numerical accuracy and low computational cost. The second sub-objective is to reduce the required data amount by relating the lower-order statistics (mean, standard deviation or skewness) to LOSWSs. The third sub-objective is to relate mean velocities and turbulence kinetic energy, which can be readily obtained from LESs, RANS simulations or experiments, to LOSWSs.

In this study, an isolated building case, a building array case and an actual urban case were analyzed. The flow chart of this study is shown in the following figure. In Chapter 2, the appropriate cell type and arrangement for the large-eddy simulation (LES), which has low computational cost and acceptable numerical accuracy, were found. In Chapter 3, two statistical methods to estimate LOSWSs using lower-order statistics were derived and validated. The estimation of the peak factor (PF) by using the coefficient of variation (CV) was based on the two-parameter Weibull distribution (2W method), while that by using the skewness was based on the three-parameter Weibull distribution (3W method). In Chapter 4, an improved 2W method (KB method) was derived to estimate LOSWSs using the mean velocities and turbulence kinetic energy from LESs. In Chapter 5, the applicability of the KB method using RANS simulation data for estimating LOSWSs was validated. In Chapter 6, the LOSWSs at the pedestrian level of an actual urban case were estimated. The strategies of cell types and arrangements, and the statistical methods in previous chapters were applied.

In summary, for the numerical simulation of the pedestrian-level wind environment in urban areas, the polyhedral cell with boundary layer mesh on the flat ground is recommended. Three statistical methods (2W method, 3W method and KB method) to estimate LOSWSs based on lower-order statistics were derived and validated in this study. The 2W method requires the mean and standard deviation of the wind speed, while the 3W method requires the mean, standard deviation and skewness of the wind speed. The 2W method and 3W method can be applied with LES, but several statistics need to be defined in solvers in advance. On the other hand, the KB method requires mean velocities and turbulence kinetic energy. The 3W method showed the best accuracy and the KB method showed the widest application potential with the data from LESs, RANS simulations and experiments. All these methods were validated to be suitable for practical applications.