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APPLICATION OF LES BASED ON BCM TO WIND ENGINEERING

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Abstract. This study discusses the applicability of LES (Large Eddy Simulation) based on BCM (Building Cube Method) to the wind-related problems which consist of various kinds of numerical examples relating to nature phenomena such as the turbulent flows around square-shaped building, high wind impact on actual complex buildings in city, coherent turbulence above and within urban canopy and wind gust on extreme meteorological events. The present numerical method is formulated on very fine Cartesian mesh system (Onishi et al., 2013). For city model, houses and buildings were not modelled and directly reproduced their shapes, in order to obtain the correct estimation of local flow field in the canopy layer close to the ground. Recently high-performance computing technique has developed distinctly, so high-resolution computation becomes possible for complicated configuration. Actual building has a very small attachment on wall or roof, balcony and penthouse. In the urban case we have to deal with buildings, vegetation and street etc. as a part of numerical model. Here, LES using the Cartesian coordinate encounters the incorrespondence of directions between the street lines and the discretized mesh lines. Very fine mesh system by BCM can solve this problem supported by the external forcing technque at the boundary named IBM(Immersed Boundary Method). This computational process is so simple that the parallel algorithm and the memory access obtain the perfect efficiency. It is strongly expected that these advantages make it possible to efficiently simulate the flow around very complicated shapes with various scales.
As numerical example, this study firstly discussed LES results on the turbulent flow around a square cylinder with a glancing angle of attack. For simple shape which has many experimental data the very large local negative pressure near the corner is investigated from a physical point of view. Next, we conducted LES for the wind load estimation of a actual high-rise building in the dense area surrounded by the other buildings. Wind impact on the cladding of building was evaluated for wind resistant design. Also, we applied LES by BCM to the turbulent wind over the real complicated urban surface at straightforward and inclined wind directions to the main streets. Here computational domain is several ten-kilometer square with resolution of 5m for urban area. From the computed results, the development process of turbulent boundary layer over buildings was examined by analyzing turbulent statistics of wind velocity (Mean velocity and turbulent intensity, power spectra etc.). This study investigates the characteristics of various wind profiles affected by the roughness level and slight undulation of the ground surface.

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