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LES analysis of roughness scale effect on rough-wall turbulent boundary layers KOJIRO NOZAWA, Shimizu Corporation, TETSURO TAMURA, Tokyo Institute of Technology — Large Eddy Simulation (LES) of turbulent boundary layer flows over small-scale and large-scale homogenous roughness were performed. The turbulent boundary layer flow over small-scale roughness whose roughness height is 0.028δ (where δ is boundary layer thickness) is expected to have outer-layer similarity in the turbulence structure as same as the case of smooth wall. While the height of large-scale roughness is so large (0.14δ) that roughness effects on the turbulence extend across the entire boundary layer, and the concept of wall similarity will be invalid [M. P. Schultz and K. A. Flack, J. Fluid Mech., 580, 381–405, (2007)]. In this study, in order to realize the spatially developing turbulent boundary layer with no pressure gradient, the quasi-periodic boundary condition is applied in streamwise direction, in which the velocities at the recycle station are rescaled and reintroduced at the inlet and the outflow boundary is set far downstream of the recycle station. We focused on the vertical distribution of second invariant of velocity gradient tensor (Q) which could identify vortical structures formed in the wake of roughness blocks with various scales, and showed physical understanding of turbulent flow structures based on its resulting distributions which have changed the range of log-law region.

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