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Applicability of Townsend's similarity hypothesis to very-rough-wall channel flow DAVID M. BIRCH, JONATHAN F. MORRISON, Department of Aeronautics, Imperial College London, U.K. — There has been considerable recent interest in the scaling of turbulent flows over rough walls, and especially in the applicability of Townsend's similarity hypothesis to flows over walls with values of k/δ exceeding 2.5 % (where k is the mean wall-normal roughness height and δ is the outer length scale). In order to investigate outer-layer similarity under these very-rough wall conditions, an experimental study of the turbulent flow through a channel has been carried out using both a broadly distributed grit-type roughness with $k/h = 0.035$ and $ku_\tau/\nu \sim 200$ (where h is the channel half-height, u_τ is the wall friction velocity and ν is the kinematic viscosity) and a mesh-type roughness with $L_x/L_z = 2.6$, $k/h = 0.031$ and $ku_\tau/\nu \sim 190$ (where L_x and L_z are the axial and spanwise mesh spacings, respectively). The channel flow in both cases is shown to be fully developed and statistically stationary, and the turbulence kinetic energy budgets are examined. Scaling of the Reynolds stresses is also examined and the behaviour of the higher-order statistics is compared with previous investigations. Single- and two-point velocity correlations are used to deduce the behaviour of the structures with special attention being given to the scaling of the spectra of the streamwise and wall-normal velocity components.

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