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Effect of wall roughness texture on transient turbulent channel flow[1] SAI CHAITANYA MANGAVELLI[2], JUNLIN YUAN[3], GILES BRERETON[4], Michigan State University — Direct numerical simulation is used to study the effect of roughness topography on the response of channel-flow turbulence to an abrupt increase in bulk flow rate. Flows with two roughness topographies: a sand-grain roughness with a dominant wavelength; and a fractal roughness replicated from the surface of a hydraulic turbine blade, are compared with the baseline case of a smooth wall. The flow is accelerated from a bulk Reynolds Number of 3000 (transitionally rough) to 12000 (fully rough) over a very short time interval. The smooth-wall flow undergoes a reverse transition towards quasi-laminar flow. Wall roughness inhibits reverse transition and promotes a faster recovery to the new equilibrium state. The rough-wall responses are attributed to rapid growths in the pressure-strain rate and form-induced turbulence production in the early transient stage, with a dependency on surface topography. The turbine-blade roughness leads to a slower turbulence recovery compared to the sand-grain roughness. This difference is connected to the distribution of intense vortical motions, associated with the sparse high-slope roughness elements in turbine blade roughness. Other connections between the roughness topography and the turbulence response will be discussed.

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