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Structural Aspects of Wall Turbulence Over Low-Order Representations of Irregular Roughness R. MEJIA-ALVAREZ, K.T. CHRISTENSEN, U. Illinois — Low-order representations of roughness replicated from a turbine blade damaged by deposition of foreign materials are generated using singular value decomposition (SVD) to decompose the surface into a set of topographical basis functions (383 total) of decreasing importance to the original ("full") surface character. The low-order surface models are then formed by truncating the full set of basis functions at the first 5 and 16 modes (containing approximately 71% and 95% of the full surface content, respectively), so that only the most dominant, and large-scale, topographical features are included in the models. Physical replications of the full surface and the two models are created by rapid prototyping and PIV is used to measure velocity fields for all cases in both wall-normal and wall-parallel planes from which the structural aspects of these flows are explored. While the three rough-wall flows are found to be similar to smooth-wall flow outside the roughness sublayer, differences are noted within the roughness sublayer. Persistent low- (LMR) and high-momentum (HMR) regions often bounded by regions of enhanced Reynolds stresses are observed at preferential spanwise positions that vary depending upon the details of the topography. These observations suggest the possibility of enhanced production and dissipation at preferential locations within the roughness sublayer that depend upon the details of the topography.

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