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Comparison of boundary layers over 2-D and 3-D rough walls[1]
RALPH J. VOLINO, MICHAEL P. SCHULTZ, KAREN A. FLACK, U. S. Naval Academy — A zero pressure gradient boundary layer over a surface with two- dimensional, k-type roughness was investigated experimentally. The roughness consisted of transverse bars of square cross section spaced 8 bar heights apart. Previous work on a wide variety of surfaces with three-dimensional roughness has shown very good similarity between rough and smooth wall boundary layers outside the roughness sublayer. Similarity was observed in Reynolds stresses, higher order moments, swirl strength and two point correlations. The roughness sublayer thickness was considered to be about 3 equivalent sand grain roughness heights, k_s, and k_s was always of the same order of magnitude as the roughness element height. On the 2-D bars, k_s was an order of magnitude larger than the bar height, encompassing most of the boundary layer thickness. Reynolds stresses were noticeably larger over the 2-D roughness than the 3-D roughness, and length scales based on two-point spatial correlations were longer in all directions for all quantities with the 2-D roughness. The differences between 2-D and 3-D roughness observed in boundary layers have not been observed in channel flow. Reasons for the differences will be discussed.

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