

## Effects of Upstream Wall Roughness on Separated Turbulent Flow over a Forward Facing Step in an Open Channel

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**Abstract :** The effect of upstream surface roughness over a smooth forward facing step in an open channel was investigated using a particle image velocimetry technique. Three different upstream surface topographies consisting of hydraulically smooth wall, sandpaper 36 grit and sand grains were examined. Besides the wall roughness conditions, all other upstream flow characteristics were kept constant. It was also observed that upstream roughness decreased the approach velocity by 2% and 10% but increased the turbulence intensity by 14% and 35% at the wall-normal distance corresponding to the top plane of the step compared to smooth upstream. The results showed that roughness decreased the reattachment lengths by 14% and 30% compared to smooth upstream. Although the magnitudes of maximum positive and negative Reynolds shear stress in separated and reattached region were  $0.02U_e$  for all the cases, the physical size of both the maximum and minimum contour levels were decreased by increasing upstream roughness.

**Keywords :** forward facing step, open channel, separated and reattached turbulent flows, wall roughness

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