World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:10, No:02, 2016

Effects of Roughness on Forward Facing Step in an Open Channel

Authors : S. M. Rifat, André L. Marchildon, Mark F. Tachie

Abstract : Experiments were performed to investigate the effects of roughness on the reattachment and redevelopment regions over a 12 mm forward facing step (FFS) in an open channel flow. The experiments were performed over an upstream smooth wall and a smooth FFS, an upstream wall coated with sandpaper 36 grit and a smooth FFS and an upstream rough wall produced from sandpaper 36 grit and a FFS coated with sandpaper 36 grit. To investigate only the wall roughness effects, Reynolds number, Froude number, aspect ratio and blockage ratio were kept constant. Upstream profiles showed reduced streamwise mean velocities close to the rough wall compared to the smooth wall, but the turbulence level was increased by upstream wall roughness. The reattachment length for the smooth-smooth wall experiment was 1.78h; however, when it is replaced with rough-smooth wall the reattachment length decreased to 1.53h. It was observed that the upstream roughness increased the physical size of contours of maximum turbulence level; however, the downstream roughness decreased both the size and magnitude of contours in the vicinity of the leading edge of the step. Quadrant analysis was performed to investigate the dominant Reynolds shear stress contribution in the recirculation region. The Reynolds shear stress and turbulent kinetic energy profiles after the reattachment showed slower recovery compared to the streamwise mean velocity, however all the profiles fairly collapse on their corresponding upstream profiles at x/h = 60. It was concluded that to obtain a complete collapse several more streamwise distances would be required.

Keywords : forward facing step, open channel, separated and reattached turbulent flows, wall roughness
Conference Title : ICFMT 2016 : International Conference on Fluid Mechanics and Thermodynamics
Conference Location : Paris, France
Conference Dates : February 22-23, 2016