

## **A study of turbulent flow over a sinusoidal boundary**

Sk Zeeshan ALI<sup>1</sup> and Subhasish DEY<sup>2</sup>

<sup>1</sup> Department of Civil Engineering, Indian Institute of Technology  
Kharagpur 721302, West Bengal, India  
e-mail: zeeshan.juce91@gmail.com

<sup>2</sup> Department of Civil Engineering, Indian Institute of Technology  
Kharagpur 721302, West Bengal, India  
e-mail: sdey@iitkgp.ac.in

### **ABSTRACT**

In this study, a steady turbulent flow over a sinusoidal boundary is investigated by applying Reynolds averaged Navier–Stokes (RANS) equations. Assuming a power law of streamwise velocity and considering the effects of curvilinear streamlines, mathematical formulations for the free surface profiles and Reynolds shear stress are obtained. The profiles of free surface, boundary shear stress and Reynolds shear stress are presented. In subcritical flow, the free surface profile is out of phase with the boundary; while the boundary shear stress is nearly in phase. However, the free surface and the boundary shear stress profiles in supercritical flow are contrary to those in subcritical flow. Downstream of the crest, the Reynolds shear stress is featured by a convex profile due to a decelerated flow; while upstream of the crest, it is featured by a concave profile due to an accelerated flow. However, over the crest and the trough of the boundary, the Reynolds shear stress profiles are nearly linear.