PARAMETRIC ANALYSIS OF HYDRODYNAMIC DRAG REDUCTION EFFECTS DETERMINED BY STREAMWISE TRIANGULAR RIBLETS

William Gordon¹, O. Remus Tutunea-Fatan¹*, Evgueni V. Bordatchev²,¹

¹Mechanical and Material Engineering, University of Western Ontario, London, Ontario, Canada
²Automotive and Surface Transportation, National Research Council of Canada, London, Ontario, Canada

ABSTRACT

Significant research efforts were recently made in studying hydrodynamics of a turbulent water flow over surfaces structured with various micro-scale features. Past studies have demonstrated drag reduction, self-cleaning, and fouling-resistant effects of streamwise triangular riblets (STR) as well as several other riblet designs. The goal of this study was to numerically simulate and parametrically analyze the effect of included angle (α) as well as other geometric characteristics of STRs on potential drag reduction effects.

The CFD simulations performed within the scope of the current study were focused on the effect of design parameters on turbulent flow hydrodynamics as well as their effect on drag reduction performance. The analysis considered several different values of the included angle namely α = 15°, 30°, and 60° as well as several flow velocity magnitudes. The flow conditions – particularly the turbulent structures formed adjacent to riblet peaks and valleys – have been analyzed in details and have been compared with results associated with previously investigated fouling resistant microstructures. In agreement with previously reported data, CFD simulations were run by means of the LES WALE model encompassing an unstructured mesh. The examination of the turbulent flow patterns near riblet tips and valleys revealed that the flow exhibits characteristics consistent with those published in the past for 60° STR. Moreover, as α decreases, the range of non-dimensional riblet spacing (s+) exhibiting drag reducing effects reduces while the range of Reynolds number increases. The smaller value of the analyzed included angle seemed to be associated with maximum drag reduction (10%) for smaller s+ values. The preliminary results also suggested that in case of comparable Reynolds numbers, the largest drag reduction effects are associated with intermediate included angle values.

This research could bring significant contributions various industry sectors for which improved drag performance constitutes one of the important avenues for technological development. Future extension of this work will attempt to devise and perform physical experiments capable to validate the numerical results obtained herein.