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Influence of Hydrophobic Surface on Flow Past Square Cylinder

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Abstract : In external flows, vortex shedding behind the bluff bodies causes to experience unsteady loads on a large number of engineering structures, resulting in structural failure. Vortex shedding can even turn out to be disastrous like the Tacoma Bridge failure incident. We need to have control over vortex shedding to get rid of this untoward condition by reducing the unsteady forces acting on the bluff body. In circular cylinders, hydrophobic surface in an otherwise no-slip surface is found to be delaying separation and minimizes the effects of vortex shedding drastically. Flow over square cylinder stands different from this behavior as separation can takes place from either of the two corner separation points (front or rear). An attempt is made in this study to numerically elucidate the effect of hydrophobic surface in flow over a square cylinder. A 2D numerical simulation has been done to understand the effects of the slip surface on the flow past square cylinder. The details of the numerical algorithm will be presented at the time of the conference. A non-dimensional parameter, Knudsen number is defined to quantify the slip on the cylinder surface based on Maxwell's equation. The slip surface condition of the wall affects the vorticity distribution around the cylinder and the flow separation. In the numerical analysis, we observed that the hydrophobic surface enhances the shedding frequency and damps down the amplitude of oscillations of the square cylinder. We also found that the slip has a negative effect on aerodynamic force coefficients such as the coefficient of lift (CL), coefficient of drag (CD) etc. and hence replacing the no slip surface by a hydrophobic surface can be treated as an effective drag reduction strategy and the introduction of hydrophobic surface could be utilized for reducing the vortex induced vibrations (VIV) and is found as an effective method in controlling VIV thereby controlling the structural failures.

Keywords : drag reduction, flow past square cylinder, flow control, hydrophobic surfaces, vortex shedding
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