Reduction of Fluid Forces on a Square Cylinder Using Passive Control Methods

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Abstract

Uncontrolled fluid flow around a cylinder can cause high fluid forces on the cylinder that will lead to an unsteady wake behind it and induced vibration. Controlling the fluid flow by effective control methods will save energy and reduce induced vibration for the body in the flow. Using passive control methods can guarantee the setup of the flow to be simple, practical, and economical.

COMSOL Multiphysics® is used in this study to simulate the flow around a square cylinder and focus on reducing the forces on the cylinder by passive control methods. The problem setup is validated and the results are improved even more with original passive control methods tested. The problem is simplified to be two-dimensional, unsteady, and incompressible case. The physics used in COMSOL for the study are selected to be laminar non-isothermal fluid flow.

For the validation of the model, the upstream vertical control plate is used to compare the results. For the upstream vertical control plate study, the optimum case happens when the control plate is of half the width of the square cylinder and three widths away from the square cylinder. The optimum case found agrees with the results reached in the published paper. The optimum case is improved by using other control methods. The study proves that using an upstream vertical and downstream horizontal control plate for the fluid flow over a square cylinder reduces the forces and fluctuations. The best case found in this study is by placing an upstream control plate of half width of the cylinder and three widths away and a downstream horizontal control plate of the same width of the cylinder and a half width away. This case is illustrated in Figure 1 for the velocity contours and streamlines.

Studying flow over bodies is important because it models real life applications such as flow around buildings, chimneys, bridges, and heat exchanger pipes. Controlling this flow is essential in order to reduce forces on bodies. This study shows the effect of using an upstream vertical and downstream horizontal control plate to significantly reduce the fluid forces on a square cylinder.

Reference

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Figures used in the abstract

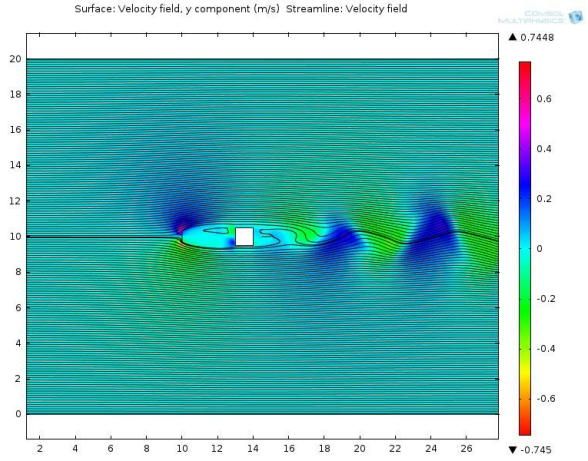

Figure 1: Instantaneous streamlines and contours around the square cylinder and control plate for optimum case.