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The effect of a passive flap geometry on the aerodynamics of a bluff body vehicle

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ABSTRACT

Several passive devices have been tested to reduce the drag force around a generic vehicle model developed by (Ahmed et al., 1984) known as the Ahmed body. Promising drag reductions have been reported in the literature where vortex cylinder, flaps, and some other passive devices have been installed at different locations to manipulate the flow on the Ahmed body. Especially flaps have been documented to perform as the most efficient way of drag reduction. However, based on the available literature, a study of the flap with different geometric shapes has not been studied around the Ahmed model. This article aims to satisfy this research gap by introducing four different flap shapes, the rectangular, elliptical, V shape, and the triangular shape. A 35° Ahmed body is used as a base model, and the flaps are installed at the top of the slant surface. The flap angles have been varied to find out the optimal angle for the drag reduction in the range of 0° to 25°. The Reynolds-Averaged Naiver-stokes equation with an SST k-omega turbulence closure model has been solved on a commercial Fluent solver. The numerical simulation is performed at a 7.8×10^5 Reynolds number based on the model height. Though all the flaps provide the drag reduction but the rectangular flap outperformed the other flap shapes and provided a maximum of 14.3% drag reduction at the optimal flap angle of 10°. The reason behind this drag reduction has been reported. The results suggest that the drag reduction is due to the pressure recovery at the slanted surface. The flap model delayed the flow separation, which exposed the flow inside the slant surface directly to the wake flow. This direct interaction led to a decrease in the velocity, which recovered the pressure at the slant surface. The focus of this investigation is to reveal the dynamics inside the slant surface and quantify the drag reduction mechanism.

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