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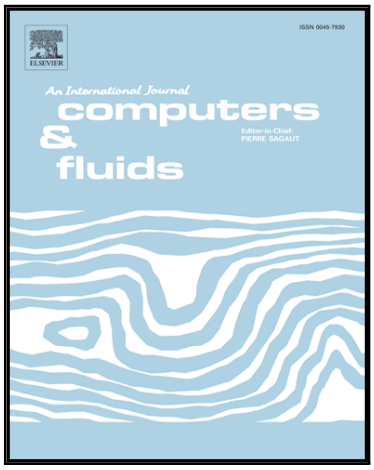

Edge curvature effects of a square cylinder on self-sustained oscillations

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Edge curvature effects of a square cylinder on self-sustained oscillations

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Abstract

A square cylinder at zero angle of attack is known to exhibit a self-sustained response beyond the lock-in region. This self-sustained response is characterized by a frequency that is lower than the vortex shedding frequency and with large amplitudes. However, this self-sustained oscillation is not present for circular cylinders. Prior literature indicates that shape changes through altering the corner sharpness can help to reduce these self sustaining oscillations. In this work, shape changes are realized through altering the curvature of the edge(side) of the square cylinder. For different edge curvature and rounded corner combinations, characterization of these self-sustained oscillations is studied. Detailed flow analysis is performed to study the effect of straight edge, curved edge, sharp corner and rounded corner on the pressure distribution. A proper combination of edge curvature and corner sharpness proves to be beneficial in reducing self sustaining oscillations.

Keywords: vortex-induced vibration, self-sustained oscillations, boundary layer, OpenFOAM.

1. Introduction

Vortex-induced vibrations of bluff bodies such as circular and/or square cylinders have applications in off-shore, power lines, and energy extraction. It is well known that circular cylinders exhibit large amplitudes in the lock-in region [13]. Beyond this lock-in region, the amplitude falls down to a minimum value and this phenomenon is referred to as desynchronization. However for square cylinders, the vortex-induced vibration (VIV) is different. At an angle of attack $\alpha = 0$, a self-sustained large amplitude response is observed after the lock-in region [15] [12][14]. The amplitude of this self-sustained oscillation reduces with increase in angle of attack and is totally suppressed at angle of attack of 45^o . In comparison with a circular cylinder, the displacement amplitudes are smaller

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