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# Modulating Vortex Dynamics Around Circular Cylinder Via Asymmetric Cross-Sectional Profile Morphing: A Comparative Study of Cylindrical and Elliptical Configurations

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**Abstract :** Active flow control around a cylinder is an extensively studied subject in aerodynamics. Researchers apply a range of techniques to alter the fluid flow surrounding a cylindrical body, with the intent of reducing drag, enhancing lift, and optimizing overall aerodynamic performance. This study investigates the manipulation of flow dynamics around a circular cylinder by introducing an original elliptical cylindrical deformation to the traditionally straight section. Through the use of a crank mechanism, precise control of the deformation is achieved, allowing a comprehensive examination of its effects on fluid flow patterns. The main objective of this research is to evaluate the effectiveness of this advanced approach in reducing the drag coefficient and modifying the wake pattern, providing valuable information on flow control and optimization. Experimental results show that varying deformation amplitudes (10%, 15% and 20%) and control frequencies strongly influence drag and flow structure, the maximum reduction in drag coefficient (approximately 44%) observed at 15% amplitude and optimum frequency. The flow structure is strongly influenced by the deformation amplitude and frequency, particularly in the frequency range close to that of the natural shedding. These results suggest that the deformation frequency and amplitude play a crucial role in modifying the flow structure and reducing the drag coefficient. Numerical simulations further support the efficiency of the active flow control technique using cylindrical-elliptical deformation, underlining a consistent drag reduction of up to 42% at extreme deformation conditions (100%). The present study aims at highlighting the potential of this original approach in the enhancement of efficiency and performance of systems involved in energy exchange with fluids. Concluding this, the current study offers fresh routes toward the development of flow control and optimization strategies in a wide range of engineering applications.

**Keywords :** control frequencies, deformation amplitudes, drag coefficient, elliptical cylindrical deformation, flow dynamics, wake pattern
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