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Vortex Dynamics in the Wake of Square Cylinder with Spanwise Geometric Disturbance[1]

Guocan Ling[2], Jiayu Niu[3] and Liming Lin[2]

Summary

The effects of spanwise geometric disturbance about a square cylinder on wake vortex dynamics and force reduction are studied by DNS for Reynolds number 100 and 180, respectively. Numerical methods used are based on hybrid of spectral (in spanwise direction) and high resolution finite difference (in streamwise and vertical directions) methods.

Results show that different degrees of waviness disturbance lead to various vortex dynamics and flow patterns, depending on the Reynolds number. Three kinds of vortex dynamics in near wake are presented for Re=100. Particularly, in the case of mild waviness, vortex shedding is completely suppressed, a "chayote"-like vortex attached to cylinder surface, followed by a steady state vortex sheet. For Re=180, the coupling effects induced by the geometric disturbance and 3-D natural instability are examined in detail. In the case of mild waviness, vortex dynamics is characterized by mode compition between "Chayote"-like structure and mode A structure. The vortex structure becomes much irregular in near wake and breaks down in downstream as the waviness increases further. Spectral analysis for the key quantity in flow field shows the irregularity behaviors of the wake flow. Great reduction of forces is reported. The mechanism responsible for the vortex dynamics and force reduction is suggested.

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[2]The State Key Laboratory of Nonlinear Mechanics, Institute of Mechanics, Chinese Academy of Sciences, Beijing 100080, China.

[3]The Key Laboratory of High Temperature Gas Dynamics, Institute of Mechanics, Chinese Academy of Sciences, Beijing 100080, China.