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Study of Bifurcation Curve with Aspect Ratio at Low Reynolds Number

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Abstract : The bifurcation curve of separation in steady two-dimensional viscous flow past an elliptic cylinder is studied by varying the angle of incidence (α) with different aspect ratio (ratio of minor to major axis). The solutions are based on numerical investigation, using finite element analysis, of the Navier-Stokes equations for incompressible flow. Results are presented for Reynolds number up to 50 and angle of incidence varies from 0° to 90°. Range of aspect ratio (Ar) is from 0.1 to 1 (in steps of 0.1) and flow is considered as unbounded flow. Bifurcation curve represents the locus of Reynolds numbers (Res) at which flow detaches or separates from the surface of the body at a given α and Ar. In earlier studies, effect of Ar on laminar separation curve or bifurcation curve is limited for Ar = 0.1, 0.2, 0.5 and 0.8. Some results are also available at α = 90° and 45°. The present study attempts to provide a systematic data and clear understanding on the effect of Ar at bifurcation curve and its point of maxima. In addition, issues regarding location of separation angle and maximum ratio of coefficient of lift to drag are studied. We found that nature of curve, separation angle and maximum ratio of lift to drag changes considerably with respect to change in Ar.

Keywords : aspect ratio, bifurcation curve, elliptic cylinder, GMRES, stabilized finite-element
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