Flow past sharp edges in uniform and accelerated flow: A biharmonic approach

Jiten C Kalita

Department of Mathematics, Indian Institute of Technology Guwahati INDIA

We present a transient extension of a recently developed compact finite difference schemes on nonuniform Cartesian grids without transformation for the Biharmonic form of the steady-state Navier-Stokes equation [1]. Subsequently we carry out numerical investigations of the unsteady wake for flow past sharp edges in uniform and accelerated flow. As test cases, we have chosen the flow past a flat plate and a wall mounted wedge for a wide range of Reynolds numbers. For the flat plate in uniform flow, numerical results are presented for the steady state regime up to Reynolds number Re=20 and unsteady flow executing vortex shedding up to Re=100. For the accelerated case, we present results for Re=400 and 500. For the wedge, we have specifically chosen the famous Pullin and Perry [2] experiment as our model problem where flow is simulated for Re=6873 with wedge angle 60° for a much longer duration than the actual lab experiment. All the typical three-fold structure of the starting vortex observed by Lian and Huang [3] was confirmed by our simulation. In all the cases, our results compare very well with established numerical and experimental results.

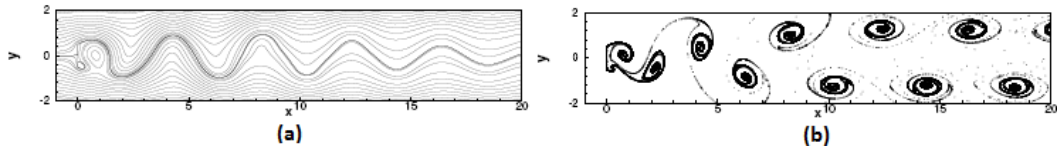

Fig 1: (a) Streamlines and (b) Streaklines depicting von Kármán vortex street for the flow past a flat plate in uniform flow for Re=100.

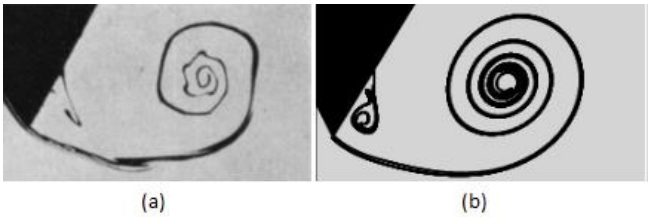

Fig 2: Streaklines from (a) the experiment of Pullin and Perry [2], and (b) the current simulation for Re=6873 for the flow past a wedge with edge angle 60° at time t=7s.

REFERENCES:

1. Kumar P, Kalita JC, J. Comp. App. Math, 353: 291-317, 2019.
2. Pullin DI, Perry AE, J. Fl. Mech, 97 (2): 239-255, 1980.
3. Lian QX, Huang Z, Experiments in Fluids, 8:95-103, 1989.