INSTABILITIES IN BLUFF BODY FLOWS

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The flow past a circular cylinder is associated with a large number of instabilities. Some of them are discussed. Global linear stability analysis is carried out to investigate the critical Reynolds number for the onset of these instabilities. A scheme for the global analysis of convective instabilities in nonparallel flows is utilized. The linearized perturbation equations for an incompressible flow are written in a moving frame of reference that travels with the perturbation. A stabilized finite element method is utilized to discretize these equations. A sub-space iteration procedure is utilized to solve the resulting generalized eigenvalue problem. In certain cases, direct numerical simulations are also carried out.

The critical Re for the onset of convective instability, associated with the wake of the cylinder, is found to be 4, approximately. The global absolute instability sets in at Re ~ 47. The critical Re for the onset of shear layer instability, from the present effort, is found to be 54, approximately. A new mode of vortex shedding is discovered beyond Re=110. Three-dimensionality in the wake is observed beyond Re=200. Mode A and B instabilities in the wake of the cylinder are investigated. While Mode A is hysteretic, mode B is not. It is shown that both oblique and parallel mode of vortex shedding arise from unstable eigenmodes of the linearized disturbance equations. The role of shear layer instability in the transition of the boundary layer will be discussed. Also presented will be results from flow induced vibrations and some cases of fluid-structure interactions of a cylinder with a flexible splitter plate.