ABSTRACT

In the present work, an attempt has been made to study the phenomenon of 'bubble type' separated flow past bodies of arbitrary shapes numerically as well as experimentally.

A potential flow solver, based on panel technique, using 'free vortex lines', has been developed initially for calculating separated flow past arbitrary two-dimensional body geometries. The solver has been applied to study the separated flow about circular cylinder as well as square and rectangular cylinder at various angles of incidence.

Two Navier-Stokes solvers, based on finite volume approach, have been developed for calculating two-dimensional incompressible flows at low and moderate Reynolds numbers. The first solver uses a Cartesian staggered grid. Using this Navier-Stokes solver, results have been obtained for unconfined, confined and partially confined flow past square and rectangular geometries at zero angle of incidence.

The second solver uses a curvilinear body-fitted non-staggered (collocated) grid. In this solver, the full Navier-Stokes equations have been solved numerically in the physical plane itself without using any transformation to the computational plane. For the proper coupling of pressure and velocity field on collocated grid, a consistent flux reconstruction scheme has been developed. This solver has been applied to unconfined flow past a square cylinder at zero and non-zero incidence.

To solve separated flow problems at high Reynolds number two turbulence models have also been developed. The Standard k-ε and a modified MMK k-ε model have been developed, based on the first Navier-Stokes solver, to study unconfined turbulent flow past a square cylinder.

Experimental investigation has also been carried out on square and rectangular cylinders in a low-speed wind tunnel. Experimental work involves measurement of detailed surface pressure distribution on these models at various angles of incidence.

The computed results using the potential solver and the Navier-Stokes solvers for laminar and turbulent flows have been compared with other numerical and experimental results. The numerical results agree reasonably well with the available results.

KEY WORDS

Incompressible, Laminar, Viscous, Two-dimensional flow, Bluff body, Separated flow, Karman vortex street, Panel method, Potential flow modelling, Free vortex lines, Navier-Stokes solver, Finite volume method, Physical plane, Grid generation, Unsteady, Explicit, Physical Interpolation Approach, Consistent Physical Interpolation, Consistent Flux Reconstruction, Turbulence modelling, Eddy viscosity model