# Abstract

Fluid-Structure Interaction occurs in many engineering fields. These interactions give rise to complicated vibrations of the structures and could cause structural damage under certain unfavourable conditions. A common fluid-structure interaction problem is the flow-induced vibrations of a structure caused by vortex shedding from the structure. To solve the problem, a time marching technique that iterates for the interaction effects at every time step, has been proposed. The interactions between the fluid and structure are considered by solving the equations governing the flow field and the structural motions in an iterative way. The flow equations are solved by Finite Element method using the primitive variables. A two-degree of freedom model is used to approximate the structural dynamic behaviour. The aim of the present work is to examine the vortex induced vibrations on a circular cylinder and the associated phenomena, such as the response of the cylinder, the unsteady lift and the drag on the cylinder, the vortex shedding frequency, and the effects of the cylinder motion on the vortex structure in the wake. After successful simulation of the flow around a rigid square and a circular cylinder in a cross flow, the model is applied to study the fluid structure interaction of an elastic circular cylinder in a uniform flow. The cylinder is modeled by a spring-damper-mass system.

The governing equation for the flow field is obviously the full Navier-Stokes equations. In this study a slight modification is introduced through the assumption that the flow be nearly incompressible, i.e. compressibility is only due to pressure variation and not due to temperature change. This isothermal approximation is accepted as flow is modeled at very low Reynolds number, in the range 10 to 500. This modified N-S equations have been solved by an explicit-implicit Galerkin finite element procedure using the so-called $P_2P_1$ element. The method is explicit-implicit in the sense that the velocities are solved explicitly and pressure is solved implicitly. A dynamic grid algorithm in which the mesh moves continuously to conform to the instantaneous shape and location of the body is incorporated to study the unsteady flows. The initial finite element mesh or the static grid is generated using the Delaunay triangulation. When the tube moves, the nodes of the grid also move accordingly. The nodal displacements are solved using spring analogy and static equilibrium in which each edge of the triangular mesh is modeled as a spring having spring stiffness (k) that equals the reciprocal of the square of the edge concern. At each time step the displacements of the interior grid points are then solved by predictor corrector method, the outer boundary being fixed. The structural analysis of the tube rod has been performed considering it to be a simple beam fixed at two ends. For the calculation of the cylinder response due to fluid structure interaction, it is assumed that the circular cylinder is mounted by the spring-damper-mass system, which represents the situation at a section of a long cylindrical structure at the location of maximum amplitude of vibration.