A COMPARISION OF CONFORMING AND NON-CONFORMING MSEH METHODS FOR A FLOW AROUND A CIRCULAR CYLINDER IN NON-INERTIAL FRAME OF REFERENCS

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ABSTRACT

The flow over moving bluff bodies received significant attention in the recent decade. For applications with large physical domains and large body displacements it is of vital importance to use an accurate and computationally affordable numerical method (Mittal and Iaccarino 2005). The immersed boundary method, which was initially developed by Peskin (1972), is a technique in which a non-conforming mesh is employed for solving flow problems in regions with irregular/moving boundaries using a simple structured grid solver. Immersed boundary simulations are carried out on Cartesian grids. At those locations where the boundary does not align with a mesh line, the solution algorithm is locally modified to enforce the desired boundary conditions on the flow (kang et al. 2009). In some applications, the need to simulate flow around a circular cylinder (e.g. oil riser) the usage of cylindrical coordinates in a non-inertial frame of reference might be beneficial as the boundary conditions around the moving body naturally conform to the structure.

The objective of the present study is to compare the accuracy and computational expenses of an immersed boundary method (using IB interpolation) with those of a boundary-conforming numerical method. For the latter, the Navier-Stokes equations were solved using cylindrical coordinates (Verzicco and Orlandi 1996). The same boundary conditions for inlet and outlet were applied in both simulations. In both cases a non-inertial frame of reference was applied to be able to model moving boundaries. The vertical structures that appear behind the cylinder, as well as the drag and lift coefficients and the Strouhal number for forced and vortex-Induced-Vibrations (VIV) under various conditions are compared. It is shown that, although in cylindrical coordinates the definition of the boundary condition at the cylindrical wall is more accurate, the definition of the outflow condition is problematic due to the usage of the moving frame of reference approach. The simulation results show that both approaches are producing acceptable results. When using a similar number of mesh points, the simulation using cylindrical coordinates is less expensive, though the need for a larger computational domain when using cylindrical coordinates (to overcome difficulties in the definition of the outflow boundary conditions) again increases the computational costs of this method.

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