World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:9, No:06, 2015

A 2D Numerical Model of Viscous Flow-Cylinder Interaction

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Abstract : The flow induced cylinder vibration or earthquake-induced cylinder motion are moving in an arbitrary direction with time. The phenomenon of flow across cylinder is highly nonlinear and a linear-superposition of flow pattern across separated oscillating direction of cylinder motion is not valid to obtain the flow pattern across a cylinder oscillating in multiple directions. A novel finite difference scheme is developed to simulate the viscous flow across an arbitrary moving circular cylinder and we call this a complete 2D (two-dimensional) flow-cylinder interaction. That is, the cylinder is simultaneously oscillating in x- and y- directions. The time-dependent domain and meshes associated with the moving cylinder are mapped to a fixed computational domain and meshes, which are time independent. The numerical results are validated by several bench mark studies. Several examples are introduced including flow across steam-wise, transverse oscillating cylinder and flow across rotating cylinder and flow across arbitrary moving cylinder. The Morison's formula can not describe the complex interaction phenomenon between cross flow and oscillating circular cylinder. And the completed 2D computational fluid dynamic analysis should be made to obtain the correct hydrodynamic force acting on the cylinder.

Keywords : 2D cylinder, finite-difference method, flow-cylinder interaction, flow induced vibration
Conference Title : ICFMT 2015 : International Conference on Fluid Mechanics and Thermodynamics
Conference Location : New York, United States
Conference Dates : June 04-05, 2015