Simulating external flow using vortex method in two- and three dimensions

Spietz, Henrik Juul; Hejlesen, Mads Mølholm; Walther, Jens Honore; Larsen, Allan

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Simulating external flow using vortex method in two- and three dimensions HENRIK JUUL SPIETZ, MADS MLHOLM HEJLESEN, Technical University of Denmark, JENS HONORE WALTHER, Technical University of Denmark and Computational Science and Engineering Laboratory, ETH Zurich, ALLAN LARSEN, COWI Consulting Engineers, COWI CONSULTING ENGINEERS COLLABORATION — Vortex methods are numerical methods for simulating fluid flow. They use a simple formulation where only the trajectories of discrete vortex particles are simulated. In our method we combine a high order particle-mesh based vortex method with an iterative penalization method to simulate external flows around arbitrary geometries such as bridge decks. The method only uses a discretized geometry as input and can easily simulate an arbitrary motion of the geometry. As vorticity is a bounded quantity and the velocity field can easily be calculated for a mixture of free-space- and periodic boundary conditions, the method allows for a minimized domain and hence minimal computational resources. However in an external flow problem, vorticity is produced in the boundary layers and transported downstream, consequently the computational domain must grow in time to encapsulate the entire vorticity field. We present a method for truncating this domain by supplementing the free-space- and periodic conditions with an outflow condition. The method is conveniently applied within the field of bridge aerodynamics as it can be used for the calculation of the aerodynamic net forces, which depend highly on the geometry and the wake forming behind it. This is demonstrated in 2D and 3D simulations

Henrik Juul Spietz
Technical University of Denmark

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