Etude numérique de voilures souples en milieu marin : aide à la propulsion

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Abstract
The behavior of a thicknessless membrane placed in a unidirectional and irrotational flow is analyzed using numerical simulation. The lift, thrust and inertial forces were calculated based on the pressure distribution over and under the membrane using the Vortex Method. The response of the solid was calculated based on the large displacement hypothesis using the Timoshenko beam theory and total Lagrangian formulation in ANSYS APDL, with time resolution based on HHT-α method, where the Newton-Raphson method was applied to resolve non-linear aspects. Fluid-solid interaction was achieved through explicit data exchange between the fluid simulation code and the structural model based on the kinetic and dynamic conditions at the interface boundary and paying special attention to the Nyquist–Shannon criteria and the Courant-Friedrich-Levy's conditions. A new matricial decomposition of hydrodynamic efforts was successfully applied, allowing us to quantify the influence of the inertial force component in the flow and demonstrate the instant value of the added inertia. A study of the thrust in relation to the beating frequencies, the mechanical properties of the deformable solid and the system's mechanical configurations was carried out to find the best propulsion conditions.