Abstract

This thesis deals with the fluid-structure interaction of marine cycloidal propeller. This propeller is well known for its maneuvering capability. In this propulsion system, both propulsion and maneuvering units are combined therefore no separate rudder is required for maneuvering the vessel. The main objective of this thesis is

- Developing a mathematical tool for unsteady flow analysis of the propeller blades with structural coupling, and
- Investigating the maneuvering dynamics of the ship, hydrodynamic load and structural response on the propeller blades for various maneuvering operations.

The maneuvering conditions considered are straight acceleration, autopilot, crash stop, towing, turning and zigzag. During this maneuvering operation, the blades are subjected to substantial fluctuation in the loading. The propeller blade continuously flaps as the disc rotates due to this effect the inflow to the blade continuously changes and that leads to unsteady flow. For computing the hydrodynamic load, unsteady flow is modeled by panel method. Viscous corrections to the predicted flow are applied by boundary layer technique. The rotating disc effect of the propeller is computed, and the flow near the root of the blade is altered. The inception of flow separation is also determined. For structural dynamics, finite element method is used, and the blade is considered as a thin plate. Weak coupling of structural dynamics with hydrodynamic loading is considered. The computing power required for the numerical scheme is discussed. The proposed numerical method will contribute to the development of unsteady CFD analysis of ship maneuvering behavior with fluid-structure coupling. The propeller engine was modeled numerically, and the torque and rpm can be computed. The individual blade thrust, torque, and load distribution along the surface are computed. The computation of those hydrodynamic parameters is too expensive and robust to compute experimentally.

Keywords: Panel method; Unsteady flow; Finite element method; Mode superposition method; Blade vibration; Maneuvering dynamics; Boundary layer problem; Flow separation; Rotating disc effect; Hydrodynamic load and parallel computing.