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Abstract

The hydrodynamic problem of a circular cylinder undergoing large amplitude oscillations in water covered by an ice sheet is investigated. The ice sheet is modelled by a thin elastic sheet and uniform physical properties are assumed. The fluid is assumed to be inviscid, incompressible and homogeneous, and the depth to be infinite. The boundary condition on the ice sheet is linearized and satisfied on its mean position, while the fully nonlinear boundary condition is imposed on the instantaneous position of the body surface. The velocity potential is formulated by the multipole expansion method in the polar coordinate system with its origin fixed at the centre of the cylinder. Detailed results through the hydrodynamic force and deformation of the ice sheet are provided. The effects of the ice sheet properties, and motion amplitude and frequency are investigated.

Keywords

Ice sheet; circular cylinder; large amplitude oscillation; multipole expansion.

1. Introduction

Water wave/structure interaction has always been a major interest in fluid mechanics. This is primarily because of the importance of the ocean. It provides a major means for trade, as well as is a rich source of food and resource. Its wave, current and wind can also provide clean and renewable energy. Therefore, there has been extensive research on this topic. However, the most work focuses on a body in open seas, in which the water surface is in direct contact with air, and the surface is commonly called free surface.

A closely related problem is when the water surface is covered by an ice sheet, which can be typically seen in the Arctic or Antarctic regions. There has also been a large number of work on ice sheet/wave interaction. Review of early work was given by Squire, et al. [1] and more recent one was given by Squire [2]. Much of the work reviewed is about wave interaction with ice sheet.

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