Water wave interaction by a bottom-standing cylinder beneath an ice-cover in a finite depth ocean water

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1 Introduction

The interaction of water waves with a submerged circular bottom-standing cylinder has an ice-cover instead of a free surface, the ice-cover being modelled as a thin elastic plate is investigated here, using semi analytical technique assuming linear potential theory. The problem is formulated based on potential flow and linear wave theory and under the assumptions of small-amplitude structural oscillations, analytical expressions are obtained for the wave motion in each flow region based on an eigenfunction expansion approach. The velocity potentials of the incident and scattered waves are expanded using the Bessel and Hankel functions for each region in the problem. To obtain the integral equations that encompass one-third singularity. Using multi-term Galerkin method in terms of ultra- spherical Gegenbauer polynomial as its basis function due to the edge conditions at the corner of the cylinder respectively, to figure out the analytical solutions. The convergence of the present analytical solution is rapid, and a few truncated numbers in the series of the basis function can yield results of six-figure accuracy for wave forces and moments. Semi-analytical expressions for the hydrodynamic excitation and reaction loads on the structure are obtained for different parametric values which are depicted graphically against the wave number. Numerical examinations are carried out to investigate the influence of flexural rigidity of the ice-cover by the bottom-standing rigid cylinder.

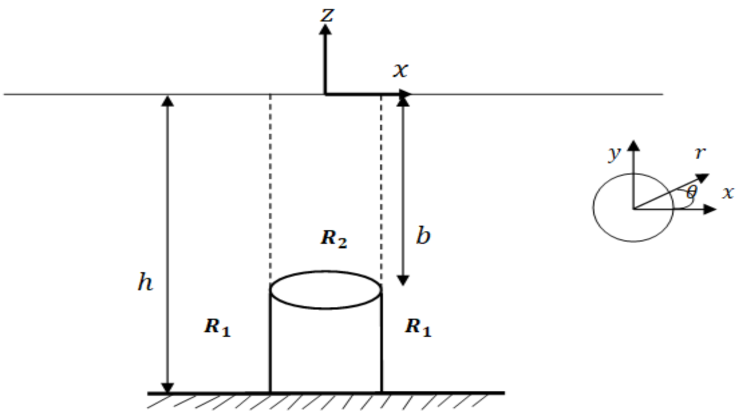

Figure 1: Schematic sketch of the cylinder

2 Numerical Results

The effect of various wave and structural parameters on the hydrodynamic exciting forces and moment are obtained numerically for different values of wave numbers by taking N = 10 in the (N+1)-th term Galerkin approximations. Figs. 2(A)-2(C) present the influence of flexural rigidity of the ice-cover on the excitation loads and moment experienced by a bottom-standing rigid cylinder. Keeping the parametric values fixed at $a/h = 0.5$, $b/h = 0.65$, $\epsilon/h = 0.01$, the variations of the wave forces and moment on truncated cylinder against the wave number Kh, are graphically represented here. At low frequencies, the horizontal wave force first attains the maximum and then significant decrease in the amount of horizontal vertical motions, especially at high frequencies. With the increase of frequencies, the vertical wave force and roll moment increase while for higher frequencies, the vertical wave force on the truncated cylinder approaches towards unity. Overall, the excitation forces and moment are highly effected by thickness of flexural rigidity of the ice-cover represented by the parameter D/h^4 for different four values at 0.1, 0.5, 1.0, 1.5. Due to the presence of ice-cover, the curves of the non-dimensional horizontal force decrease with increase of flexural rigidity of the ice-cover and attain a moderate value after that increase with increase of flexural rigidity of ice-cover whereas

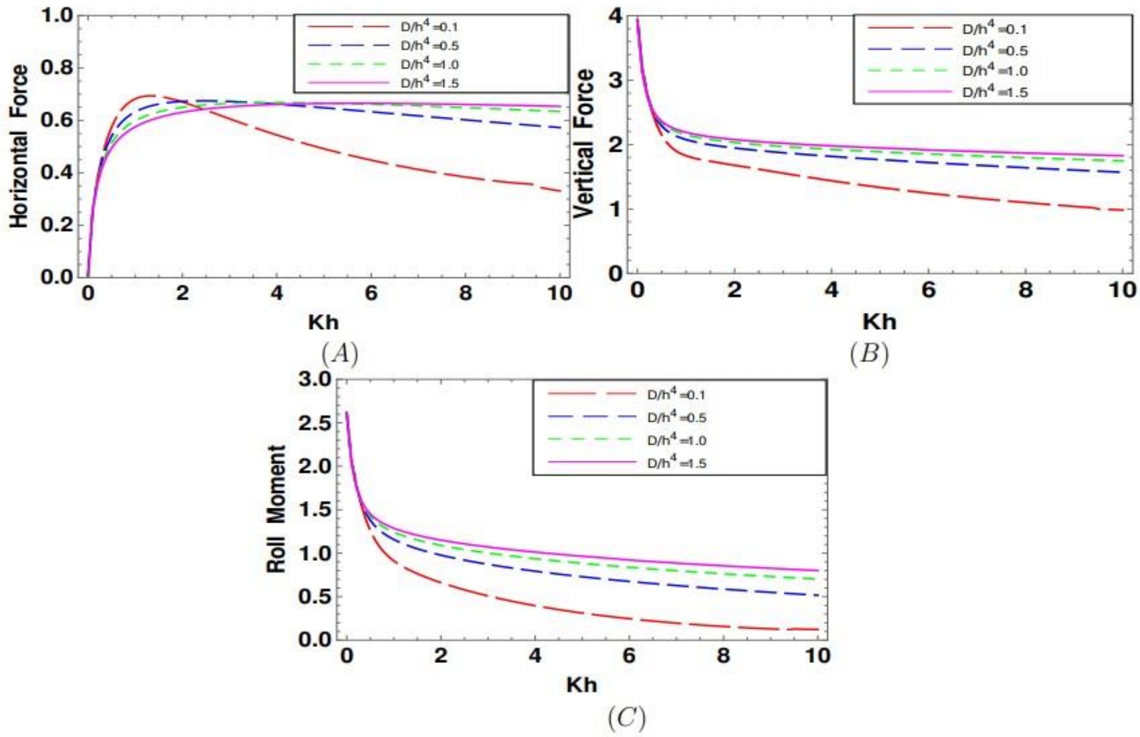

Figure 2: (A) Horizontal Force, (B) Vertical Force, (C) Roll Moment vs. wave number for different flexural rigidity of the ice-cover with a/h = 0.5, b/h = 0.65, ϵ/h = 0.01

its influence on the vertical forces is relatively minor.

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