Wave structure interaction problem on an immersed prolate spheroid in the presence of surface tension

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ABSTRACT

The present study focuses on wave structure interaction problem of a stationary submerged prolate spheroid in water of infinite depth when the effect of surface tension on the free surface is included. The formulation is established on employing multipole expansion method based on Havelock's spheroid theorem (1952). A prolate spheroidal coordinate system is introduced to utilize the symmetry of the body. An approximate form of velocity potential in prolate spheroidal coordinates is thus obtained to determine hydrodynamic loads (both surge and heave forces) exerted on a fixed spheroid exposed to monochromatic time-harmonic incident waves. Magnitudes of exciting forces have been plotted against wave numbers by varying surface tension, depth of submergence and eccentricity of the spheroidal body. The current results are verified with the results already existing in the literature, which implies the accuracy of the method presented here. It is noticed that presence of surface tension plays a pivotal role in the present study.

1. NUMERICAL RESULTS

In this section, exciting forces have been shown graphically against wave numbers by varying surface tension, depth of submergence and eccentricity of the submerged body. Also, by neglecting the presence of surface tension at free surface, we have validated our study with the result already present in Chatjigeorgiou (2013b). We can conclude from the figures that; the peak values of both exciting forces increase as the surface tension increases and the exciting forces vanish for large incident wave frequencies. Here Fig.1 shows the validation of the present study and Fig.2 shows the effect of surface tension on the magnitudes of exciting forces.

2. CONCLUSION

As wave frequency and amplitude depend on surface tension, so wave propagation is affected by presence of surface tension. From computational results it can be concluded that for some fixed value of wave numbers the peak value of heave and surge forces increases when the value of surface tension increases. When effect of surface tension is present, variation of eccentricity of the body and depth of submergence play significant roles in the magnitudes of the exerted forces acting on the axisymmetric prolate spheroid

3. FIGURES

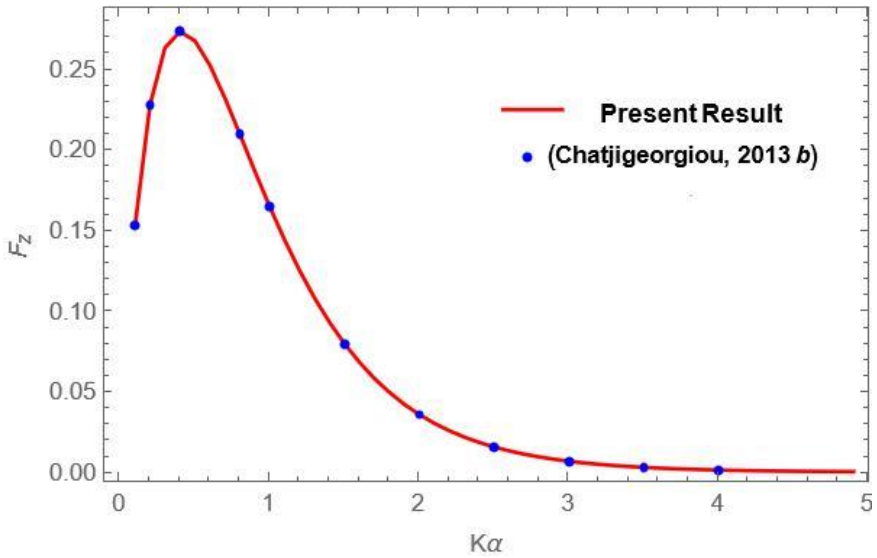

Fig.1: Surge force on prolate spheroidal body (β/α=0.5) submerged at h/α=2.5 with M=0

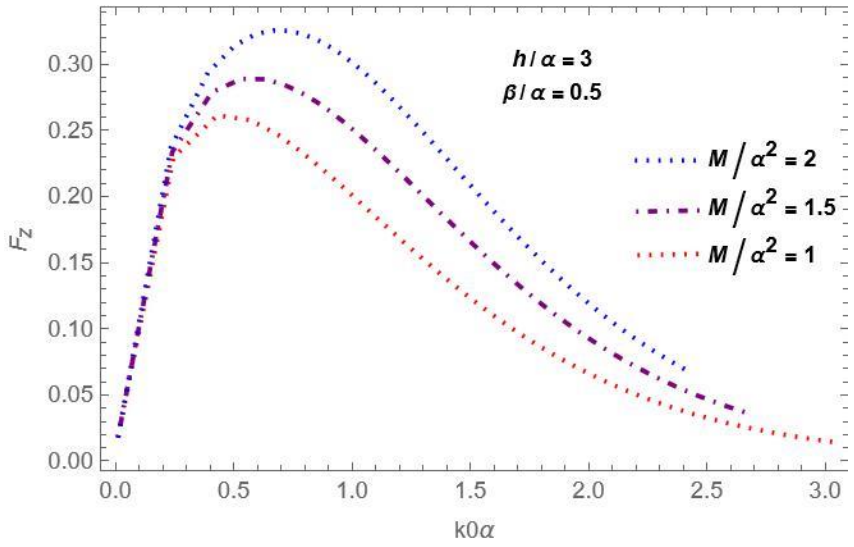

Fig.2: Magnitudes of surge exciting forces on prolate spheroid (β/α =0.5) at submergence h/α =3 with various coefficient of surface tension

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