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Numerical study on evolution of an internal solitary wave over a horizontal cylinder at various topography

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In South China Sea, internal solitary waves (ISWs) exist in a density stratified flow and usually generated by the tide-topography. Due to its large amplitudes up to 170m and strong velocity difference exceeding 2.4 ms^{-1} between its upper and lower water layers, an ISW has significant ramification not only in marine ecology but also engineering works in the ocean. While an ISW propagates over continental shelf, the submarine cable or pipeline may be subjected to be damaged. Although the effect of surface waves on the submarine cable or pipeline has been studied in literature, the interaction between ISW and horizontal cylinder is still unclear. Hence, a series of numerical simulations about an ISW with depression ISW propagating over a horizontal cylinder on a trapezoidal obstacle are investigated in order to discuss the variations of flow field and forces.

In present investigation, the Improved Delayed Detached Eddy Simulation (IDDES) model based on the spatial filtering of Navier-Stokes equations is adopted to calculate the interaction on an ISW over a horizontal cylinder on a trapezoidal obstacle. Beyond, a depression ISW is generated by the so-called collapse mechanism and the different depth ratio between upper and lower layer are employed in order to generate like-elevated or original depression ISW on trapezoidal obstacle. Based on the numerical results, the waveform type causes different variations of vortices as the wave approaches the horizontal cylinder. As the depth in upper layer is larger than that in lower layer on the plateau, the like-elevated ISW encounters the horizontal cylinder and induces the vortices in the rear of the submarine cable; when the depth in upper layer is less than that in lower layer on the plateau, the depression ISW approaches the obstacle and the vortices are generated in front of submarine pipeline. Moreover, the height of submarine cable also affects the strength of the wave-obstacle interaction. Based on these numerical simulations, the mechanism of ISW-horizontal cylinder is further studied and may support the significant foundations for ocean engineering.

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