ABSTRACT

In the present thesis, the green water loading of an ocean-going vessel with/without forward speed is investigated numerically as well as experimentally. In this work, an Impulse Response Function (IRF) based solver has been coupled with commercially available Computational Fluid Dynamic (CFD) solver for predicting the green water load numerically. The global hydrodynamic forces such as radiation, diffraction, and Froude-Kyrlov forces are computed using frequency domain panel method/strip theory and then expressed in the time domain through IRF. However, the green water load is computed using commercial CFD solver (ANSYS), in which finite volume method is used for modeling the fluid field and the volume of fluid (VOF) method is used to capture the free surface deformation. The green water load is then added as an external force in the equation of motion at each time step. The global motions and velocities obtained by solving the equation of motion are again used for the evaluation of the green water loading and global hydrodynamic forces for the next time step.

Several case studies are made to understand the nature of the green water impact, and the dependence of the green water loading on various physical and geometric parameters such as wavelength, wave steepness, forward speed, bow rake angle, etc. for head sea condition. In order to do that, the following work progression is executed. (i) The green water occurrence for a fixed vessel with forward speed is considered for the initial study. In this case, the effect of wavelength, wave steepness, forward speed and bow rake angle on the green water loading is systematically investigated. Also, efficiency and robustness of the ANSYS-Fluent solver in capturing green water loading are validated using the available literature. (ii) Green water loading for floating FPSO is studied, in which the vessel motion is computed using potential flow based method priory and used as an input to the CFD solver. The dynamic mesh is used to capture the vessel motion in CFD solver. The effect of vessel motion on green water loading is then thoroughly investigated. (iii) The coupled IRF-CFD based method is proposed for the solution of the green water occurrence. (iv) An experimental study of green water occurrence is done for a container vessel and the results are compared with the proposed coupled IRF-CFD based solution to check the correctness of the proposed numerical technique, and (v) A systematic parametric study is performed to check the effect of the several physical and geometric factors as mentioned above on green water loading.

Overall, the present study indicates that green water loading is highly dependent on the wavelength, wave steepness, vessel motion, and forward speed. Moreover, the results show that an increase in bow rake angle reduces the green water loading. In addition, it is observed

that the proposed IRF-CFD based scheme is capable of predicting the green water loading with reasonable accuracy, which can assist in the calculation of the design green water load.

Keywords: Impulse Response Function (IRF), Green Water, FVM, Froude number, wavelength, bow rake angle, wave steepness, heave and pitch motions, CFD