Prediction of Parametric Rolling for a Container Ship in Regular and Irregular Waves Using a Fully Nonlinear Time Domain Potential Flow Method

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ABSTRACT

Even though studies on parametric rolling have been carried out from the half of the previous century, they have mainly been focusing on fishing vessels and small coastal cargo carriers in following seas. After an accident in the late nineties with a large container ship in head sea, see [1], parametric rolling has increased the attention of researchers and international authorities. In the last twenty years, it has become an important aspect considered thoroughly in the design phase, especially when dealing with container ships and ferries. Numerical methods that allow for a correct prediction of parametric rolling have become important tools.

In this paper, the 3-D fully nonlinear time domain potential flow method SHIPFLOW MOTIONS has been used. The code has shown to give accurate predictions of ship motions in head sea, see for instance [2]. Its capability is extended and has been used here to simulate parametric rolling in head and following waves. Fully nonlinear boundary conditions on the free surface are implemented in the code, as well as fully coupled rigid body motions. The advancing in time is performed with an Adam-Bashforth-Moulton method. The forces acting on the ship are obtained integrating the pressure on the instantaneous wetted surface. Since roll motion is usually heavily influenced by viscosity and roll damping has a primary role in the phenomena of parametric rolling, damping coefficients are added in the roll motion equation. There are various techniques available to predict these coefficients, see for example [3]. For this paper, two formulations have been used. One proposed by Watanabe and Inoue has been used to estimate roll damping starting from geometrical and inertial characteristics and a parameter identification technique to obtain these coefficients from roll-decay model tests has been applied to a partial set of simulations, where model tests were available.

The numerical simulations presented here reproduce a benchmark study (SAFEDOR, see [4]) for a container ship, where solutions from different numerical methods were compared with model test results. Semi-captive tests were carried out in head and following seas, for monochromatic and three components regular waves and for irregular waves. The benchmark study had two focuses: first of all to assess the capability of the different codes to simulate the resonance occurrence of parametric rolling and second, to evaluate the quality of the amplitude of roll motion predicted.

In the benchmark study, the best performing methods both in terms of occurrence and amplitude prediction are identified. The numerical simulations presented here show a good agreement with model test results. In terms of the ability of the code to replicate the resonance occurrence of parametric rolling,

results are aligned with the mean value of the best performing methods. Regarding the amplitude of the simulated conditions, results show a satisfactory match with model tests, showing, furthermore, to be aligned again with the best performing methods.

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