Comparisons of Experimental and Numerical Results for Global Hydroelastic Response of Container Ship within the WILS III JIP

E. Tiphine(1), F. Bigot(1), J. De-Lauzon(1), F. X. Sireta(1), Y. S. Chung(2), S. Malenica(1)

(1) Bureau Veritas, Research Department, Neuilly sur Seine, France
(2) Bureau Veritas Korea, R&D Local Coordinator, Busanjin-Gu, Busan, Korea

ABSTRACT

The hydro-elastic ship structural response might be an important part of the overall response. The difficulties related to the correct modeling of this type of structural response, either numerically or experimentally, are very important and it is fair to say that the problem is not fully mastered today. There are currently several research projects worldwide aiming at solving this problem, most of them combining numerical modeling, small scale model tests and full scale measurements. One of these projects is the WILS III project, in which model tests of an ultra large container ship flexible model are conducted in different operating conditions. The focus is made on the measurement of the bow flare impact loads that drive the whipping response, and on the improved modeling and measurement of the ship torsional behavior. To this purpose, a new elastic backbone has been fitted on the model, and an innovative procedure for torsion measurement has been proposed.

The first part of the paper is dedicated to the new measurement method. Torsion induced strains in the model backbone are influenced by the entire distribution of torsional moment, so that usual strain conversion procedures fail. The new method uses a base of distortion modes to take all strain gauges into account at once and overcome the difficulty.

In the second part of the paper, comparisons of a hydro-elastic numerical model with the model tests are presented. The numerical model is the combination of a full 3D FEM structural model and a 3D hydrodynamic model based on Boundary Integral Equation (BIE) technique. In addition, a 2D slamming model is added in time domain. Special accent is given to the oblique wave cases which are much more complex to model.

KEY WORDS: Springing; whipping; slamming; model test; elastic backbone.

INTRODUCTION

The WILS III (Wave Induced Loads on Ships) Joint Industrial Project (JIP) is the third in an interesting series of projects initiated by the Maritime and Ocean Engineering Research Institute (MOERI). The first phase of the project (WILS I – 2006-2008) was devoted to the quasi static structural response of the Ultra Large Container Ships, the second phase (WILS II – 2008-2010) was devoted to both quasi static and hydroelastic types of structural loading and responses, and the third phase (WILS III), which is currently ongoing, is dedicated to more thorough investigations of the hydroelastic response. Further to the conclusions of the second phase it was decided to concentrate on the driving mechanism of the whipping response, i.e. the bow flare impact loads. In addition to dedicated drop tests of a 2D ship section, more complex sea keeping tests are performed with measurements of the pressure and force exerted on the bow during the slamming events.

The second work axis in WILS III is the improved modeling and measurement of the ship torsional behavior. Compared to the bending, the torsion is much more difficult to replicate faithfully in a scaled model. The coupling between horizontal shear force and torsion due to the very low hull girder shear center, in particular, cannot be exactly obtained on the model, unless the elastic backbone is located below the hull. In the WILS III project a U shaped backbone was selected and located as low as possible in the model in an attempt to reduce the discrepancy between model and full scale.

This paper focuses on the sea keeping model tests of the WILS III JIP, and their comparison with a numerical model hydroelastic model. After describing the scale model and the tests, the theoretical background on which the numerical model is built is recalled, before the numerical model itself is presented. The torsion measurement issue is then explained, and the new method that is proposed to solve this issue is described, both from a theoretical and from a practical point of view. The numerical analysis of the experimental model is used to demonstrate the efficiency of the new method, compared with standard ones. In the second part of the paper, some comparisons of the hydroelastic numerical model with the model tests are presented, including springing and whipping tests. Special accent is given to the oblique wave cases which are much more complex to model numerically.

DESCRIPTION OF MODEL TESTS

Model setup

The model tests are conducted on an elastic scaled model of a 10,000 TEU container ship. The model is composed of six segments made of fiber reinforced plastic with a wooden frame structure. Each segment is