Rule formulation of vertical hull girder wave loads based on direct computation

Q. Derbanne 1), G. Storhaug 2), V. Shigunov2), G. Xie3) and G. Zheng4)

1) IACS - Bureau Veritas, France
2) IACS - DNV GL, Germany and Norway
3) IACS - American Bureau of Shipping, USA
4) IACS - China Classification Society, China

Abstract

Following major structural failures of large Container ships in recent years a review of existing requirements with focus on the structural performance of such ships was initiated by IACS. IACS established a project team to conduct a review of existing structural requirements, especially the existing UR S11, and propose improvements to the unified requirement. The project team developed UR S11A which was published and comes into force on 01 July 2016.

This paper presents the work of the project team related to the redefinition of the hull girder wave loads. A database of 124 ships covering many ship types and dimensions has been used to calculate the longitudinal distributions of the long-term values of hull girder vertical loads (wave bending moments and wave shear forces). The calculated values have been compared to the current IACS rule values, and new rule formulae have been proposed.

Keywords

Container ship; Longitudinal strength; Vertical bending moment; Non-linear loads; Rule formulation; Wave parameter.

Introduction

On 18th January 2007 “MSC NAPOLI” suffered a failure of the hull structure in the English Channel. The UK Marine Accident Investigation Branch (MAIB) investigated the accident and released a report. One conclusion in the report was that the IACS Unified Requirement S11 on Longitudinal Strength Standard (IACS, 2015a) has lagged behind the development of container ship design and operation. It was determined that UR S11 requires immediate revision and that it is necessary to assess buckling strength based on global hull stress along the entire length of the hull. IACS established a project team to review the existing IACS UR S11 and propose improvements to the unified requirement. The main project task was to check the applicability of the vertical hull girder loads formulations (bending moment and shear force) for container ships, and propose new formulations if deemed necessary. The S11 formulations, which have been used for more than 30 years, were developed for bulk carriers and oil tankers and may not be applicable to fine form ships.

In recent years direct hydrodynamic calculations (direct approach), based on the first principles, have become more commonly used to define design loads, in order to either replace the rule loads or complement the rule approach. In the offshore industry, this direct approach is common practice, as wave loads are site specific and need to be computed for each offshore unit. The marine industry is now ready to use this direct approach to justify and calibrate the rule formulations. The only significant differences are forward speed and weather routing. In the development of the Common Structural Rules for Oil Tankers and Bulk Carriers (IACS, 2015b) the direct approach has been used extensively to derive some formulations, e.g. accelerations, Load Combination Factors (LCF) and sea pressure.

The project team, composed of 5 representatives from IACS classification societies, decided to use the direct approach to redefine the vertical hull girder loads for container ships with respect to both magnitude and distribution along the ship.

Methodology

Although UR S11A is only applicable to container ships at scantling draft, the formulations were developed such that they are appropriate for any ship type and loading condition (draft). This was done in order to avoid inconsistency in load formulations for fine form and blunt ships, e.g. at intermediate block coefficient values.

Ship database

In order to derive the new formulations from the direct approach, many results for a variety of ships were needed. For this purpose, a database of 124 ships was built, including slender and blunt ships for comparison. For each ship two different loading conditions were considered (full load / ballast, or maximum / minimum hogging). The primary objective was to define load formu-