ABSTRACT

Ultimate strength assessments in current IACS Common Structural Rules (CSR) are determined by a limited number of constant partial safety factors (PSF). These coefficients are inherited from the previous Common Structural Rules for Oil Tankers, and were determined using a structural reliability analysis (SRA) based on a limited number ship. The authors decided to lead a more comprehensive structural reliability analysis to propose and discuss a new set of rule formulations.

A literature review is carried out in order to determine an extensive database of virtual ships covering the whole range of existing ships with a few representative parameters. SRA is applied for ultimate strength assessment on this database. Uncertainties are modeled by a set of probability distributions applied to each characteristic quantity (still water bending moment, wave bending moment and capacity) and a Second Order Reliability Method (SORM) is used to target the ultimate capacity corresponding to a given failure probability for each ship.

A set of several PSF formulations are then derived from these results using both Working Stress Design (WSD) and Load and Resistance Factor Design (LRFD) approaches. These formulations are then discussed to get an optimum between simplicity and accuracy of the results.

Keywords: Hull girder, ultimate strength, structural reliability, partial safety factors, rule calibration

NOMENCLATURE

CSR  Common Structural Rules
IWSD Implicit Working Stress Design
LRFD Load and Resistance Factor Design
PSF Partial Safety Factor
SORM Second Order Reliability Method
SRA Structural Reliability Analysis
VBM Vertical Bending Moment
WSD Working Stress Design
$C_c$ Characteristic value for capacity
$S_c$ Characteristic value for still water bending moment
$W_c$ Characteristic value for wave bending moment
$\gamma_C$ PSF applied to capacity
$\gamma_S$ PSF applied to still water bending moment
$\gamma_W$ PSF applied to wave bending moment

INTRODUCTION

Hull girder ultimate strength is one of the most critical failure modes since it directly causes the loss of the ship and its dramatic consequences. Therefore, it must be treated very carefully by shipbuilders and class societies in order to guarantee ships safety.

In 2006, IACS released the so-called Common Structural Rules for Oil Tankers (CSR-OT) which includes a criterion for hull girder ultimate strength check. The exact same criterion has then be re-used for oil tankers and bulk carriers in the harmonized Common Structural Rules (CSR) which entered into force on 1st July 2015. The rule formula was determined