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EDITORIAL

Ultimate Strength of Ships and Offshore Structures

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The assessment of the ultimate strength of floating structures is an essential step in their design process and thus it is included as one of the checks in the Rules of Classification Societies. Several years ago, the Rule requirement was based on the section modulus associated with the yield condition, a situation that has been shown to be clearly conservative by an amount that would depend on the geometry of the section. The development of methods to quantify the ultimate strength, including the ability of numerical methods to deal with those predictions in a relatively cost-efficient manner, led to proposals that the ultimate strength should be used as the reference value expressing the strength of the ship hull structure (Guedes Soares et al. 1996), which was adopted 10 years later by the Classification Societies in their Common Structural Rules (CSR 2006; IACS 2014). Indeed, the present status of design relies on ultimate strength assessment and on nonlinear wave induced loads, which have been covered in and earlier special issue (Guedes Soares and Duan 2018).

Different numerical methods have been developed for ultimate strength assessment and new simplified approaches are continuously being proposed, as simplified methods dully calibrated and validated are always welcome as substitutes of very heavy computational approaches. The Common Structural Rules, prescribe simplified methods such as the one of Smith (1977) for the assessment of hull girder collapse and of Gordo and Guedes Soares (1993) for the ultimate strength of stiffened panels.

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The ultimate strength assessment, which was primarily concerned with intact structures, have been extended to damaged structures, including both the prediction of damage induced in accidental situations as the residual strength of damaged structures. Again, it has been the improved capabilities of numerical methods that allowed the study of the complicated geometries of damaged structures that allowed the design work to rely on this type of predictions.

This special issue covers various of these aspects, including papers of review nature with others presenting new research results. The paper by Tekgoz et al. (2020) is a typical review paper that covers the area of the ultimate strength of ageing and damaged ship structures, dealing extensively with numerical, analytical and experimental work on plates, stiffened panels and hull girders that have suffered aging due for example to corrosion and fatigue or damage due for example to minor collisions.

Liu et al. (2020) concentrates on aluminium structures and at the same time as it presents a good review of the work done on ultimate strength of plates and stiffened panels in aluminium, it also includes a research contribution using finite element analyses to study the influence of manufacturing technology on the ultimate compressive strength of aluminium-alloy stiffened panels. As an important problem in aluminium structures is the heat-affected zone associated with welding, the study compares the performance of these panels with extruded ones, which are being used in progressively more applications.

Barsotti et al. (2020) present an overview of recent industrial developments of marine composites limit states assessments and design approaches, focusing on pleasure crafts and yachts as well as navy ships. Inter-ply and intra-ply failure modes are discussed and the corresponding limit states are presented. The main factors influencing marine composite robustness were found to be three-dimensional aspects in failure modes and manufacturing methods as well as fire resistance and joining techniques.

Romanoff et al. (2020) deals with a very special type of problem somewhat associated with cruise ships, in which developments of laser-welded thin-walled steel plates have been made in order to keep light weight at the same time avoiding the weld induced distortions induced by conventional arc welding. This type of structural elements have found application in other vessels and the authors review work that has been done in collision simulations based on finite element analysis of this type of structures.

Wahab et al. (2020) present a different type of problem, which is related with fixed offshore jacket platforms that have been used for many years and are subjected to the problems of planning appropriately their maintenance and eventually develop studies of life extension. The design limit state of these platforms is generally the ultimate strength and thus the paper deals with the problems that degrade the strength of these structures, discussing how a good maintenance plan can maintain the structural strength for longer periods.

The other papers in this issue deal with more specific problems, presenting research results. A first group deals with the buckling strength of shell structures mainly used in subsea applications, while the other papers deal with stiffened panels and with ship hull girders.

Cho et al. (2020) deal with steel-welded hemispheres under external hydrostatic pressure, Zhang et al. (2020) with the buckling of multiple intersecting spherical shells under uniform external pressure and Al-Hamati et al. (2020) study the buckling properties of a subsea function chamber for oil and gas processing in deep-waters.

Lee and Paik (2020) study the ultimate compressive strength computational modelling for stiffened plate panels with non-uniform thickness, a situation that occurs when there is the need to have a transition between plates with different thicknesses.

The rest of the papers deal with the hull girder. Nouri and Khedmati (2020) and Vu and Dong (2020) study the ultimate strength of hull girders deteriorated with different types of corrosion, while Xu and Guedes Soares (2020) study the influence of collision damage on the ultimate strength of hull girders. They consider a box girder representing the parallel middle body of tankers and similar vessels and they validate their finite element model against experiments, before analysing the effect of an impact on different locations, assessing afterwards the residual strength of the damaged structure.

Primorac et al. (2020) continue with the topic of damaged ship hulls by collision or grounding and they analyse the problem of conducting a structural reliability assessment of these damaged ship hulls adopting the procedures recommended in IMO (2006), and they discuss the various limitations of the presently recommended approach.

This set of papers present a good overview of current problems related with the strength assessment of ship and offshore structures, with a certain emphasis on damaged structures, as this type of topic has attracted the attention of several researches in the recent past, and these are in general more complicated problems than dealing with undamaged structures. We hope that this collection of papers will contribute to an overview of this general topic, which can be of interest to readers.

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