# A PROBABILISTIC ANALYSIS OF ULTIMATE STRENGTH OF SHIP STRUCTURES UNDER RANDOM INITIAL IMPERFECTIONS AND CORROSION LOSS

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# ABSTRACT

This dissertation describes the effect of random initial imperfections (initial deflection and welding residual stresses developed in the initial fabrication process of ship hulls) and ageing (random corrosion loss initiated in the service life) on the ultimate strength of the ship hull girder.

An advanced methodology that combines the membrane stress theory based on elastic large deformation plate theory and rigid plastic mechanism, is developed to derive more accurate stress-strain relationship of the of the un-stiffened plating between two longitudinals under axial compressive load. This model accounts for initial imperfections and is able to predict load shedding after attainment of ultimate strength. Based on this stress-strain relationship the effective width of the attached plating to stiffener is determined which, in turn, is used to determine the stress-strain relationships of stiffened plates, which finally lead to the evaluation of hull girder ultimate strength. Randomness in the initial imperfections and material yield strength is incorporated and statistics of random effective width are studied. The same idea is extended to hull girders (including correlation between different elements) to generate statistics of random ultimate strength using Monte-Carlo simulation.

In the second part of the study, the ageing effects of general corrosion are analysed. Existing statistical models are modified to adapt to survey data obtained from two existing bulk carriers and statistics of random corrosion initiation time and random corrosion growth law are derived for two different location types (one wet and one wet/dry). Statistical analysis of the spatial aspects of random corrosion loss of ship plating are performed using data from another 15-year old bulk carrier. The correlation structure of the random corrosion loss field thus obtained reveal that the field is not isotropic, not homogeneous and certainly does not have a decreasing autocorrelation function with increasing separation. These spatial and temporal models of random corrosion loss are incorporated in the above model of random effective plate width, which along with consideration of random initial imperfections, are used to estimate statistics of the random ultimate hull girder strength as a function of time. Such estimates can be essential for an accurate reliability analysis of the ship structural system.

Keywords: Ultimate strength; Effective width; Randomness; Initial imperfections; Corrosion loss; Random corrosion field.