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# A Study on Assessment of Ultimate Strength of Ship Structural Plate with Pitting Corrosion Damnification

*Yan Zhang, Yi Huang, Gang Liu*
School of Naval Architecture, Dalian University of Technology
Dalian, Liaoning, China

## ABSTRACT

The goal of this report focuses on the development of an assessing method for ultimate strength of ship hull plate with corrosion damnification. It is confirmed that corrosion damnification on ship hull plate generally appears as pits with different shape, size and distributing density. According to a long term inspected results for pitting on ship hull plates, all the kinds of pits appearing on the hull plate would be equivalent to semi-spherical shape, conical shape and cylindrical shape. Pitting corrosion results in a quantity loss of the plate material as well as a significant degradation of the ultimate strength of the hull plate due to reducing of the effective thickness of the plate. Accordingly, the model for describing the correlations between the ultimate strength and the corroded volume loss of a corroded plate is firstly proposed based on relative theory. Such model was then completed through numerical experiment by nonlinear finite element analyses for series of corroded plate models. The corroded volume loss based ultimate strength assessing model is expected to be applicable to assessment of the ultimate strength of corroded plate in a ship hull structure.

KEY WORDS: Ultimate strength; corroded volume loss; pitting corrosion; assessment; buckling analysis; ship hull plate.

## INTRODUCTION

People have paid increasing attention to the corrosion-caused structural damage in recent half century. Corrosion-caused thickness loss makes the ultimate strength of typical thin-walled ship structural plates degraded significantly. For general corrosion, it is thought that the thickness is uniformly reduced over the entire plate, so the ultimate strength of the corroded plate can be assessed based on the thickness. However, for pitting corrosion, the corrosion form is complicated and the thickness of the whole plate is not uniform. Until now, there is still no acknowledged method to assess the ultimate strength of the plate with pitting corrosion damnification.

The method of ultimate strength assessment for the pitted plate has been developed from the effective thickness method to the method in which many factors have been considered to represent the characteristics of pitting corrosion.

Paik and Thayamballi (2002) analyzed the ultimate strength of ship panels with pitting corrosion under axial compressive loads using ANSYS. The rectangular was used to model the shape of pits. The results indicated that one isolated small corrosion pit located anywhere in the plate may not reduce the plate ultimate compressive strength to any significant extent. However, such a pit does affect post-ultimate strength behavior for the plate. Subsequently, Paik, Lee and Ko (2003) proposed a new parameter, i.e. the smallest cross-sectional area, to represent the ultimate strength reduction characteristics due to pitting corrosion. It was proved that the proposed parameter-based approach is more useful than the traditional approach based on effective thickness in terms of the accuracy of ultimate strength predictions of pitted plates.

Nakai, Matsushita, Yamamoto and Arai (2004) investigated the effect of corrosion pits on the ultimate strength of hold frames of bulk carriers by a series of compressive buckling tests and the finite element analysis. It was found that compressive buckling strength of pitted members is smaller than or equal to that of members with uniform thickness loss in terms of average thickness loss.

Ok, Pu and Incecik (2007a) studied on assessing the effects of localized pitting corrosion which concentrates at one or several possibly large area on the ultimate strength of unstiffened plates by over 256 nonlinear finite element analyses of panels with various locations and sizes of pitting corrosion. The multi-variable regression method was applied to derive new formulae to predict ultimate strength of unstiffened plates with localized corrosion. In addition, artificial neural network method was applied (Ok, Pu and Incecik, 2007b) to derive a formula to predict ultimate strength reduction of locally corroded plates. It was found out that the proposed formulae can accurately predict the ultimate strength of locally corroded plates under uniaxial in-plane compression. The proposed formulae can also be applied to any ship structural members with concentrated pitting corrosion at one or several possibly large areas.

The purpose of this paper focuses on the development of an assessing method for ultimate strength of ship hull plate with pitting corrosion damnification. It is proposed that the effective thickness of a plate with