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Probabilistic Modeling of Corroded Ship Structural Panels

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Probabilistic Modeling of Corroded Ship Structural Panels

by I.R. Orisamolu, D.P. Brennan and U.O. Akpan

Research and Emerging Technologies Department
Martec Limited, Suite 400, 1888 Brunswick Street, Halifax, NS, Canada, B3J 3J8

ABSTRACT

Corrosion is one of the most important damage mechanisms for ship structures and a significant portion of the maintenance budget is directed toward corrosion-related problems. A major challenge associated with the assessment of the impact of corrosion on the integrity of engineering structures is the quantification of the amount and severity of the corrosion damage that is present in those structures. Corrosion defects are typically characterized by random spatial distributions and variabilities in sizes, shapes, and morphological characteristics throughout the exposed part of the structure. For ship structures in particular, current corrosion pit survey practices are largely based on a visual assessment of the state of corrosion, making the assessment of the impact of corrosion a highly qualitative process that is also very susceptible to error. The present work has been motivated by the desire to provide a realistic and systematic framework for utilizing data collected during ship structural surveys to assess the probabilistic residual strength of corroded ship structural panels.

In this work some probabilistic models that have been developed to realistically represent corrosion damage on typical engineering structures are presented. These models include extreme value distribution representations of the individual corrosion pits as well as random field models of the distribution of a population of corrosion pits or general corrosion. Random field models offer a powerful strategy for the characterization of the uncertainties that are associated with the spatial distribution, extent, severity, as well as the stochastic interaction between neighboring defects. This study reports the development and implementation of robust computational algorithms for defining appropriate probabilistic models of the corrosion damage on engineering structures from observed data. The application of these algorithms is demonstrated for representative ship structural panels and pipeline structures.

Application of Probabilistic Corrosion Model for Reliability Assessment of Ship Structural Panels

by I.R. Orisamolu, U. O. Akpan and D.P. Brennan

Research and Emerging Technologies Department
Martec Limited, Suite 400, 1888 Brunswick Street, Halifax, Nova Scotia, Canada
B3J 3J8

ABSTRACT

Corrosion is one of the most important damage mechanisms for ship structures and a significant portion of the maintenance budget is directed toward corrosion-related problems. There are several forms of corrosion that could be present in ship panels. The two broad categories in this regard are pitting and general corrosion. Although ship engineers have employed this categorization scheme, the natural morphology of real corrosion defects is usually somewhere between the two. In a companion presentation [1] a random filed modelling approach for characterization of the effective thickness of ship structural panels due to corrosion has been developed.

In this work the reliability assessment of the residual strength of ship structural panels based on the random field model of effective thickness is undertaken. Advanced probabilistic reliability techniques namely: the first-order and second-order reliability methods are employed to compute the reliability of corroded ship panels with reference to different failure modes. The merit of the probabilistic approach is demonstrated via the solution of several example problems, and the use of quantitative measures of probabilistic sensitivity to illustrate the most important model parameters and their associated uncertainties is given.

1. I.R. Orisamolu, D.P. Brennan and U.O. Akpan., Probabilistic Modeling of Corroded Ship Structural Panels, to be presented at the 8th CF/CRAD Meeting on Naval Applications of Material Technology, Halifax, NS, May 1999