Exact Mapping of Residual Stress

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1.0 OBJECTIVE.

1.1 The proposed project is a scoping study, aimed at solving the question about the true state of residual stress distributions. It is planned to examine Neutron Diffraction (ND) as a technology to accurately measure true total stresses in ship structures. The way towards a more complete and comprehensive stress assessment technology, along with plans for the development of new tools and technologies for measurement of residual stresses is the main aim of the study.

2.0 BACKGROUND.

2.1 Ship hull structure is made of steel plates stiffened by steel beams and girders. The connections between various structural components (beams, girders, plates) are done by welding. The welding creates localized residual stresses. As well, there are numerous other self-equilibrating stress systems developed in ships. These can arise from construction processes, local damage or self weight. All these stresses are quasi static, and can last for periods of time from hours to years. These 'locked-in' stresses are then added to all manner of dynamic stresses.

Ships experience continuous fatigue loads and thus, the fatigue failure and fatigue life is one of the major design considerations for the ship structures. The majority of the fatigue cracks and subsequent fatigue failures occur at the connections between two structural components due to a combination of stress concentrations along with the presence of residual stresses. Significant research work has been done to determine the fatigue life of ship structures considering the effect of residual stresses. In these studies, idealized and simple distributions of residual stresses at the connections are assumed. However, true fatigue damage and exact fatigue life of ship structure depends on true (realistic) magnitude and distribution of residual stresses at the connections. Thus, determination of true magnitudes and distributions of residual stress at various connections is essential for exact prediction of fatigue failure and fatigue life of structural components of ship structures.

2.2 The project idea has arisen from a number of recent developments and activities. The area of aging processes in ships is a complex subject that deserves increased attentions. Numerical analysis of structures is becoming increasingly sophisticated. We are now able to perform detailed linear and non-linear analyses of ship structural behavior and obtain excellent results. The coming area of challenge and scientific development will be the area of interacting lad and response effects. Aging involves several of these interacting effects. Corrosion, fatigue and plastic behavior all interact and reinforce the other. In coming years we will need to tackle these combined effects if we are to come to grips with aging processes in ships and get a true assessment of safety of older vessel. This project focuses on one of these issues and aims to give of a key tool for such work. Without the ability to measure true total stress (and strain), will be left with only rough guesses and empirical estimates of residual life of working vessels.

3.0 REQUIREMENTS.

3.1 Scope.

3.1.1 The Contractor shall conduct an extensive literature review on various numerical and experimental techniques that are used to determine the residual stress distribution.

3.1.2 The Contractor shall conduct a feasibility study to determine application of Neutron Diffraction (ND) technique to map accurate distribution of residual stresses at typical connections of ship's hull. Even though the ND technique has never been used for mapping the residual stress of ship structural components, the technique has been successfully used for mapping internal residual stresses in turbine blades, turbine discs, rails, and pipes.

3.1.3 The Contractor shall address the practicalities of using the ND technique on small samples (2-10 cm size samples), lab tests (up to 2m component size) and actual ship structures.

3.2 Tasks. (Identify the tasks to carry out the scope of the project).

3.2.1 The Contractor shall conduct a literature review of the techniques for residual stress assessment, including equipment used, calibration data availability, numerical validation and accuracy of techniques.

3.2.2 The Contractor shall specifically examine Neutron Diffraction of a method for trough thickness true stress measurement. This will include discussion with experts in the field, conduct of simple tests on simple samples and review of practical requirements to perform more extensive tests on ship structures.

3.2.3 The contractor will identify possibilities for technology and product development activities that will further the goal of being able to determine true streses in ship constructions.

3.3 Project Timeline. The study will take 12 months.

4.0 GOVERNMENT FURNISHED INFORMATION.

4.1 Standards for the Preparation and Publication of SSC Technical Reports.

5.0 DELIVERY REQUIREMENTS. (Identify the deliverables of the project).

5.1 The Contractor shall provide quarterly progress reports to the Project Technical Committee, the Ship Structure Committee Executive Director, and the Contract Specialist.

5.2 The Contractor shall provide a print ready master final report and an electronic copy, including the above deliverables, formatted as per the SSC Report Style Manual.

6.0 PERIOD OF PERFORMANCE.

6.1 Project Initiation Date: date of award.

6.2 Project Completion Date: 12 months from the date of award.

7.0 GOVERNMENT ESTIMATE. These contractor direct costs are based on previous project participation expenses.

7.1 Project Duration: 12 months.

7.2 Total Estimate: $ 50,000