Proceedings of the Eighth (1998) International Offshore and Polar Engineering Conference
Montréal, Canada, May 24-29, 1998

ISBN 1-880653-34-6 (Set); ISBN 1-880653-38-9 (Vol. IV)

Advanced Finite Element Techniques for Hull Structural Analysis

A. Geiro, P. Grundy, S. Cannon and V. Nguyen
Monash University
Clayton, Australia

ABSTRACT

Advanced technology is proposed for the understanding of structural integrity of cargo vessels. The objective of the analysis is to determine the global structural response of a vessel for different load conditions and then by transfer of global outputs to a local model to find the structural response in critical areas.

The approach permits the identification or confirmation of local stress hot spots. These are then able to be reviewed under different loading conditions. Using a dry bulk carrier as an example the effect of local mechanical damage, corrosion, repair or modification can be systematically studied to enable a rational assessment of safety and risk in operation.

KEY WORDS: Bulk carrier hull structure, Finite Element Analysis, Mechanical damage, Corrosion, local stresses hot spots.

1. INTRODUCTION

Advanced finite element techniques in this context are defined as techniques for obtaining precise stresses in local areas of large complex structures subjected to global distributed loads. For example, the actual stresses in vicinity of the intersection of a stiffener and a web attached to the side shell of a dry bulk carrier can only be obtained with accurate representation of the local geometry, yet the response depends upon both the global response of the whole vessel to imposed actions, as well as the local pressures from water and cargo. The vessel might be 300 m long, but the detailed stresses are required in local area with element sizes down to 200 mm typical dimension. A further problem lies in identifying critical areas for study. This means that mesh refinement must extend over large areas of the structure.

The reasons for developing this form of analysis are:

- identification of location and quantification of magnitude of hot spot stresses,
- exploration of sensitivity to change in design parameters such as plate thickness or attachment detail,
- exploration of sensitivity to mechanical damage in holds,
- quantification of stress ranges for fatigue life estimation.

Current practice of using large super-elements (up to 2.4 m x 3.6 m) does not permit such refinement. Such super-elements can be used to assess hull girder bending response, but not local stresses.

The traditional step to a local model has been to build one extending over two holds which still tends to use "beam" elements and other compound elements which still prevent accurate prediction of local stresses in many cases. It becomes necessary to embed yet another level of refinement of local model with full geometric representation of the local plating. This is rarely attempted.

This paper describes a technique which meets the objectives of the FE analysis efficiently, without resorting to the third level of detailed modelling.

2. GLOBAL MODELLING TECHNIQUES

The global model of a vessel was generated in NASTRAN compatible format. PATRAN was selected as preprocessor and ABAQUS as a FE solver to carry out the FE analysis. There was a need to convert this global model to ABAQUS format.

PATRAN is used as pre and/or post processor for several packages including NASTRAN and ABAQUS. However the current version of PATRAN fails to translate NASTRAN material and element properties into ABAQUS format for complex models, where various isotropic and orthotropic material models are employed. As a result a program was developed to convert the incompatible elements of the global model. The program reformats the data according ABAQUS analysis preferred formats for all of 6000 elements.