Sectional load effects derived from strain measurements using the modal approach

Marcus Schierea, Theo Bosmanb, Quentin Derbanne c, Karl Stambaugh d, Ingo Drummen a

a MARIN, Haagsteeg 2, 6708 PM, Wageningen, The Netherlands
b SBM Offshore, Karel Doormanweg 66, 3115 JD, Schiedam, The Netherlands
b Bureau Veritas, 67/71 Boulevard du Château, 92200 Neuilly-sur-Seine, France
b United States Coast Guard, Surface Force Logistics Centre, ESD Naval Architecture, United States

ARTICLE INFO

Article history:
Received 20 November 2016
Received in revised form 8 March 2017
Accepted 20 April 2017
Available online 5 May 2017

Keywords:
Modal method
Finite element methods
Full scale monitoring
Sectional load effects
Naval ship

ABSTRACT

It is not possible to measure cross sectional load effects (i.e. bending moments and shear forces) of ships directly. In complex structures, the sectional load effects must be derived from strain measurements. Knowing these load effects is important because they do determine the necessary overall structural strength of the ship, both in ultimate load but also in fatigue loads. Traditionally, load effects in specific prismatic shaped sections are derived using strain gauges placed in the section itself. An alternative approach is to derive the load effects in a cross section using measurements of the global strains across the length of the vessel. When this derivation of load effects is based on the first few global flexural vibration modes of the ship, this method is referred to as the modal method. This paper explains both traditional and modal methods and applies them to a simple barge and a more complex ship structure. Experimental data from full scale trials and model tests are used along with numerical simulations to compare the methods. Although the paper focuses on the sectional load effects, it also shows that the local strains can be calculated through the modal approach. The modal method gives better results and has more advantages compared to the more traditional sectional method in ships with complex configurations and effective house structures.

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1. Introduction

Hydrodynamic models provide local pressures, motions, and sectional load effects obtained by integrating the pressure and inertia loads. These sectional load effects are used to determine the required overall structural strength of the ship. An accurate and validated tool to estimate these global load effects is essential to obtain a safe structural design. Full scale measurements are an important step in validating numerical methods. But here, other challenges like measuring the environmental conditions arise. Results are nearly always of a statistical nature instead of a deterministic nature. Model tests may