Stochastic Modelling of Wave Loads on Floating Bridges: Efficient Calculation of Cross-Spectral Densities

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Abstract

This paper outlines a fast and accurate approach for calculation of the auto- and cross-spectral densities in the stochastic modelling of wave loads on floating bridges. For long-term response predictions used in extreme response assessment and fatigue design, the efficiency of this approach may prove valuable. An illustration of the approach is given for a pontoon type floating bridge, and the performance is compared with the traditional computation method. The gain in computational effort is seen to increase with increasing bridge length.

Keywords: Floating bridge; pontoon; wave excitation load; directional waves; cross-spectral density.

1 Introduction

New technologies for crossing wide and deep fjords are currently focused upon in Norway, especially in connection with the Norwegian Public Roads Administration project "Coastal Highway Route E39". In order to facilitate the design of cost-efficient and reliable fjord crossing structures, the development of robust and fast methods for calculating environmental loads is important. The subject of the present paper is computation of the spectral characteristics for the wave loads acting on pontoon bridges. This is an important input for dynamic analysis of floating bridges both in time and frequency domain [1, 2]. Especially for long-term response predictions, efficiency is vital [3].

This paper outlines new formulations for calculation of the auto- and cross-spectral densities in relation to the stochastic modelling of wave loads. Auto- and cross-spectral densities are generally expressed in terms of an integral that traditionally has been computed using numerical quadrature. For this straightforward approach, the computational effort increases with increasing distance between the pontoons due to rapid oscillation of the relevant analytical functions. The new approach avoids this effect of increasing computational efforts by a reformulation of the basic expressions.

An application of the approach is demonstrated in relation to a pontoon bridge, and the performance is compared with the more traditional method. The gain in computational effort (as compared to

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