Algorithm for Finding Extreme Motions of Forward Speed Vessels

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ABSTRACT

Extreme motion analysis is vital in shipping industry for finding the inertial loads on the structure. Extreme motions are generally found for zero forward speed, where spectral analysis imposes no problems. But significant motions of the vessel may also be required to be found for speeded vessels. For speeded vessel wave induced motion Response Amplitude Operator needs to be transformed to encounter frequency. As well as sea spectrum needs to be transformed to encounter frequency. In the present work an algorithm for finding the significant (and extreme) motions of forward speed vessels is discussed.

KEY WORDS: RAO; Sea Spectrum; PM; JONSWAP; SWAN

INTRODUCTION

Initially, spectral analysis technique is discussed in short. Wave induced vessel motions are the input to the spectral analysis. Computation of these motions (Response Amplitude Operator - RAO) is a very standard and well established technique, hence is not discussed in this paper. Only the interpolation of RAO in angular direction is discussed in brief. The main focus is the sea spectrum and the motion spectrum computations. Standard sea spectrum, viz. Joint North Sea Wave Project (JONSWAP) and Pierson – Moskowitz (PM) definitions are given for the reference. Spreading function and the encounter sea spectrum are discussed in sequence. The significant values of motions are finally found out. The results are compared with the Rankine panel based sea keeping code SWAN.

METHODOLOGY – SPECTRAL ANALYSIS

Ship motion in an irregular seaway is determined as (Fig. 1) (Bhattacharya, 1978)

1. Response Amplitude Operators (RAO) for wave induced motions is found out analytically or experimentally. RAO is defined as ratio of motion amplitude to unit wave amplitude. A plot of RAO square versus the encountering frequency is first obtained.
2. A suitable wave spectrum is chosen for the particular seaway in which the vessel is to operate.
3. Wave spectrum is transformed to encounter wave spectrum.
4. Multiplication of the ordinates of the (RAO)^2 with the encounter spectrum for corresponding frequencies results in a motion spectrum. Area under the motion spectrum is found to obtain various motion characteristics.

Fig. 1 Spectral analysis