ABSTRACT

WAFO (Wave Analysis for Fatigue and Oceanography) is a toolbox of Matlab routines for statistical analysis and simulation of random waves and random loads. An important part are routines for calculation of theoretical distributions of wave characteristics from observed or theoretical power spectra of the sea. A new philosophy concerning documentation is presented. The toolbox contains scripts for generation of plots in recent publications and scripts for comparison with results in the literature. The theoretical density of rainflow cycles can be computed from parameters of random loads.

KEYWORDS: Gaussian processes, wave spectra, estimation, simulation, rainflow cycles, fatigue

INTRODUCTION

In a random wave model, like that for Gaussian or transformed Gaussian waves, the distribution of wave characteristics such as wave period and crest-trough wave height can be calculated by high accuracy for almost any spectral type. WAFO is a third-generation package of Matlab routines for handling statistical modelling, calculation and analysis of random waves and wave characteristics and their statistical distributions. The package also contains routines for cycle counting and computation in random load models, in particular the rainflow counting often used in fatigue life prediction.

Random wave distributions are notoriously difficult to obtain in explicit form from a random wave model, but numerical algorithms, based on the so-called regression approximation, work well. This method to calculate wave distributions is the only known method that gives correct answers valid for general spectra. The theoretical background is reviewed in Lindgren and Rychlik (1993).

The algorithms are based on a specification of the random waves by means of their (uni-directional or directional) spectrum, and on the underlying assumption of linear wave theory and Gaussian distribution. However, a transformation of sea elevation data can be made to obtain a desired (horizontal) asymmetric marginal distribution.

A first complete toolbox FAT (Fatigue Analysis Toolbox) was presented in 1993 (Frendahl, Lindgren and Rychlik 1993); this was followed by WAT (Wave Analysis Toolbox) in 1995 (Rychlik and Lindgren 1995), being extended with routines for probabilistic-modelling problems in oceanography. In WAFO, new numerical routines have been introduced, and a considerable improvement in computational speed and accuracy has been achieved. WAFO allows treatment of more complicated problems; for example, spatial waves with time dynamics can be handled, thus extending the analysis to random fields. Algorithms for rainflow analysis of switching Markov chains are included, as well as for decomposition of the rainflow matrix. Many of the new tools are the result of recent research, e.g. Rychlik, Johannesson and Leadbetter (1997), Podgórski et al. (1999), Podgórski, Rychlik and Machado (2000), Johannesson (1999), and Brodtkorb et al. (1999).

Further, WAFO has a modular structure, so users can easily add their own algorithms for special purposes. The modules of the toolbox handle

- wave/load data analysis and estimation
- spectral distributions
- transformation to Gaussian marginals (exact distributions)
- simple parametric approximations to wave characteristic distributions
- simulation of Gaussian and Markovian wave/load time series
- extreme value and other statistical analysis

1http://www.maths.lth.se/matstat/staff/georg/watinfo.html