AUTO REGRESSIVE MOVING AVERAGE SIMULATION OF RANDOM WAVE FORCES ON OFFSHORE STRUCTURES

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Abstract

A new method is presented for numerical simulation of wave kinematics at any place on an offshore structure and at any time. The random wave particle kinematics are modelled by an auto-regressive moving average process which generates a time history using Gaussian white noise as input. For each desired wave spectrum, a small number of ARMA coefficients are required. The method for computing these coefficients is described. From the origin of coordinates, the waves are propagated horizontally and vertically throughout the water column to each node of a finite element model of an offshore structure. The stretched linear approximation is incorporated into the method to model finite amplitude effects. Spectral directionality is incorporated to take into account the effects of wave energy spreading. In all examples the deep water wave dispersion relation is assumed. In the case of shallow waters or intermediate depths, the same methodology applies: only the dispersion relation is different. Once the wave kinematics are simulated at each grid-point or node, it is a simple step then to compute wave forces, using the Morison equation.

The strong points of this method are its accuracy, its numerical efficiency, the inclusion of finite wave amplitude effects and the means for accounting for the effects of wave spreading. In contrast to the discrete spikes which result when one sums sinusoids, the ARMA spectrum is smooth and continuous, properly modelling the non-linearities which depend on difference frequencies, as in the case of slowly varying drift forces. When compared to summing sinusoids, this method is more efficient in terms of calculations, memory storage, and input/output memory transfer because it is based on a series of recursive algorithms. Moreover, by dividing the wave propagation problem into a horizontal one and a vertical one, the wave spreading and directionality problem is easily solved. The finite amplitude non-linearities are modelled by implementing the stretched linear approximation. For both deepwater and shallow waters, the same methodology yields a numerically efficient random wave force time history simulation, modelling wave dispersion, spreading, and finite amplitudes.

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