

## Wave Spectra used in OrcaFlex

### Formulae for OrcaFlex random wave spectra

OrcaFlex can simulate waves from a number of the more commonly used random wave spectra. This document gives details of the spectral formulae for these wave spectra.

#### 1 ISSC spectrum

The ISSC spectrum  $S_{\text{ISSC}}(f)$  for frequency  $f \geq 0$  is given by the formula

$$S_{\text{ISSC}}(f) = \left( \frac{5H_s^2 f_m^4}{16} \right) f^{-5} \exp \left[ -\frac{5}{4} \left( \frac{f}{f_m} \right)^{-4} \right]$$

where  $f_m$  is the peak frequency;  $H_s$  is the significant wave height.

See Tucker MJ, Waves in Ocean Engineering, p107. Note that in this reference the ISSC spectrum is called the generalised Pierson-Moskowitz spectrum and the notation differs slightly.

#### 2 JONSWAP spectrum

The JONSWAP spectrum  $S_{\text{JONSWAP}}(f)$  for frequency  $f \geq 0$  is given by the formula

$$S_{\text{JONSWAP}}(f) = \left( \frac{\alpha g^2}{(2\pi)^4} \right) f^{-5} \exp \left[ -\frac{5}{4} \left( \frac{f}{f_m} \right)^{-4} \right] \gamma^{\exp \left[ -\frac{1}{2\sigma^2} \left( \frac{f}{f_m} - 1 \right)^2 \right]}$$

where  $f_m$  is the peak frequency;  $g$  is the gravitational constant;  $\sigma = \sigma_1$  for  $f \leq f_m$ ,  $\sigma = \sigma_2$  for  $f > f_m$ ;  $\gamma$ ,  $\alpha$ ,  $\sigma_1$  and  $\sigma_2$  are OrcaFlex data items.

See

- Barltrop NDP and Adams AJ, Dynamics of Fixed Marine Structures (3rd edition), p277.
- Tucker MJ, Waves in Ocean Engineering, p108.
- Isherwood R M, 1987. Applied Ocean Research, Vol 9, No. 1 (January), pp 47-50.

Note that the notation differs in these references.

#### 3 Ochi-Hubble spectrum

The Ochi-Hubble spectrum  $S_{\text{Ochi-Hubble}}(f)$  for frequency  $f \geq 0$  is given by the formula

$$S_{\text{Ochi-Hubble}}(f) = \sum_{j=1}^2 \left[ \frac{\left( \frac{4\lambda_j + 1}{4} \right)^{\lambda_j} f_{mj}^{4\lambda_j} H_{sj}^2}{4\Gamma(\lambda_j)} \right] f^{-(4\lambda_j + 1)} \exp \left[ -\left( \frac{4\lambda_j + 1}{4} \right) \left( \frac{f}{f_{mj}} \right)^{-4} \right]$$

where  $\Gamma(\cdot)$  is the gamma function;  $H_{s_1}$ ,  $f_{m_1}$ ,  $\lambda_1$ ,  $H_{s_2}$ ,  $f_{m_2}$  and  $\lambda_2$  are OrcaFlex data items.

See equation 10 in Ochi M K and Hubble E N, 1976, Six-parameter wave spectra; Proc 15th Coastal Engineering Conference, 301-328.