

## GENERAL FORMULA FOR PERFECT CUBES OR ANTIFER CUBES (DETERMINISTIC):

$$N_s = \frac{H_s}{\Delta D_n} = \left( k1 \frac{N_{od}^{k2}}{N_z^{k3}} + k4 \right) s_{0m}^{-k5}$$

$$s_{0m} = \frac{H_s}{L_{0m}} = \frac{2\pi H_s}{g T_m^2} \quad N_z = \frac{3600 \text{ dur}(h)}{T_m} \quad D_n = \left( \frac{W}{\gamma_c} \right)^{1/3}$$

$$\Delta = \frac{\gamma_c}{\gamma_w} - 1, \gamma_w = 10.05 \frac{kN}{m^3}, \gamma_c = 24 \frac{kN}{m^3} \Rightarrow \Delta = \frac{24}{10.05} - 1 = 1.38806$$

## NOMOGRAM:

$$\frac{H_s}{\Delta D_n} = \frac{1}{f} s_{0m}^{-k5} \quad \frac{1}{f} = \left( k1 \frac{N_{od}^{k2}}{N_z^{k3}} + k4 \right) \quad \frac{\frac{1}{f} - k4}{k1} = \frac{N_{od}^{k2}}{N_z^{k3}} \quad \frac{\frac{1}{f} - k4}{k1} = \frac{N_{od}^{k2}}{\left( \frac{3600 \text{ d}(h)}{T_m} \right)^{k3}}$$

$$\log_{10} \left( \frac{\frac{1}{f} - k4}{k1} \right) = \log_{10} \left( \frac{N_{od}^{k2}}{\left( \frac{3600 \text{ d}(h)}{T_m} \right)^{k3}} \right) = k2 \log_{10}(N_{od}) - k3 \log_{10} \left( \frac{3600 \text{ d}(h)}{T_m} \right)$$

$$\log_{10} \left( \frac{\frac{1}{f} - k4}{k1} \right) - k2 \log_{10}(N_{od}) + k3 \log_{10}(3600 \text{ d}(h)) - k3 \log_{10}(T_m) = 0 \quad [1]$$

$$D_n = \left(\frac{W}{\gamma_c}\right)^{1/3} = \frac{f H_s}{\Delta} s_{m0}^{k5} \quad \left(\frac{W}{\gamma_c}\right)^{1/3} = \frac{f H_s}{\Delta} \left(\frac{2\pi H_s}{g T_m^2}\right)^{k5} \quad \frac{W}{\gamma_c} = \left(\frac{f H_s}{\Delta}\right)^3 \left(\frac{2\pi H_s}{g T_m^2}\right)^{(3 k5)}$$

$$W = \gamma_c \left(\frac{f H_s}{\Delta}\right)^3 \left(\frac{2\pi H_s}{g T_m^2}\right)^{(3 k5)} \quad W = \frac{\gamma_c \left(\frac{2\pi}{g}\right)^{(3 k5)}}{\left(\frac{\gamma_c}{\gamma_w} - 1\right)^3} \frac{f^3 H_s^{(3+3 k5)}}{T_m^{(6 k5)}}$$

$$\log_{10}(W) = \log_{10} \left( \frac{\gamma_c \left(\frac{2\pi}{g}\right)^{(3 k5)}}{\left(\frac{\gamma_c}{\gamma_w} - 1\right)^3} \frac{f^3 H_s^{(3+3 k5)}}{T_m^{(6 k5)}} \right)$$

$$\log_{10}(W) = \log_{10} \left( \frac{\gamma_c \left(\frac{2\pi}{g}\right)^{(3 k5)}}{\left(\frac{\gamma_c}{\gamma_w} - 1\right)^3} \right) + 3 \log_{10}(f) + (3 + 3 k5) \log_{10}(H_s) - (6 k5) \log_{10}(T_m)$$

$$\log_{10}(W) - \log_{10} \left( \frac{\gamma_c \left(\frac{2\pi}{g}\right)^{(3 k5)}}{\left(\frac{\gamma_c}{\gamma_w} - 1\right)^3} \right) - 3 \log_{10}(f) - (3 + 3 k5) \log_{10}(H_s) + (6 k5) \log_{10}(T_m) = 0 \quad [2]$$

**Van Der Meer (1988a) formula for Cubes (not Antifer)**

$k_1 = 6.7$ ;  $k_2 = 0.4$ ;  $k_3 = 0.3$ ;  $k_4 = 1.0$ ;  $k_5 = 0.1$

**Chegini-Aghtouman (2006) formula for Antifer Cubes, slope 1.5:1**

$k_1 = 6.951$ ;  $k_2 = 0.443$ ;  $k_3 = 0.291$ ;  $k_4 = 1.082$ ;  $k_5 = 0.082$

**Chegini-Aghtouman (2006) formula for Antifer Cubes, slope 2:1**

$k_1 = 6.138$ ;  $k_2 = 0.443$ ;  $k_3 = 0.276$ ;  $k_4 = 1.164$ ;  $k_5 = 0.07$