Important Cnoidal Wave Theory Formulas PDF

Formulas
Examples
with Units

List of 14
Important Cnoidal Wave Theory Formulas

1) Complete Elliptic Integral of Second Kind Formula

Evaluate Formula

Formula

$$E_k = -\left(\left(\left(\left(\frac{y_t}{d_c}\right)+\left(\frac{H_w}{d_c}\right)-1\right)\cdot\frac{3\cdot\lambda^2}{\left(16\cdot d_c^{\,2}\right)\cdot K_k}\right)-K_k\right)$$

Example with Units

$$27.9682 = -\left(\left(\left(\left(\frac{21\,\text{m}}{16\,\text{m}}\right)+\left(\frac{14\,\text{m}}{16\,\text{m}}\right)-1\right)\cdot\frac{3\cdot 32\,\text{m}^{\,2}}{\left(16\cdot 16\,\text{m}^{\,2}\right)\cdot 28}\right)-28\right)$$

2) Distance from Bottom to Crest Formula

Evaluate Formula

Formula

$$y_c = d_c\cdot\left(\left(\frac{y_t}{d_c}\right)+\left(\frac{H_w}{d_c}\right)\right)$$

Example with Units

$$35\,\text{m} = 16\,\text{m}\cdot\left(\left(\frac{21\,\text{m}}{16\,\text{m}}\right)+\left(\frac{14\,\text{m}}{16\,\text{m}}\right)\right)$$

3) Distance from Bottom to Wave Trough Formula

Evaluate Formula

Formula

$$y_t = d_c\cdot\left(\left(\frac{y_c}{d_c}\right)-\left(\frac{H_w}{d_c}\right)\right)$$

Example with Units

$$21\,\text{m} = 16\,\text{m}\cdot\left(\left(\frac{35\,\text{m}}{16\,\text{m}}\right)-\left(\frac{14\,\text{m}}{16\,\text{m}}\right)\right)$$

4) Elevation above Bottom given Pressure under Cnoidal Wave in Hydrostatic Form Formula

Evaluate Formula

Formula

$$y = -\left(\left(\frac{p}{\rho_s\cdot[g]}\right)-y_s\right)$$

Example with Units

$$4.92\,\text{m} = -\left(\left(\frac{804.1453\,\text{Pa}}{1025\,\text{kg/m}^3\cdot 9.8066\,\text{m/s}^2}\right)-5\right)$$

5) Free Surface Elevation of Solitary Waves Formula

Evaluate Formula

Formula

$$\eta = H_w \cdot \left(\frac{u}{\sqrt{[g] \cdot d_c \cdot \left(\frac{H_w}{d_c} \right)}} \right)$$

Example with Units

$$25.5464\,\text{m} = 14\,\text{m} \cdot \left(\frac{20\,\text{m/s}}{\sqrt{9.8066\,\text{m/s}^2 \cdot 16\,\text{m} \cdot \left(\frac{14\,\text{m}}{16\,\text{m}} \right)}} \right)$$

6) Ordinate of Water Surface given Pressure under Cnoidal Wave in Hydrostatic Form Formula

Evaluate Formula

Formula

$$y_s = \left(\frac{p}{\rho_s \cdot [g]} \right) + y$$

Example with Units

$$5 = \left(\frac{804.1453\,\text{Pa}}{1025\,\text{kg/m}^3 \cdot 9.8066\,\text{m/s}^2} \right) + 4.92\,\text{m}$$

7) Particle Velocities given Free Surface Elevation of Solitary Waves Formula

Evaluate Formula

Formula

$$u = \eta \cdot \sqrt{[g] \cdot d_c \cdot \frac{\frac{H_w}{d_c}}{H_w}}$$

Example with Units

$$19.995\,\text{m/s} = 25.54\,\text{m} \cdot \sqrt{9.8066\,\text{m/s}^2 \cdot 16\,\text{m} \cdot \frac{\frac{14\,\text{m}}{16\,\text{m}}}{14\,\text{m}}}$$

8) Pressure under Cnoidal Wave in Hydrostatic Form Formula

Evaluate Formula

Formula

$$p = \rho_s \cdot [g] \cdot \left(y_s - y \right)$$

Example with Units

$$804.1453\,\text{Pa} = 1025\,\text{kg/m}^3 \cdot 9.8066\,\text{m/s}^2 \cdot \left(5 - 4.92\,\text{m} \right)$$

9) Trough to Crest Wave Height Formula

Evaluate Formula

Formula

$$H_w = d_c \cdot \left(\left(\frac{y_c}{d_c} \right) - \left(\frac{y_t}{d_c} \right) \right)$$

Example with Units

$$14\,\text{m} = 16\,\text{m} \cdot \left(\left(\frac{35\,\text{m}}{16\,\text{m}} \right) - \left(\frac{21\,\text{m}}{16\,\text{m}} \right) \right)$$

10) Wave Height given Distance from Bottom to Wave Trough and Water Depth Formula

Evaluate Formula

Formula

$$H_w = -d_c \cdot \left(\left(\frac{y_t}{d_c} \right) - 1 - \left(\left(16 \cdot \frac{d_c^{\,2}}{3 \cdot \lambda^2} \right) \cdot K_k \cdot \left(K_k - E_k \right) \right) \right)$$

Example with Units

$$14.1147\,\text{m} = -16\,\text{m} \cdot \left(\left(\frac{21\,\text{m}}{16\,\text{m}} \right) - 1 - \left(\left(16 \cdot \frac{16\,\text{m}^{\,2}}{3 \cdot 32\,\text{m}^{\,2}} \right) \cdot 28 \cdot \left(28 - 27.968 \right) \right) \right)$$

11) Wave Height Required to Produce Difference in Pressure on Seabed Formula

Evaluate Formula

Formula

$$H_{w'} = \frac{\Delta P_c}{\left(\rho_s \cdot [g]\right) \cdot \left(0.5 + \left(0.5 \cdot \sqrt{1 - \left(\frac{3 \cdot \Delta P_c}{\rho_s \cdot [g] \cdot d_c}\right)}\right)\right)}$$

Example with Units

$$0.9912\,\text{m} = \frac{9500\,\text{Pa}}{\left(1025\,\text{kg/m}^3 \cdot 9.8066\,\text{m/s}^2\right) \cdot \left(0.5 + \left(0.5 \cdot \sqrt{1 - \left(\frac{3 \cdot 9500\,\text{Pa}}{1025\,\text{kg/m}^3 \cdot 9.8066\,\text{m/s}^2 \cdot 16\,\text{m}}\right)}\right)\right)}$$

12) Wave Height when Free Surface Elevation of Solitary Waves Formula

Evaluate Formula

Formula

$$H_{w'} = \eta \cdot \frac{\sqrt{[g] \cdot d_c}}{u \cdot d_c}$$

Example with Units

$$0.9997\,\text{m} = 25.54\,\text{m} \cdot \frac{\sqrt{9.8066\,\text{m/s}^2 \cdot 16\,\text{m}}}{20\,\text{m/s} \cdot 16\,\text{m}}$$

13) Wavelength for Complete Elliptic Integral of First Kind Formula

Evaluate Formula

Formula

$$\lambda = \sqrt{16 \cdot \frac{d_c^{\,3}}{3 \cdot H_w}} \cdot k \cdot K_k$$

Example with Units

$$32.739\,\text{m} = \sqrt{16 \cdot \frac{16\,\text{m}^{\,3}}{3 \cdot 14\,\text{m}}} \cdot 0.0296 \cdot 28$$

14) Wavelength for Distance from Bottom to Wave Trough Formula

Evaluate Formula

Formula

$$\lambda = \sqrt{\frac{16 \cdot d_c^{\,2} \cdot K_k \cdot \left(K_k - E_k\right)}{3 \cdot \left(\left(\frac{y_t}{d_c}\right) + \left(\frac{H_w}{d_c}\right) - 1\right)}}$$

Example with Units

$$32.0964\,\text{m} = \sqrt{\frac{16 \cdot 16\,\text{m}^{\,2} \cdot 28 \cdot \left(28 - 27.968\right)}{3 \cdot \left(\left(\frac{21\,\text{m}}{16\,\text{m}}\right) + \left(\frac{14\,\text{m}}{16\,\text{m}}\right) - 1\right)}}$$

Variables used in list of Cnoidal Wave Theory Formulas above

- d_c Water Depth for Cnoidal Wave *(Meter)*
- E_k Complete Elliptic Integral of the Second Kind
- H_w Height of the Wave *(Meter)*
- $H_{w'}$ Cnoidal Wave Height *(Meter)*
- k Modulus of the Elliptic Integrals
- K_k Complete Elliptic Integral of the First Kind
- p Pressure Under Wave *(Pascal)*
- u Particle Velocity *(Meter per Second)*
- y Elevation above the Bottom *(Meter)*
- y_c Distance from the Bottom to the Crest *(Meter)*
- y_s Ordinate of the Water Surface
- y_t Distance from the Bottom to the Wave Trough *(Meter)*
- ΔP_c Change in Pressure of Coast *(Pascal)*
- η Free Surface Elevation *(Meter)*
- λ Wavelength of Wave *(Meter)*
- ρ_s Density of Salt Water *(Kilogram per Cubic Meter)*

Constants, Functions, Measurements used in list of Cnoidal Wave Theory Formulas above

- constant(s): **[g]**, 9.80665
  Gravitational acceleration on Earth
- Functions: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Pressure** in Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion

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