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Solitary Wave Formulas

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List of 17 Solitary Wave Formulas

Solitary Wave

1) Celerity of Solitary Wave

Open Calculator

fx $C = \sqrt{[g] \cdot (H_w + D_w)}$

ex $24.05395\text{m/s} = \sqrt{[g] \cdot (14\text{m} + 45\text{m})}$

2) Elevation above Bottom given Pressure Beneath Solitary Wave

Open Calculator

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

ex $4.92\text{m} = 5 - \left(\frac{804.1453\text{Pa}}{1025\text{kg/m}^3 \cdot [g]}\right)$

3) Empirical Relationship between Slope and Breaker Height-to-Water Depth Ratio

Open Calculator

fx $HD_{ratio} = 0.75 + (25 \cdot \text{m}) - \left(112 \cdot \text{m}^2\right) + \left(3870 \cdot \text{m}^3\right)$

ex $1.23616 = 0.75 + (25 \cdot 0.02) - \left(112 \cdot (0.02)^2\right) + \left(3870 \cdot (0.02)^3\right)$

4) Maximum Velocity of Solitary Wave

Open Calculator

fx $u_{max} = \frac{C \cdot N}{1 + \cos\left(M \cdot \frac{y}{D_w}\right)}$

ex $6.024014\text{m/s} = \frac{24.05\text{m/s} \cdot 0.5}{1 + \cos\left(0.8 \cdot \frac{4.92\text{m}}{45\text{m}}\right)}$

5) Pressure Beneath Solitary Wave

Open Calculator

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

ex $804.1453\text{Pa} = 1025\text{kg/m}^3 \cdot [g] \cdot (5 - 4.92\text{m})$

6) Total Wave Energy per Unit Crest Width of Solitary Wave

Open Calculator

$$E = \left(\frac{8}{3 \cdot \sqrt{3}}\right) \cdot \rho_s \cdot [g] \cdot H_w^{\frac{3}{2}} \cdot D_w^{\frac{3}{2}}$$

$$2.4E\hat{}8J/m = \left(\frac{8}{3 \cdot \sqrt{3}}\right) \cdot 1025kg/m^3 \cdot [g] \cdot (14m)^{\frac{3}{2}} \cdot (45m)^{\frac{3}{2}}$$

7) Volume of Water above Still Water Level per Unit Crest Width

Open Calculator

$$V = \left(\left(\frac{16}{3}\right) \cdot D_w^3 \cdot H_w\right)^{0.5}$$

$$2608.448m^2 = \left(\left(\frac{16}{3}\right) \cdot (45m)^3 \cdot 14m\right)^{0.5}$$

8) Water Depth given Celerity of Solitary Wave

Open Calculator

$$D_w = \left(\frac{C^2}{[g]}\right) - H_w$$

$$44.98064m = \left(\frac{(24.05m/s)^2}{[g]}\right) - 14m$$

9) Water Depth given Total Wave Energy per Unit Crest Width of Solitary Wave

Open Calculator

$$D_w = \left(\frac{E}{\left(\frac{8}{3 \cdot \sqrt{3}}\right) \cdot \rho_s \cdot [g] \cdot H_w^{\frac{3}{2}}}\right)^{\frac{2}{3}}$$

$$44.41991m = \left(\frac{2.4E\hat{}8J/m}{\left(\frac{8}{3 \cdot \sqrt{3}}\right) \cdot 1025kg/m^3 \cdot [g] \cdot (14m)^{\frac{3}{2}}}\right)^{\frac{2}{3}}$$

10) Water Depth given Volume of Water within Wave above Still Water Level

Open Calculator

$$D_w = \left(\frac{(V)^2}{\left(\frac{16}{3}\right) \cdot H_w}\right)^{\frac{1}{3}}$$

$$45m = \left(\frac{(2608.448m^2)^2}{\left(\frac{16}{3}\right) \cdot 14m}\right)^{\frac{1}{3}}$$

11) Water Surface above Bottom

Open Calculator

$$y_{s'} = D_w + H_w \cdot \left(\operatorname{sech}\left(\sqrt{\left(\frac{3}{4}\right) \cdot \left(\frac{H_w}{D_w^3}\right)} \cdot (x - (C \cdot t)) \right) \right)^2$$

$$45.00041 = 45\text{m} + 14\text{m} \cdot \left(\operatorname{sech}\left(\sqrt{\left(\frac{3}{4}\right) \cdot \left(\frac{14\text{m}}{(45\text{m})^3}\right)} \cdot (50 - (24.05\text{m/s} \cdot 25)) \right) \right)^2$$

12) Water Surface above Bottom given Pressure Beneath Solitary Wave

Open Calculator

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

$$5 = \left(\frac{804.1453\text{Pa}}{1025\text{kg/m}^3 \cdot [g]}\right) + 4.92\text{m}$$

13) Wave Height for Total Wave Energy per Unit Crest Width of Solitary Wave

Open Calculator

$$H_w = \left(\frac{E}{\left(\frac{8}{3 \cdot \sqrt{3}}\right) \cdot \rho_s \cdot [g] \cdot D_w^{\frac{3}{2}}} \right)^{\frac{2}{3}}$$

$$13.81953\text{m} = \left(\frac{2.4\text{E}\text{^}8\text{J/m}}{\left(\frac{8}{3 \cdot \sqrt{3}}\right) \cdot 1025\text{kg/m}^3 \cdot [g] \cdot (45\text{m})^{\frac{3}{2}}} \right)^{\frac{2}{3}}$$

14) Wave Height given Celerity of Solitary Wave

Open Calculator

$$H_w = \left(\frac{C^2}{[g]}\right) - D_w$$

$$13.98064\text{m} = \left(\frac{(24.05\text{m/s})^2}{[g]}\right) - 45\text{m}$$

15) Wave Height given Volume of Water within Wave above Still Water Level

Open Calculator

fx $$H_w = \frac{V^2}{\left(\frac{16}{3}\right) \cdot D_w^3}$$

ex $$14\text{m} = \frac{(2608.448\text{m}^2)^2}{\left(\frac{16}{3}\right) \cdot (45\text{m})^3}$$

16) Wave Height of Unbroken Wave in Water of Finite Depth

Open Calculator

fx $$H_w = D_w \cdot \left(\frac{\left(0.141063 \cdot \left(\frac{L}{D_w}\right)\right) + \left(0.0095721 \cdot \left(\frac{L}{D_w}\right)^2\right) + \left(0.0077829 \cdot \left(\frac{L}{D_w}\right)^3\right)}{1 + \left(0.078834 \cdot \left(\frac{L}{D_w}\right)\right) + \left(0.0317567 \cdot \left(\frac{L}{D_w}\right)^2\right) + \left(0.0093407 \cdot \left(\frac{L}{D_w}\right)^3\right)} \right)$$

ex $$14.01028\text{m} = 45\text{m} \cdot \left(\frac{\left(0.141063 \cdot \left(\frac{90\text{m}}{45\text{m}}\right)\right) + \left(0.0095721 \cdot \left(\frac{90\text{m}}{45\text{m}}\right)^2\right) + \left(0.0077829 \cdot \left(\frac{90\text{m}}{45\text{m}}\right)^3\right)}{1 + \left(0.078834 \cdot \left(\frac{90\text{m}}{45\text{m}}\right)\right) + \left(0.0317567 \cdot \left(\frac{90\text{m}}{45\text{m}}\right)^2\right) + \left(0.0093407 \cdot \left(\frac{90\text{m}}{45\text{m}}\right)^3\right)} \right) \cdot 1.106\text{m}$$

17) Wavelength of Regions of Validity Stokes and Cnoidal Wave Theory

Open Calculator

fx $$L_w = D_w \cdot \left(21.5 \cdot \exp\left(-1.87 \cdot \left(\frac{H_w}{D_w}\right)\right)\right)$$

ex $$540.7395\text{m} = 45\text{m} \cdot \left(21.5 \cdot \exp\left(-1.87 \cdot \left(\frac{14\text{m}}{45\text{m}}\right)\right)\right)$$

Variables Used

- a_s Solitary Wave Amplitude *(Meter)*
- **C** Celerity of the Wave *(Meter per Second)*
- D_w Water Depth from Bed *(Meter)*
- **E** Total Wave Energy per Unit Crest Width *(Joule per Meter)*
- H_w Height of the Wave *(Meter)*
- HD_{ratio} Breaker Height-to-Water Depth Ratio
- **L** Length of Water Wave *(Meter)*
- L_w Water Wave Length *(Meter)*
- **m** Wave Slope
- **M** Function of Wave Height
- **N** Function of H/d as N
- **p** Pressure Under Wave *(Pascal)*
- **t** Temporal (Progressive Wave)
- u_{max} Maximum Velocity of Solitary Wave *(Meter per Second)*
- **V** Volume of Water per Unit Crest Width *(Square Meter)*
- **x** Spatial (Progressive Wave)
- **y** Elevation above the Bottom *(Meter)*
- y_s Ordinate of the Water Surface
- $y_{s'}$ Water Surface Ordinate
- ρ_s Density of Salt Water *(Kilogram per Cubic Meter)*

Constants, Functions, Measurements used

- Constant: **[g]**, 9.80665
  Gravitational acceleration on Earth
- Function: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Function: **exp**, exp(Number)
  n an exponential function, the value of the function changes by a constant factor for every unit change in the independent variable.
- Function: **sech**, sech(Number)
  The hyperbolic secant function is a hyperbolic function that is the reciprocal of the hyperbolic cosine function.
- Function: **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: **Area** in Square Meter (m^2)
  Area 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/m^3)
  Density Unit Conversion
- Measurement: **Energy per Unit Length** in Joule per Meter (J/m)
  Energy per Unit Length Unit Conversion

Check other formula lists

- Cnoidal Wave Theory Formulas
- Horizontal and Vertical Semi-Axis of Ellipse Formulas
- Parametric Spectrum Models Formulas
- Solitary Wave Formulas
- Subsurface Pressure Formulas
- Wave Celerity Formulas
- Wave Energy Formulas
- Wave Height Formulas
- Wave Parameters Formulas
- Wave Period Formulas
- Wave Period Distribution and Wave Spectrum Formulas
- Wavelength Formulas
- Zero-Crossing Method Formulas

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