Important Wave Setup Formulas PDF

Formulas
Examples
with Units

List of 20
Important Wave Setup Formulas

1) Beach Slope given Nonbreaking Upper Limit of Runup Formula

Evaluate Formula

Formula

$$\beta = \frac{\pi}{2} \cdot \left(\frac{R}{H_o} \cdot \left(2 \cdot \pi \right)^{0.5} \right)^4$$

Example with Units

$$0.7656 = \frac{3.1416}{2} \cdot \left(\frac{20\,\text{m}}{60\,\text{m}} \cdot \left(2 \cdot 3.1416 \right)^{0.5} \right)^4$$

2) Breaker Depth Index given Set-down at Breaker Point at Still-Water Shoreline Formula

Evaluate Formula

Formula

$$\gamma_b = \sqrt{\frac{8}{3} \cdot \left(\left(\frac{d_b}{\eta_s - \eta_b} \right) - 1 \right)}$$

Example with Units

$$0.3357 = \sqrt{\frac{8}{3} \cdot \left(\left(\frac{55\,\text{m}}{53.0\,\text{m} - 0.23\,\text{m}} \right) - 1 \right)}$$

3) Cross-Shore Component of Cross-Shore directed Radiation Stress Formula

Evaluate Formula

Formula

$$S_{xx'} = \left(\frac{3}{16} \right) \cdot \rho_{water} \cdot [g] \cdot d \cdot H^2$$

Example with Units

$$17376.158 = \left(\frac{3}{16} \right) \cdot 1000\,\text{kg/m}^3 \cdot 9.8066\,\text{m/s}^2 \cdot 1.05\,\text{m} \cdot 3\,\text{m}^2$$

4) Deepwater Wave Height given Nonbreaking Upper Limit of Runup on Uniform Slope Formula

Evaluate Formula

Formula

$$H_d = \frac{R}{\left(2 \cdot \pi \right)^{0.5} \cdot \left(\frac{\pi}{2} \cdot \beta \right)^{\frac{1}{4}}}$$

Example with Units

$$7.6332\,\text{m} = \frac{20\,\text{m}}{\left(2 \cdot 3.1416 \right)^{0.5} \cdot \left(\frac{3.1416}{2} \cdot 0.76 \right)^{\frac{1}{4}}}$$

5) Deepwater Wave Height given Wave Runup above Mean Water Level Formula

Evaluate Formula

Formula

$$H_d = \frac{R}{\varepsilon_{o'}}$$

Example with Units

$$6.0241\,\text{m} = \frac{20\,\text{m}}{3.32}$$

6) Mean Water Surface Elevation given Total Water Depth Formula

Evaluate Formula

Formula

$$\eta' = H_c - h$$

Example with Units

$$29\,\text{m} = 49\,\text{m} - 20.0\,\text{m}$$

7) Nonbreaking Upper Limit of Runup on Uniform Slope Formula

Evaluate Formula

Formula

$$R = H_d \cdot \left(2 \cdot \pi\right)^{0.5} \cdot \left(\frac{\pi}{2 \cdot \beta}\right)^{\frac{1}{4}}$$

Example with Units

$$18.033\,\text{m} = 6.0\,\text{m} \cdot \left(2 \cdot 3.1416\right)^{0.5} \cdot \left(\frac{3.1416}{2 \cdot 0.76}\right)^{\frac{1}{4}}$$

8) Set down for Regular Waves Formula

Evaluate Formula

Formula

$$\eta'_o = \left(-\frac{1}{8}\right) \cdot \left(\frac{H^2 \cdot \left(2 \cdot \frac{\pi}{\lambda}\right)}{\sinh\left(4 \cdot \pi \cdot \frac{d}{\lambda}\right)}\right)$$

Example with Units

$$-0.5147\,\text{m} = \left(-\frac{1}{8}\right) \cdot \left(\frac{3\,\text{m}^2 \cdot \left(2 \cdot \frac{3.1416}{26.8\,\text{m}}\right)}{\sinh\left(4 \cdot 3.1416 \cdot \frac{1.05\,\text{m}}{26.8\,\text{m}}\right)}\right)$$

9) Setdown at Breaker Point at Still-Water Shoreline Formula

Evaluate Formula

Formula

$$\eta_b = \eta_s - \left(\frac{1}{1 + \left(\frac{8}{3 \cdot \Upsilon_{b'}^2}\right)}\right) \cdot d_b$$

Example with Units

$$0.2483\,\text{m} = 53.0\,\text{m} - \left(\frac{1}{1 + \left(\frac{8}{3 \cdot 7.91^2}\right)}\right) \cdot 55\,\text{m}$$

10) Setup at Mean Shoreline Formula

Evaluate Formula

Formula

$$\eta'_{max} = \eta_s + \left(d\eta'dx \cdot \Delta_x\right)$$

Example with Units

$$53.6776 = 53.0\,\text{m} + \left(0.012 \cdot 56.47\right)$$

11) Setup at Still-Water Shoreline Formula

Evaluate Formula

Formula

$$\eta_s = \eta_b + \left(\frac{1}{1 + \left(\frac{8}{3 \cdot \Upsilon_{b'}^2}\right)}\right) \cdot d_b$$

Example with Units

$$52.9817\,\text{m} = 0.23\,\text{m} + \left(\frac{1}{1 + \left(\frac{8}{3 \cdot 7.91^2}\right)}\right) \cdot 55\,\text{m}$$

12) Shoreward Displacement of Shoreline Formula

Evaluate Formula

Formula

$$\Delta_x = \frac{\eta_s}{\tan\left(\beta\right) - d\eta'dx}$$

Example with Units

$$56.476 = \frac{53.0\,\text{m}}{\tan\left(0.76\right) - 0.012}$$

13) Still Water Depth given Total Water Depth Formula

Evaluate Formula

Formula

$$h = H_c - \eta'$$

Example with Units

$$20\,\text{m} = 49\,\text{m} - 29\,\text{m}$$

14) Surf Similarity Parameter given Wave Runup above Mean Water Level Formula

Evaluate Formula

Formula

$$\varepsilon_{o'} = \frac{R}{H_d}$$

Example with Units

$$3.3333 = \frac{20\,\text{m}}{6.0\,\text{m}}$$

15) Total Water Depth Formula

Evaluate Formula

Formula

$$H_c = h + \eta'$$

Example with Units

$$49\,\text{m} = 20.0\,\text{m} + 29\,\text{m}$$

16) Water Depth at Breaking given Setdown at Breaker Point at Still-Water Shoreline Formula

Evaluate Formula

Formula

$$d_b = \frac{\eta_s - \eta_b}{\frac{1}{1+\left(\frac{8}{3\cdot \gamma_b'^2}\right)}}$$

Example with Units

$$55.0191\,\text{m} = \frac{53.0\,\text{m} - 0.23\,\text{m}}{\frac{1}{1+\left(\frac{8}{3\cdot 7.91^2}\right)}}$$

17) Water Depth given Cross Shore Component Formula

Evaluate Formula

Formula

$$d = \frac{S_{xx'}}{\left(\frac{3}{16}\right)\cdot \rho_{water}\cdot [g]\cdot H^2}$$

Example with Units

$$1.05\,\text{m} = \frac{17376}{\left(\frac{3}{16}\right)\cdot 1000\,\text{kg/m}^3\cdot 9.8066\,\text{m/s}^2\cdot 3\,\text{m}^2}$$

18) Wave Height given Cross-Shore Component Formula

Evaluate Formula

Formula

$$H = \sqrt{\frac{16\cdot S_{xx'}}{3\cdot \rho_{water}\cdot [g]\cdot d}}$$

Example with Units

$$3\,\text{m} = \sqrt{\frac{16\cdot 17376}{3\cdot 1000\,\text{kg/m}^3\cdot 9.8066\,\text{m/s}^2\cdot 1.05\,\text{m}}}$$

19) Wave Height given Mean Water Surface Elevation Set down for Regular Waves Formula

Evaluate Formula

Formula

$$H = \sqrt{\eta'_o\cdot 8\cdot \frac{\sinh\left(4\cdot \pi\cdot \frac{d}{\lambda}\right)}{2\cdot \frac{\pi}{\lambda}}}$$

Example with Units

$$2.9864\,\text{m} = \sqrt{0.51\,\text{m}\cdot 8\cdot \frac{\sinh\left(4\cdot 3.1416\cdot \frac{1.05\,\text{m}}{26.8\,\text{m}}\right)}{2\cdot \frac{3.1416}{26.8\,\text{m}}}}$$

20) Wave Runup above Mean Water Level Formula

Evaluate Formula

Formula	Example with Units
$R = H_d \cdot \varepsilon_{o'}$	$19.92\,\text{m} = 6.0\,\text{m} \cdot 3.32$

Variables used in list of Wave Setup Formulas above

- **d** Water Depth *(Meter)*
- d_b Water Depth at Breaking *(Meter)*
- **dη'dx** Cross-Shore Balance Momentum
- **h** Still-Water Depth *(Meter)*
- **H** Wave Height *(Meter)*
- H_c Coastal Water Depth *(Meter)*
- H_d Deepwater Wave Height *(Meter)*
- H_o Deepwater Wave Height of Ocean *(Meter)*
- **R** Wave Runup *(Meter)*
- $S_{xx'}$ Coastal Cross-Shore Component
- **β** Beach Slope
- γ_b Breaker Depth Index
- Δ_x Shoreward Displacement of the Shoreline
- $\varepsilon_{o'}$ Deepwater Surf Similarity Parameter
- **η'** Mean Water Surface Elevation *(Meter)*
- η_b Set Down at the Breaker Point *(Meter)*
- η'_{max} Setup at the Mean Shoreline
- η'_o Mean Water Surface Elevation of Coast *(Meter)*
- η_s Setup at the Still-Water Shore Line *(Meter)*
- **λ** Wavelength of Coast *(Meter)*
- ρ_{water} Water Density *(Kilogram per Cubic Meter)*
- $Y_{b'}$ Coastal Breaker Depth Index

Constants, Functions, Measurements used in list of Wave Setup Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- constant(s): **[g]**, 9.80665
  Gravitational acceleration on Earth
- Functions: **sinh**, sinh(Number)
  The hyperbolic sine function, also known as the sinh function, is a mathematical function that is defined as the hyperbolic analogue of the sine function.
- 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.
- Functions: **tan**, tan(Angle)
  The tangent of an angle is a trigonometric ratio of the length of the side opposite an angle to the length of the side adjacent to an angle in a right triangle.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion

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