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Subsurface Pressure Formulas

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List of 35 Subsurface Pressure Formulas

Subsurface Pressure

Group Velocity

1) Deepwater Celerity

Open Calculator

fx $$C_o = \frac{Vg_{deep}}{0.5}$$

ex $$0.332\text{m/s} = \frac{0.166\text{m/s}}{0.5}$$

2) Deepwater Wavelength

Open Calculator

fx $$\lambda_o = \frac{Vg_{deep} \cdot P}{0.5}$$

ex $$0.34196\text{m} = \frac{0.166\text{m/s} \cdot 1.03}{0.5}$$

3) Group Velocity for Deepwater

Open Calculator

fx $$Vg_{deep} = 0.5 \cdot \left(\frac{\lambda_o}{P_{sz}}\right)$$

ex $$0.167157\text{m/s} = 0.5 \cdot \left(\frac{0.341\text{m}}{1.02}\right)$$

4) Group Velocity for Shallow Water

Open Calculator

fx $$Vg_{shallow} = \frac{\lambda}{P}$$

ex $$26.01942\text{m/s} = \frac{26.8\text{m}}{1.03}$$

5) Group Velocity given Deepwater Celerity

Open Calculator

fx $$Vg_{deep} = 0.5 \cdot C_o$$

ex $$0.166\text{m/s} = 0.5 \cdot 0.332\text{m/s}$$

6) Group Velocity of Wave given Wavelength and Wave Period

Open Calculator

$$\mathrm{Vg_{shallow}} = 0.5 \cdot \left(\frac{\lambda}{\mathrm{P}}\right) \cdot \left(1 + \frac{4 \cdot \pi \cdot \frac{\mathrm{d}}{\lambda}}{\sinh\left(4 \cdot \pi \cdot \frac{\mathrm{d}}{\lambda}\right)}\right)$$

$$25.50832\mathrm{m/s} = 0.5 \cdot \left(\frac{26.8\mathrm{m}}{1.03}\right) \cdot \left(1 + \frac{4 \cdot \pi \cdot \frac{1.05\mathrm{m}}{26.8\mathrm{m}}}{\sinh\left(4 \cdot \pi \cdot \frac{1.05\mathrm{m}}{26.8\mathrm{m}}\right)}\right)$$

7) Wave Period given Group Velocity for Shallow Water

Open Calculator

$$\mathrm{P} = \frac{\lambda}{\mathrm{Vg_{shallow}}}$$

$$1.030373 = \frac{26.8\mathrm{m}}{26.01\mathrm{m/s}}$$

8) Wavelength given Group Velocity of Shallow Water

Open Calculator

$$\lambda = \mathrm{Vg_{shallow}} \cdot \mathrm{P_{wave}}$$

$$27.33651\mathrm{m} = 26.01\mathrm{m/s} \cdot 1.051\mathrm{s}$$

Energy per unit Length of Wave Crest

9) Kinetic Energy per unit Length of Wave Crest

Open Calculator

$$\mathrm{KE} = \left(\frac{1}{16}\right) \cdot \rho \cdot [\mathrm{g}] \cdot \mathrm{H}^2 \cdot \lambda$$

$$147.3917\mathrm{KJ} = \left(\frac{1}{16}\right) \cdot 997\mathrm{kg/m^3} \cdot [\mathrm{g}] \cdot (3\mathrm{m})^2 \cdot 26.8\mathrm{m}$$

10) Potential Energy per unit Length of Wave Crest

Open Calculator

$$\mathrm{PE} = \left(\frac{1}{16}\right) \cdot \rho \cdot [\mathrm{g}] \cdot \mathrm{H}^2 \cdot \lambda$$

$$147391.7\mathrm{J} = \left(\frac{1}{16}\right) \cdot 997\mathrm{kg/m^3} \cdot [\mathrm{g}] \cdot (3\mathrm{m})^2 \cdot 26.8\mathrm{m}$$

11) Wave Height given Kinetic Energy per unit Length of Wave Crest

Open Calculator

$$H = \sqrt{\frac{KE}{\left(\frac{1}{16}\right) \cdot \rho \cdot [g] \cdot \lambda}}$$

$$3.003135\text{m} = \sqrt{\frac{147.7\text{KJ}}{\left(\frac{1}{16}\right) \cdot 997\text{kg/m}^3 \cdot [g] \cdot 26.8\text{m}}}$$

12) Wave Height given Potential Energy per unit Length of Wave Crest

Open Calculator

$$H = \sqrt{\frac{PE}{\left(\frac{1}{16}\right) \cdot \rho \cdot [g] \cdot \lambda}}$$

$$3\text{m} = \sqrt{\frac{147391.7\text{J}}{\left(\frac{1}{16}\right) \cdot 997\text{kg/m}^3 \cdot [g] \cdot 26.8\text{m}}}$$

13) Wavelength for Kinetic Energy per unit Length of Wave Crest

Open Calculator

$$\lambda = \frac{KE}{\left(\frac{1}{16}\right) \cdot \rho \cdot [g] \cdot H^2}$$

$$26.85605\text{m} = \frac{147.7\text{KJ}}{\left(\frac{1}{16}\right) \cdot 997\text{kg/m}^3 \cdot [g] \cdot (3\text{m})^2}$$

14) Wavelength given Potential Energy per unit Length of Wave Crest

Open Calculator

$$\lambda = \frac{PE}{\left(\frac{1}{16}\right) \cdot \rho \cdot [g] \cdot H^2}$$

$$26.79999\text{m} = \frac{147391.7\text{J}}{\left(\frac{1}{16}\right) \cdot 997\text{kg/m}^3 \cdot [g] \cdot (3\text{m})^2}$$

Pressure Component

15) Atmospheric Pressure given Gauge Pressure

Open Calculator

$$P_{atm} = P_{abs} - P_g$$

$$99987\text{Pa} = 100000\text{Pa} - 13\text{Pa}$$

16) Atmospheric Pressure given Total or Absolute Pressure

Open Calculator

$$P_{atm} = P_{abs} - \left(\rho \cdot [g] \cdot H \cdot \cosh\left(2 \cdot \pi \cdot \frac{D_{Z+d}}{\lambda}\right)\right) \cdot \frac{\cos(\theta)}{2 \cdot \cosh\left(2 \cdot \pi \cdot \frac{d}{\lambda}\right)} + (\rho \cdot [g] \cdot Z)$$

$$100964.8\text{Pa} = 100000\text{Pa} - \left(997\text{kg/m}^3 \cdot [g] \cdot 3\text{m} \cdot \cosh\left(2 \cdot \pi \cdot \frac{2\text{m}}{26.8\text{m}}\right)\right) \cdot \frac{\cos(60^\circ)}{2 \cdot \cosh\left(2 \cdot \pi \cdot \frac{1.05\text{m}}{26.8\text{m}}\right)} + (997\text{kg/m}$$

17) Correction Factor given Height of Surface Waves based on Subsurface Measurements

Open Calculator

$$f = \eta \cdot \rho \cdot [g] \cdot \frac{k}{P_{ss} + (\rho \cdot [g] \cdot z)}$$

$$0.507003 = 19.2\text{m} \cdot 997\text{kg/m}^3 \cdot [g] \cdot \frac{1.32}{800\text{Pa} + (997\text{kg/m}^3 \cdot [g] \cdot 49.906\text{m})}$$

18) Depth below SWL of Pressure Gauge

Open Calculator

$$z = \frac{\left(\eta \cdot \rho \cdot [g] \cdot \frac{k}{f}\right) - P_{ss}}{\rho \cdot [g]}$$

$$49.90634\text{m} = \frac{\left(19.2\text{m} \cdot 997\text{kg/m}^3 \cdot [g] \cdot \frac{1.32}{0.507}\right) - 800\text{Pa}}{997\text{kg/m}^3 \cdot [g]}$$

19) Friction Velocity given Dimensionless Time

Open Calculator

$$V_f = \frac{[g] \cdot t_d}{t'}$$

$$6.000002\text{m/s} = \frac{[g] \cdot 68\text{s}}{111.142}$$

20) Phase Angle for Total or Absolute Pressure

Open Calculator

$$\theta = a\cos\left(\frac{P_{abs} + (\rho \cdot [g] \cdot Z) - (P_{atm})}{\frac{\rho \cdot [g] \cdot H \cdot \cosh\left(2 \cdot \pi \cdot \frac{D_{Z+d}}{\lambda}\right)}{2 \cdot \cosh\left(2 \cdot \pi \cdot \frac{d}{\lambda}\right)}}\right)$$

$$55.82076^\circ = a\cos\left(\frac{100000\text{Pa} + (997\text{kg/m}^3 \cdot [g] \cdot 0.908) - (99987\text{Pa})}{\frac{997\text{kg/m}^3 \cdot [g] \cdot 3\text{m} \cdot \cosh\left(2 \cdot \pi \cdot \frac{2\text{m}}{26.8\text{m}}\right)}{2 \cdot \cosh\left(2 \cdot \pi \cdot \frac{1.05\text{m}}{26.8\text{m}}\right)}}\right)$$

21) Radian Frequency given Wave Period

Open Calculator

$$\omega = \frac{1}{T'}$$

$$0.384615\text{rad/s} = \frac{1}{2.6\text{s}}$$

22) Total or Absolute Pressure

Open Calculator

$$P_{abs} = \left(\rho \cdot [g] \cdot H \cdot \cosh\left(2 \cdot \pi \cdot \frac{D_{Z+d}}{\lambda}\right) \cdot \frac{\cos(\theta)}{2} \cdot \cosh\left(2 \cdot \pi \cdot \frac{d}{\lambda}\right)\right) - (\rho \cdot [g] \cdot Z) + P_{atm}$$

$$99511.5\text{Pa} = \left(997\text{kg/m}^3 \cdot [g] \cdot 3\text{m} \cdot \cosh\left(2 \cdot \pi \cdot \frac{2\text{m}}{26.8\text{m}}\right) \cdot \frac{\cos(60^\circ)}{2} \cdot \cosh\left(2 \cdot \pi \cdot \frac{1.05\text{m}}{26.8\text{m}}\right)\right) - (997\text{kg/m}^3 \cdot$$

23) Total Pressure given Gauge Pressure

Open Calculator

$$P_T = P_g + P_{atm}$$

$$100000\text{Pa} = 13\text{Pa} + 99987\text{Pa}$$

24) Water Depth given Wave Celerity for Shallow Water

Open Calculator

$$d = \frac{C^2}{[g]}$$

$$1.044189\text{m} = \frac{(3.2\text{m/s})^2}{[g]}$$

25) Water Surface Elevation

Open Calculator

$$\eta'' = \left(\frac{H}{2}\right) \cdot \cos(\theta)$$

$$0.75\text{m} = \left(\frac{3\text{m}}{2}\right) \cdot \cos(60^\circ)$$

26) Water Surface Elevation of Two Sinusoidal Wave

Open Calculator

$$\eta'' = \left(\frac{H}{2}\right) \cdot \cos\left(\left(2 \cdot \pi \cdot \frac{x}{L1}\right) - \left(2 \cdot \pi \cdot \frac{t}{T_1}\right)\right) + \left(\frac{H}{2}\right) \cdot \cos\left(\left(2 \cdot \pi \cdot \frac{x}{L2}\right) - \left(2 \cdot \pi \cdot \frac{t}{T_2}\right)\right.$$

ex

$$1.500938\text{m} = \left(\frac{3\text{m}}{2}\right) \cdot \cos\left(\left(2 \cdot \pi \cdot \frac{50.0}{50}\right) - \left(2 \cdot \pi \cdot \frac{24.99}{25.0\text{s}}\right)\right) + \left(\frac{3\text{m}}{2}\right) \cdot \cos\left(\left(2 \cdot \pi \cdot \frac{50.0}{25}\right) - \left(2 \cdot \pi \cdot \frac{24}{10}\right.\right.$$

27) Wave celerity for shallow water given water depth

Open Calculator

$$C = \sqrt{[g] \cdot d}$$

ex

$$3.208891\text{m/s} = \sqrt{[g] \cdot 1.05\text{m}}$$

28) Wave Period given Average Frequency

Open Calculator

$$P = \frac{1}{\omega}$$

ex

$$2.631579 = \frac{1}{0.38\text{rad/s}}$$

Pressure Reference Factor

29) Pressure given Height of Surface Waves based on Subsurface Measurements

Open Calculator

$$p = \left(\frac{\eta'' \cdot \rho \cdot [g] \cdot K}{f}\right) - \left(\rho \cdot [g] \cdot z''\right)$$

ex

$$320.5254\text{kPa} = \left(\frac{19.2\text{m} \cdot 997\text{kg/m}^3 \cdot [g] \cdot 0.9}{0.507}\right) - \left(997\text{kg/m}^3 \cdot [g] \cdot 1.3\text{m}\right)$$

30) Pressure given Pressure Response Factor

Open Calculator

$$P_{ss} = \rho \cdot [g] \cdot \left(\left(\left(\frac{H}{2}\right) \cdot \cos(\theta) \cdot k\right) - Z\right)$$

ex

$$801.7329\text{Pa} = 997\text{kg/m}^3 \cdot [g] \cdot \left(\left(\left(\frac{3\text{m}}{2}\right) \cdot \cos(60^\circ) \cdot 1.32\right) - 0.908\right)$$

31) Pressure Reference Factor

Open Calculator

$$K = \frac{\cosh\left(2 \cdot \pi \cdot \frac{D_{Z+d}}{\lambda}\right)}{\cosh\left(2 \cdot \pi \cdot \frac{d}{\lambda}\right)}$$

$$1.079098 = \frac{\cosh\left(2 \cdot \pi \cdot \frac{2m}{26.8m}\right)}{\cosh\left(2 \cdot \pi \cdot \frac{1.05m}{26.8m}\right)}$$

32) Pressure Reference Factor given Height of Surface Waves based on Subsurface Measurements

Open Calculator

$$K = f \cdot \frac{p + \left(\rho \cdot [g] \cdot z''\right)}{\eta \cdot \rho \cdot [g]}$$

$$0.899985 = 0.507 \cdot \frac{320.52kPa + \left(997kg/m^3 \cdot [g] \cdot 1.3m\right)}{19.2m \cdot 997kg/m^3 \cdot [g]}$$

33) Pressure Response Factor at Bottom

Open Calculator

$$K = \frac{1}{\cosh\left(2 \cdot \pi \cdot \frac{d}{\lambda}\right)}$$

$$0.970447 = \frac{1}{\cosh\left(2 \cdot \pi \cdot \frac{1.05m}{26.8m}\right)}$$

34) Pressure taken as Gauge Pressure relative to Wave Mechanics

Open Calculator

$$p = \left(\rho \cdot [g] \cdot H \cdot \cosh\left(2 \cdot \pi \cdot \frac{D_{z'+d'}}{\lambda}\right)\right) \cdot \frac{\cos(\theta)}{2 \cdot \cosh\left(2 \cdot \pi \cdot \frac{d}{\lambda}\right)} - \left(\rho \cdot [g] \cdot Z\right)$$

$$320.2747kPa = \left(997kg/m^3 \cdot [g] \cdot 3m \cdot \cosh\left(2 \cdot \pi \cdot \frac{19.31m}{26.8m}\right)\right) \cdot \frac{\cos(60°)}{2 \cdot \cosh\left(2 \cdot \pi \cdot \frac{1.05m}{26.8m}\right)} - \left(997kg/m^3 \cdot [g] \cdot 0.9\right.$$

35) Wavelength for Pressure Response Factor at bottom

Open Calculator

$$\lambda = 2 \cdot \pi \cdot \frac{d}{a\cosh\left(\frac{1}{K}\right)}$$

$$14.12268m = 2 \cdot \pi \cdot \frac{1.05m}{a\cosh\left(\frac{1}{0.9}\right)}$$

Variables Used

- **C** Wave Celerity *(Meter per Second)*
- **C_o** Deep Water Wave Celerity *(Meter per Second)*
- **d** Water Depth *(Meter)*
- **$D_{z'+d'}$** Upper Bottom Distance *(Meter)*
- **D_{Z+d}** Distance above the Bottom *(Meter)*
- **f** Correction Factor
- **H** Wave Height *(Meter)*
- **k** Pressure Response Factor
- **K** Pressure Factor
- **KE** Kinetic Energy of Wave Crest *(Kilojoule)*
- **L1** Wavelength of Component Wave 1
- **L2** Wavelength of Component Wave 2
- **p** Sub Surface Pressure *(Kilopascal)*
- **P** Wave Period
- **P_{abs}** Absolute Pressure *(Pascal)*
- **P_{atm}** Atmospheric Pressure *(Pascal)*
- **P_g** Gauge Pressure *(Pascal)*
- **P_{ss}** Pressure *(Pascal)*
- **P_{sz}** Surf Zone Wave Period
- **P_T** Total Pressure *(Pascal)*
- **P_{wave}** Annual Wave Period *(Second)*
- **PE** Potential Energy *(Joule)*
- **t** Temporal Progressive Wave
- **t'** Dimensionless Time
- **T'** Mean Wave Period *(Second)*
- **T_1** Wave Period of Component Wave 1 *(Second)*
- **T_2** Wave Period of Component Wave 2 *(Second)*
- **t_d** Time for Dimensionless Parameter Calculation *(Second)*
- **V_f** Friction Velocity *(Meter per Second)*
- **Vg_{deep}** Group Velocity for Deep Water *(Meter per Second)*
- **$Vg_{shallow}$** Group Velocity for Shallow Water *(Meter per Second)*
- **x** Spatial Progressive Wave
- **z** Depth below the SWL of Pressure Gauge *(Meter)*
- **Z** Seabed Elevation

- z'' Depth of Pressure Gauge *(Meter)*
- η Water Surface Elevation *(Meter)*
- η'' Water Elevation *(Meter)*
- θ Phase Angle *(Degree)*
- λ Wavelength *(Meter)*
- λ_o Deep Water Wavelength *(Meter)*
- ρ Mass Density *(Kilogram per Cubic Meter)*
- ω Wave Angular Frequency *(Radian per Second)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **[g]**, 9.80665
  Gravitational acceleration on Earth
- Function: **acos**, acos(Number)
  The inverse cosine function, is the inverse function of the cosine function. It is the function that takes a ratio as an input and returns the angle whose cosine is equal to that ratio.
- Function: **acosh**, acosh(Number)
  Hyperbolic cosine function, is a function that takes a real number as an input and returns the angle whose hyperbolic cosine is that number.
- 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: **cosh**, cosh(Number)
  The hyperbolic cosine function is a mathematical function that is defined as the ratio of the sum of the exponential functions of x and negative x to 2.
- Function: **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.
- 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: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Pressure** in Pascal (Pa), Kilopascal (kPa)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Energy** in Kilojoule (KJ), Joule (J)
  Energy Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Wavelength** in Meter (m)
  Wavelength Unit Conversion
- Measurement: **Mass Concentration** in Kilogram per Cubic Meter (kg/m³)
  Mass Concentration Unit Conversion
- Measurement: **Angular Frequency** in Radian per Second (rad/s)
  Angular Frequency Unit Conversion

Check other formula lists

- Cnoidal Wave Theory Formulas
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