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Estimating Marine and Coastal Winds Formulas

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List of 28 Estimating Marine and Coastal Winds Formulas

Estimating Marine and Coastal Winds

Measured Wind Directions

1) Ambient Pressure at Periphery of Storm

Open Calculator

fx $$p_n = \left(\frac{p - p_c}{\exp\left(-\frac{A}{r^B}\right)} \right) + p_c$$

ex $$975\text{mbar} = \left(\frac{975\text{mbar} - 965\text{mbar}}{\exp\left(-\frac{50\text{m}}{(48\text{m})^5}\right)} \right) + 965\text{mbar}$$

2) Characteristic Wave Height given Dimensionless Wave Height

Open Calculator

fx $$H = \frac{H' \cdot V_f^2}{[g]}$$

ex $$110.1294\text{m} = \frac{30 \cdot (6\text{m/s})^2}{[g]}$$

3) Cyclostrophic Approximation to Wind Speed

Open Calculator

fx $$U_c = \left(A \cdot B \cdot (p_n - p_c) \cdot \frac{\exp\left(-\frac{A}{r^B}\right)}{\rho \cdot r^B} \right)^{0.5}$$

ex $$0.027408 = \left(50\text{m} \cdot 5 \cdot (974.90\text{mbar} - 965\text{mbar}) \cdot \frac{\exp\left(-\frac{50\text{m}}{(48\text{m})^5}\right)}{1.293\text{kg/m}^3 \cdot (48\text{m})^5} \right)^{0.5}$$

4) Dimensionless Fetch

Open Calculator

fx $$X' = \left([g] \cdot \frac{X}{V_f^2} \right)$$

ex $$4.086104 = \left([g] \cdot \frac{15\text{m}}{(6\text{m/s})^2} \right)$$

5) Dimensionless Fetch given Fetch-limited Dimensionless Wave Height

Open Calculator

fx $$X' = \left(\frac{H'}{\lambda} \right)^{\frac{1}{m1}}$$

ex $$4.330127 = \left(\frac{30}{1.6} \right)^{\frac{1}{2}}$$

6) Dimensionless Wave Frequency

Open Calculator

$$f'_p = \frac{V_f \cdot f_p}{[g]}$$

$$7.953786 = \frac{6\text{m/s} \cdot 13\text{Hz}}{[g]}$$

7) Dimensionless Wave Height

Open Calculator

$$H' = \frac{[g] \cdot H}{V_f^2}$$

$$29.96476 = \frac{[g] \cdot 110\text{m}}{(6\text{m/s})^2}$$

8) Direction in Cartesian Coordinate System

Open Calculator

$$\theta_{vec} = 270 - \theta_{met}$$

$$180 = 270 - 90$$

9) Direction in Standard Meteorological Terms

Open Calculator

$$\theta_{met} = 270 - \theta_{vec}$$

$$90 = 270 - 180$$

10) Distance from Center of Storm Circulation to Location of Maximum Wind Speed

Open Calculator

fx $R_{max} = A^{\frac{1}{B}}$

ex $2.186724\text{m} = (50\text{m})^{\frac{1}{5}}$

11) Fetch-Limited Dimensionless Wave Height

Open Calculator

fx $H' = \lambda \cdot \left(X'^{m1}\right)$

ex $29.584 = 1.6 \cdot \left((4.3)^{2}\right)$

12) Frequency of Spectral Peak for Dimensionless Wave Frequency

Open Calculator

fx $f_p = \frac{f'_p \cdot [g]}{V_f}$

ex $13.07553\text{Hz} = \frac{8 \cdot [g]}{6\text{m/s}}$

13) Friction Velocity for Dimensionless Wave Frequency

Open Calculator

fx $V_f = \frac{f'_p \cdot [g]}{f_p}$

ex $6.034862\text{m/s} = \frac{8 \cdot [g]}{13\text{Hz}}$

14) Friction Velocity given Dimensionless Fetch

Open Calculator

fx $$V_f = \sqrt{[g] \cdot \frac{X}{X'}}$$

ex $$5.848867\text{m/s} = \sqrt{[g] \cdot \frac{15\text{m}}{4.3}}$$

15) Friction Velocity given Dimensionless Wave Height

Open Calculator

fx $$V_f = \sqrt{\frac{[g] \cdot H}{H'}}$$

ex $$5.996475\text{m/s} = \sqrt{\frac{[g] \cdot 110\text{m}}{30}}$$

16) Fully Developed Wave Height

Open Calculator

fx $$H_\infty = \frac{\lambda \cdot U^2}{[g]}$$

ex $$2.610474\text{m} = \frac{1.6 \cdot (4\text{m/s})^2}{[g]}$$

17) Maximum Velocity in Storm

Open Calculator

fx $$V_{Max} = \left(\frac{B}{\rho} \cdot e\right)^{0.5} \cdot (p_n - p_c)^{0.5}$$

ex $$102.0118\text{m/s} = \left(\frac{5}{1.293\text{kg/m}^3} \cdot e\right)^{0.5} \cdot (974.90\text{mbar} - 965\text{mbar})^{0.5}$$

18) Pressure Profile in Hurricane Winds

Open Calculator

fx $$p = p_c + (p_n - p_c) \cdot \exp\left(-\frac{A}{r^B}\right)$$

ex $$974.9\text{mbar} = 965\text{mbar} + (974.90\text{mbar} - 965\text{mbar}) \cdot \exp\left(-\frac{50\text{m}}{(48\text{m})^5}\right)$$

19) Wind Speed given Fully Developed Wave Height

Open Calculator

fx $$U = \sqrt{H_\infty \cdot \frac{[g]}{\lambda}}$$

ex $$3.991968\text{m/s} = \sqrt{2.6\text{m} \cdot \frac{[g]}{1.6}}$$

Wave Hindcasting and Forecasting

20) Drag Coefficient for Wind Speed at 10m Elevation

Open Calculator

fx $$C_D = 0.001 \cdot (1.1 + (0.035 \cdot V_{10}))$$

ex $$0.00187 = 0.001 \cdot (1.1 + (0.035 \cdot 22\text{m/s}))$$

21) Limiting Wave Period

Open Calculator

fx $$T_p = 9.78 \cdot \left(\left(\frac{D_w}{[g]}\right)^{0.5}\right)$$

ex $$20.95004\text{s} = 9.78 \cdot \left(\left(\frac{45\text{m}}{[g]}\right)^{0.5}\right)$$

22) Spectral Energy Density

Open Calculator

fx $$E_{(f)} = \frac{\lambda \cdot \left([g]^2 \right) \cdot \left(f^{-5} \right)}{(2 \cdot \pi)^4}$$

ex $$0.003085 = \frac{1.6 \cdot \left([g]^2 \right) \cdot \left((2)^{-5} \right)}{(2 \cdot \pi)^4}$$

23) Spectral Energy Density or Classical Moskowitz Spectrum

fx

Open Calculator

$$E_{(f)} = \left(\frac{\lambda \cdot \left([g]^2 \right) \cdot \left(f^{-5} \right)}{(2 \cdot \pi)^4} \right) \cdot \exp\left(0.74 \cdot \left(\frac{f}{f_u} \right)^{-4} \right)$$

ex $$0.003085 = \left(\frac{1.6 \cdot \left([g]^2 \right) \cdot \left((2)^{-5} \right)}{(2 \cdot \pi)^4} \right) \cdot \exp\left(0.74 \cdot \left(\frac{2}{0.0001} \right)^{-4} \right)$$

24) Straight-Line Distance given Time required for Waves Crossing Fetch under Wind Velocity

Open Calculator

fx $$X = \left(\frac{t_{x,u} \cdot U^{0.34} \cdot [g]^{0.33}}{77.23} \right)^{\frac{1}{0.67}}$$

ex $$15.11712\text{m} = \left(\frac{140\text{s} \cdot (4\text{m/s})^{0.34} \cdot [g]^{0.33}}{77.23} \right)^{\frac{1}{0.67}}$$

25) Straight-Line Distance over which Wind Blows

Open Calculator

$$X = \left(\frac{V_f^2}{[g]}\right) \cdot 5.23 \cdot 10^{-3} \cdot \left([g] \cdot \frac{t}{V_f}\right)^{\frac{3}{2}}$$

$$14.99991\text{m} = \left(\frac{(6\text{m/s})^2}{[g]}\right) \cdot 5.23 \cdot 10^{-3} \cdot \left([g] \cdot \frac{51.9\text{s}}{6\text{m/s}}\right)^{\frac{3}{2}}$$

26) Time required for Waves Crossing Fetch under Wind Velocity to become Fetch Limited

Open Calculator

$$t_{x,u} = 77.23 \cdot \left(\frac{X^{0.67}}{U^{0.34} \cdot [g]^{0.33}}\right)$$

$$139.2724\text{s} = 77.23 \cdot \left(\frac{(15\text{m})^{0.67}}{(4\text{m/s})^{0.34} \cdot [g]^{0.33}}\right)$$

27) Water Depth for given Limiting Wave Period

Open Calculator

$$D_w = [g] \cdot \left(\frac{T_p}{9.78}\right)^{\frac{1}{0.5}}$$

$$45.2149\text{m} = [g] \cdot \left(\frac{21\text{s}}{9.78}\right)^{\frac{1}{0.5}}$$

28) Wind Speed given Time required for Waves crossing Fetch under Wind Velocity

Open Calculator

fx $$U = \left(\frac{77.23 \cdot X^{0.67}}{t_{x,u} \cdot [g]^{0.33}} \right)^{\frac{1}{0.34}}$$

ex $$3.939162\text{m/s} = \left(\frac{77.23 \cdot (15\text{m})^{0.67}}{140\text{s} \cdot [g]^{0.33}} \right)^{\frac{1}{0.34}}$$

Variables Used

- **A** Scaling Parameter *(Meter)*
- **B** Parameter Controlling Peakedness
- C_D Drag Coefficient
- D_w Water Depth from Bed *(Meter)*
- $E_{(f)}$ Spectral Energy Density
- **f** Coriolis Frequency
- f_p Frequency at Spectral Peak *(Hertz)*
- f'_p Dimensionless Wave Frequency
- f_u Limiting Frequency
- **H** Characteristic Wave Height *(Meter)*
- **H'** Dimensionless Wave Height
- H_∞ Fully Developed Wave Height *(Meter)*
- **m1** Dimensionless Exponent
- **p** Pressure at Radius *(Millibar)*
- p_c Central Pressure in Storm *(Millibar)*
- p_n Ambient Pressure at Periphery of Storm *(Millibar)*
- **r** Arbitrary Radius *(Meter)*
- R_{max} Distance from Center of Storm Circulation *(Meter)*
- **t** Wind Duration *(Second)*
- T_p Limiting Wave Period *(Second)*
- $t_{x,u}$ Time required for Waves crossing Fetch *(Second)*
- **U** Wind Speed *(Meter per Second)*
- U_c Cyclostrophic Approximation to Wind Speed

- V_{10} Wind Speed at Height of 10 m *(Meter per Second)*
- V_f Friction Velocity *(Meter per Second)*
- V_{Max} Maximum Velocity of Wind *(Meter per Second)*
- X Straight Line Distance over which Wind Blows *(Meter)*
- X' Dimensionless Fetch
- θ_{met} Direction in Standard Meteorological Terms
- θ_{vec} Direction in Cartesian Coordinate system
- λ Dimensionless Constant
- ρ Density of Air *(Kilogram per Cubic Meter)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **[g]**, 9.80665
  Gravitational acceleration on Earth
- Constant: **e**, 2.71828182845904523536028747135266249
  Napier's constant
- 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: **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 Millibar (mbar)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion

Check other formula lists

- Calculation of Forces on Ocean Structures Formulas
- Density Currents in Harbors Formulas
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