Important Bay Superelevation, Effect of Freshwater Inflow, Multiple Inlets and Wave-Current Interaction Formulas PDF

Formulas
Examples
with Units

List of 24
Important Bay Superelevation, Effect of Freshwater Inflow, Multiple Inlets and Wave-Current Interaction Formulas

1) Bay Superelevation Formulas

1.1) Depth given Water Surface Slope Formula

Evaluate Formula

Formula

$$h = \frac{\Delta \cdot \tau}{\beta \cdot \rho_{water} \cdot [g]}$$

Example with Units

$$11.9167\,\text{m} = \frac{1.49 \cdot 0.6\,\text{N/m}^2}{0.00000765 \cdot 1000\,\text{kg/m}^3 \cdot 9.8066\,\text{m/s}^2}$$

1.2) Superelevation Formula

Evaluate Formula

Formula

$$\Delta_{BS} = a_o \cdot \left(\frac{\sin\left(2 \cdot \pi \cdot \frac{t}{T}\right)}{1 - \cos\left(2 \cdot \pi \cdot \frac{t}{T}\right)} \right)$$

Example with Units

$$4.5151\,\text{m} = 4.0\,\text{m} \cdot \left(\frac{\sin\left(2 \cdot 3.1416 \cdot \frac{1.2\,\text{h}}{130\,\text{s}}\right)}{1 - \cos\left(2 \cdot 3.1416 \cdot \frac{1.2\,\text{h}}{130\,\text{s}}\right)} \right)$$

1.3) Superelevation due to Varying Entrance Channel Cross-Section Formula

Evaluate Formula

Formula

$$S = a_o \cdot \left(1 - \left(\frac{\left(\frac{a_B}{a_o}\right)^2}{4 \cdot \left(\frac{D_t}{a_o}\right)} \right) - \left(\frac{a_o}{m \cdot W} \right) \cdot \left(0.5 - \left(\frac{a_B}{a_o} \right) \cdot \cos(k) - \left(\left(\frac{3}{2} \right) \cdot \left(\frac{a_B}{a_o} \right)^2 \right) + 4 \cdot \left(\frac{D_t}{a_o} \right)^2 \right) \right)$$

Example with Units

$$2.0029\,\text{m} = 4.0\,\text{m} \cdot \left(1 - \left(\frac{\left(\frac{3.7}{4.0\,\text{m}}\right)^2}{4 \cdot \left(\frac{5.01\,\text{m}}{4.0\,\text{m}}\right)} \right) - \left(\frac{4.0\,\text{m}}{1.5 \cdot 52\,\text{m}} \right) \cdot \left(0.5 - \left(\frac{3.7}{4.0\,\text{m}} \right) \cdot \cos(185.2) - \left(\left(\frac{3}{2} \right) \cdot \left(\frac{3.7}{4.0\,\text{m}} \right)^2 \right) + 4 \cdot \left(\frac{5.01\,\text{m}}{4.0\,\text{m}} \right)^2 \right) \right)$$

1.4) Tidal Amplitude in Ocean Formula

Evaluate Formula

Formula

$$a_o = \frac{\Delta_{BS}}{\frac{\sin\left(2 \cdot \pi \cdot \frac{t}{T}\right)}{1 - \cos\left(2 \cdot \pi \cdot \frac{t}{T}\right)}}$$

Example with Units

$$3.9955\,\text{m} = \frac{4.51\,\text{m}}{\frac{\sin\left(2 \cdot 3.1416 \cdot \frac{1.2\,\text{h}}{130\,\text{s}}\right)}{1 - \cos\left(2 \cdot 3.1416 \cdot \frac{1.2\,\text{h}}{130\,\text{s}}\right)}}$$

2) Effect of Freshwater Inflow Formulas

2.1) King's Dimensionless Variable Formula

Evaluate Formula

Formula

$$Qr' = Qr \cdot \frac{T}{2 \cdot \pi \cdot a_o \cdot A_b}$$

Example with Units

$$0.5747 = 10\,\text{m}^3/\text{min} \cdot \frac{130\,\text{s}}{2 \cdot 3.1416 \cdot 4.0\,\text{m} \cdot 1.5001\,\text{m}^2}$$

2.2) Ocean Tide Amplitude using King's Dimensionless Variable Formula

Evaluate Formula

Formula

$$a_o = \frac{Qr \cdot T}{Qr' \cdot 2 \cdot \pi \cdot A_b}$$

Example with Units

$$4.0329\,\text{m} = \frac{10\,\text{m}^3/\text{min} \cdot 130\,\text{s}}{0.57 \cdot 2 \cdot 3.1416 \cdot 1.5001\,\text{m}^2}$$

2.3) River or Freshwater Inflow to Bay using King's Dimensionless Variable Formula

Evaluate Formula

Formula

$$Qr = \frac{Qr' \cdot 2 \cdot \pi \cdot a_o \cdot A_b}{T}$$

Example with Units

$$9.9184\,\text{m}^3/\text{min} = \frac{0.57 \cdot 2 \cdot 3.1416 \cdot 4.0\,\text{m} \cdot 1.5001\,\text{m}^2}{130\,\text{s}}$$

2.4) Surface Area of Bay or Basin using King's Dimensionless Variable Formula

Evaluate Formula

Formula

$$A_b = \frac{Qr \cdot T}{Qr' \cdot 2 \cdot \pi \cdot a_o}$$

Example with Units

$$1.5124\,\text{m}^2 = \frac{10\,\text{m}^3/\text{min} \cdot 130\,\text{s}}{0.57 \cdot 2 \cdot 3.1416 \cdot 4.0\,\text{m}}$$

2.5) Tidal Period using King's Dimensionless Variable Formula

Evaluate Formula

Formula

$$T = \frac{Qr' \cdot 2 \cdot \pi \cdot a_o \cdot A_b}{Qr}$$

Example with Units

$$128.9396\,\text{s} = \frac{0.57 \cdot 2 \cdot 3.1416 \cdot 4.0\,\text{m} \cdot 1.5001\,\text{m}^2}{10\,\text{m}^3/\text{min}}$$

3) Multiple Inlets Formulas

3.1) Maximum Velocity in Inlet Throat given Total Maximum Discharge Formula

Evaluate Formula

Formula

$$V_{max} = \frac{Q_{max} \cdot T}{2 \cdot \pi \cdot a_o \cdot A_b}$$

Example with Units

$$34.9985\,\text{m/s} = \frac{10.15\,\text{m}^3/\text{s} \cdot 130\,\text{s}}{2 \cdot 3.1416 \cdot 4.0\,\text{m} \cdot 1.5001\,\text{m}^2}$$

3.2) Ocean Tide Amplitude given Total Maximum Discharge for Total of all Inlets Formula

Evaluate Formula

Formula

$$a_o = \frac{Q_{max} \cdot T}{2 \cdot \pi \cdot A_b \cdot V_{max}}$$

Example with Units

$$3.9998\,\text{m} = \frac{10.15\,\text{m}^3/\text{s} \cdot 130\,\text{s}}{2 \cdot 3.1416 \cdot 1.5001\,\text{m}^2 \cdot 35\,\text{m/s}}$$

3.3) Surface Area of Bay or Basin given Total Maximum Discharge Formula

Evaluate Formula

Formula

$$A_b = \frac{Q_{max} \cdot T}{2 \cdot \pi \cdot a_o \cdot V_{max}}$$

Example with Units

$$1.5\,\text{m}^2 = \frac{10.15\,\text{m}^3/\text{s} \cdot 130\,\text{s}}{2 \cdot 3.1416 \cdot 4.0\,\text{m} \cdot 35\,\text{m/s}}$$

3.4) Tidal Period given Total Maximum Discharge for Total of all Inlets Formula

Evaluate Formula

Formula

$$T = \frac{2 \cdot \pi \cdot a_o \cdot V_{max} \cdot A_b}{Q_{max}}$$

Example with Units

$$130.0056\,\text{s} = \frac{2 \cdot 3.1416 \cdot 4.0\,\text{m} \cdot 35\,\text{m/s} \cdot 1.5001\,\text{m}^2}{10.15\,\text{m}^3\text{/s}}$$

3.5) Total Maximum Discharge for Total of all Inlets Formula

Evaluate Formula

Formula

$$Q_{max} = \frac{2 \cdot \pi \cdot a_o \cdot A_b \cdot V_{max}}{T}$$

Example with Units

$$10.1504\,\text{m}^3\text{/s} = \frac{2 \cdot 3.1416 \cdot 4.0\,\text{m} \cdot 1.5001\,\text{m}^2 \cdot 35\,\text{m/s}}{130\,\text{s}}$$

4) Wave-Current Interaction Formulas

4.1) Angle Wave Orthogonal makes with Current in Non-propagated Wave Values on Forbidden Region Formula

Evaluate Formula

Formula

$$\theta = acos\left(F \cdot \frac{\left([g] \cdot d_T\right)^{0.5}}{V}\right)$$

Example with Units

$$3.768° = acos\left(0.57 \cdot \frac{\left(9.8066\,\text{m/s}^2 \cdot 5\,\text{m}\right)^{0.5}}{4\,\text{m/s}}\right)$$

4.2) Channel Depth in Non-propagated Wave Values Formula

Evaluate Formula

Formula

$$d_T = [g] \cdot \left(\frac{\Omega \cdot T_p}{2 \cdot \pi}\right)^{\frac{1}{0.5}}$$

Example with Units

$$4.9523\,\text{m} = 9.8066\,\text{m/s}^2 \cdot \left(\frac{0.047 \cdot 95\,\text{s}}{2 \cdot 3.1416}\right)^{\frac{1}{0.5}}$$

4.3) Channel Depth in Non-propagated Wave values in Forbidden Region Formula

Evaluate Formula

Formula

$$d_T = \frac{\left(\left(V \cdot \frac{\cos(\theta)}{F}\right)\right)^2}{[g]}$$

Example with Units

$$5.0001\,\text{m} = \frac{\left(\left(4\,\text{m/s} \cdot \frac{\cos(3.76°)}{0.57}\right)\right)^2}{9.8066\,\text{m/s}^2}$$

4.4) Channel Velocity in Non-propagated Wave Values in Forbidden Region Formula

Evaluate Formula

Formula

$$V = \frac{F \cdot \left([g] \cdot d_T\right)^{0.5}}{\cos(\theta)}$$

Example with Units

$$4\,\text{m/s} = \frac{0.57 \cdot \left(9.8066\,\text{m/s}^2 \cdot 5\,\text{m}\right)^{0.5}}{\cos(3.76°)}$$

4.5) Effect of Current on Wave Height Formula

Evaluate Formula

Formula

$$H = R_h \cdot H_A$$

Example with Units

$$80\,\text{m} = 0.8 \cdot 100\,\text{m}$$

4.6) Inlet Current Wave Height Factor Formula

Evaluate Formula

Formula

$$R_h = \frac{H}{H_A}$$

Example with Units

$$0.8 = \frac{80\,\text{m}}{100\,\text{m}}$$

4.7) Non-propagated Wave Values in Forbidden Region Boundary Line Formula

Evaluate Formula

Formula

$$F = \frac{V \cdot \cos(\theta)}{([g] \cdot d_T)^{0.5}}$$

Example with Units

$$0.57 = \frac{4\,\text{m/s} \cdot \cos(3.76°)}{(9.8066\,\text{m/s}^2 \cdot 5\,\text{m})^{0.5}}$$

4.8) Non-propagated Wave Values in Forbidden Region of Boundary Line Formula

Evaluate Formula

Formula

$$\Omega = \left(\frac{2 \cdot \pi}{T_p}\right) \cdot \left(\frac{d_T}{[g]}\right)^{0.5}$$

Example with Units

$$0.0472 = \left(\frac{2 \cdot 3.1416}{95\,\text{s}}\right) \cdot \left(\frac{5\,\text{m}}{9.8066\,\text{m/s}^2}\right)^{0.5}$$

4.9) Wave Height Entering Inlet Formula

Evaluate Formula

Formula

$$H_A = \frac{H}{R_h}$$

Example with Units

$$100\,\text{m} = \frac{80\,\text{m}}{0.8}$$

4.10) Wave Period in Non-propagated Wave Values Formula

Evaluate Formula

Formula

$$T_p = \frac{2 \cdot \pi \cdot \left(\frac{d_T}{[g]}\right)^{\frac{1}{2}}}{\Omega}$$

Example with Units

$$95.4568\,\text{s} = \frac{2 \cdot 3.1416 \cdot \left(\frac{5\,\text{m}}{9.8066\,\text{m/s}^2}\right)^{\frac{1}{2}}}{0.047}$$

Variables used in list of Bay Superelevation, Effect of Freshwater Inflow, Multiple Inlets and Wave-Current Interaction Formulas above

- a_B Bay Tide Amplitude
- A_b Surface Area of Bay *(Square Meter)*
- a_o Ocean Tide Amplitude *(Meter)*
- d_T Time Averaged Water Depth *(Meter)*
- D_t Channel Depth *(Meter)*
- **F** Non-propagated Wave Values of 'F'
- **h** Eckman Constant Depth *(Meter)*
- **H** Wave Height *(Meter)*
- H_A Wave Height Entering Inlet *(Meter)*
- **k** Phase Lag
- **m** Bank Slope
- Q_{max} Maximum Discharge of Total Inlets *(Cubic Meter per Second)*
- **Qr** River or Freshwater Inflow to a Bay *(Cubic Meter per Minute)*
- **Qr'** King's Dimensionless Variable for Freshwater
- R_h Inlet Current Wave Height Factor
- **S** Superelevation *(Meter)*
- **t** Duration of Inflow *(Hour)*
- **T** Tidal Period *(Second)*
- T_p Wave Period *(Second)*
- **V** Velocity in Channel *(Meter per Second)*
- V_{max} Maximum Velocity in the Inlet Throat *(Meter per Second)*
- **W** Channel Width corresponding to Mean Water Depth *(Meter)*
- **β** Water Surface Slope
- **Δ** Coefficient of Eckman
- Δ_{BS} Bay Superelevation *(Meter)*
- **θ** Angle b/w Horizontal Velocity and Horizontal Wave *(Degree)*
- ρ_{water} Water Density *(Kilogram per Cubic Meter)*
- **τ** Shear Stress at the Water Surface *(Newton per Square Meter)*
- **Ω** Non-propagated Wave Values

Constants, Functions, Measurements used in list of Bay Superelevation, Effect of Freshwater Inflow, Multiple Inlets and Wave-Current Interaction Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- constant(s): **[g]**, 9.80665
  Gravitational acceleration on Earth
- Functions: **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.
- Functions: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Functions: **sin**, sin(Angle)
  Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Time** in Hour (h), Second (s)
  Time Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Pressure** in Newton per Square Meter (N/m²)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Minute (m³/min), Cubic Meter per Second (m³/s)
  Volumetric Flow Rate Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion

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