Important Arch Dams Formulas PDF

Formulas
Examples
with Units

List of 45
Important Arch Dams Formulas

1) Angle between Crown and Abutments given Thrust at Abutments of Arch Dam Formula

Evaluate Formula

Formula

$$\theta = \operatorname{acos}\left(\frac{P - P_v \cdot r}{-P_v \cdot r + F}\right)$$

Example with Units

$$29.9568° = \operatorname{acos}\left(\frac{16\,\text{kN/m} - 21.7\,\text{kPa/m}^2 \cdot 5.5\,\text{m}}{-21.7\,\text{kPa/m}^2 \cdot 5.5\,\text{m} + 63.55\,\text{N}}\right)$$

2) Extrados Stresses on Arch Dam Formula

Evaluate Formula

Formula

$$S = \left(\frac{F}{t}\right) - \left(6 \cdot \frac{M_t}{t^2}\right)$$

Example with Units

$$-174.125\,\text{N/m}^2 = \left(\frac{63.55\,\text{N}}{1.2\,\text{m}}\right) - \left(6 \cdot \frac{54.5\,\text{N*m}}{1.2\,\text{m}^2}\right)$$

3) Intrados Stresses on Arch Dam Formula

Evaluate Formula

Formula

$$S = \left(\frac{F}{t}\right) + \left(6 \cdot \frac{M_t}{t^2}\right)$$

Example with Units

$$280.0417\,\text{N/m}^2 = \left(\frac{63.55\,\text{N}}{1.2\,\text{m}}\right) + \left(6 \cdot \frac{54.5\,\text{N*m}}{1.2\,\text{m}^2}\right)$$

4) Radius to centerline given Thrust at Abutments of Arch Dam Formula

Evaluate Formula

Formula

$$r = \frac{\frac{P - F \cdot \cos(\theta)}{1 - \cos(\theta)}}{P_v}$$

Example with Units

$$5.4846\,\text{m} = \frac{\frac{16\,\text{kN/m} - 63.55\,\text{N} \cdot \cos(30°)}{1 - \cos(30°)}}{21.7\,\text{kPa/m}^2}$$

5) Rotation due to Moment on Arch Dam Formula

Evaluate Formula

Formula

$$\Phi = M_t \cdot \frac{K_1}{E \cdot t \cdot t}$$

Example with Units

$$37.1422\,\text{rad} = 54.5\,\text{N*m} \cdot \frac{10.01}{10.2\,\text{N/m}^2 \cdot 1.2\,\text{m} \cdot 1.2\,\text{m}}$$

6) Rotation due to Shear on Arch Dam Formula

Evaluate Formula

Formula

$$\Phi = F_s \cdot \frac{K_5}{E \cdot t}$$

Example with Units

$$37.643\,\text{rad} = 48.5\,\text{N} \cdot \frac{9.5}{10.2\,\text{N/m}^2 \cdot 1.2\,\text{m}}$$

7) Rotation due to Twist on Arch Dam Formula

Evaluate Formula

Formula

$$\Phi = M \cdot \frac{K_4}{E \cdot t^2}$$

Example with Units

$$34.7917\,\text{rad} = 51\,\text{N*m} \cdot \frac{10.02}{10.2\,\text{N/m}^2 \cdot 1.2\,\text{m}^2}$$

8) Shear Force given Deflection due to Shear on Arch Dam Formula

Evaluate Formula

Formula

$$F_s = \delta \cdot \frac{E}{K_3}$$

Example with Units

$$49.1111\,\text{N} = 48.1\,\text{m} \cdot \frac{10.2\,\text{N/m}^2}{9.99}$$

9) Shear Force given Rotation due to Shear on Arch Dam Formula

Evaluate Formula

Formula

$$F_s = \Phi \cdot \frac{E \cdot t}{K_5}$$

Example with Units

$$45.0947\,\text{N} = 35\,\text{rad} \cdot \frac{10.2\,\text{N/m}^2 \cdot 1.2\,\text{m}}{9.5}$$

10) Constant Thickness on Arch Dam Formulas

10.1) Constant K1 given Rotation due to Moment on Arch Dam Formula

Evaluate Formula

Formula

$$K_1 = \frac{\Phi \cdot \left(E \cdot t \cdot t \right)}{M_t}$$

Example with Units

$$9.4327 = \frac{35\,\text{rad} \cdot \left(10.2\,\text{N/m}^2 \cdot 1.2\,\text{m} \cdot 1.2\,\text{m} \right)}{54.5\,\text{N*m}}$$

10.2) Constant K2 given Deflection due to Thrust on Arch Dam Formula

Evaluate Formula

Formula

$$K_2 = \delta \cdot \frac{E}{F}$$

Example with Units

$$7.7202 = 48.1\,\text{m} \cdot \frac{10.2\,\text{N/m}^2}{63.55\,\text{N}}$$

10.3) Constant K3 given Deflection due to Shear on Arch Dam Formula

Evaluate Formula

Formula

$$K_3 = \delta \cdot \frac{E}{F_s}$$

Example with Units

$$10.1159 = 48.1\,\text{m} \cdot \frac{10.2\,\text{N/m}^2}{48.5\,\text{N}}$$

10.4) Constant K4 given Rotation due to Twist on Arch Dam Formula

Evaluate Formula

Formula

$$K_4 = \left(E \cdot t^2 \right) \cdot \frac{\Phi}{M}$$

Example with Units

$$10.08 = \left(10.2\,\text{N/m}^2 \cdot 1.2\,\text{m}^2 \right) \cdot \frac{35\,\text{rad}}{51\,\text{N*m}}$$

10.5) Constant K5 given Deflection due to Moments on Arch Dam Formula

Evaluate Formula

Formula

$$K_5 = \delta \cdot \frac{E \cdot t}{M_t}$$

Example with Units

$$10.8026 = 48.1\,\text{m} \cdot \frac{10.2\,\text{N/m}^2 \cdot 1.2\,\text{m}}{54.5\,\text{N*m}}$$

10.6) Constant K5 given Rotation due to Shear on Arch Dam Formula

Evaluate Formula

Formula

$$K_5 = \Phi \cdot \frac{E \cdot t}{F_s}$$

Example with Units

$$8.833 = 35\,\text{rad} \cdot \frac{10.2\,\text{N/m}^2 \cdot 1.2\,\text{m}}{48.5\,\text{N}}$$

11) Deflection on Arch Dams Formulas

11.1) Deflection due to Moments on Arch Dam Formula

Evaluate Formula

Formula

$$\delta = M_t \cdot \frac{K_5}{E \cdot t}$$

Example with Units

$$42.2998\,\text{m} = 54.5\,\text{N*m} \cdot \frac{9.5}{10.2\,\text{N/m}^2 \cdot 1.2\,\text{m}}$$

11.2) Deflection due to Shear on Arch Dam Formula

Evaluate Formula

Formula

$$\delta = F_s \cdot \frac{K_3}{E}$$

Example with Units

$$47.5015\,\text{m} = 48.5\,\text{N} \cdot \frac{9.99}{10.2\,\text{N/m}^2}$$

11.3) Deflection due to Thrust on Arch Dam Formula

Evaluate Formula

Formula

$$\delta = F \cdot \frac{K_2}{E}$$

Example with Units

$$62.927\,\text{m} = 63.55\,\text{N} \cdot \frac{10.1}{10.2\,\text{N/m}^2}$$

12) Elastic Modulus of Rock Formulas

12.1) Elastic Modulus of Rock given Deflection due to Moments on Arch Dam Formula

Evaluate Formula

Formula

$$E = M_t \cdot \frac{K_5}{\delta \cdot T}$$

Example with Units

$$8.8959\,\text{N/m}^2 = 54.5\,\text{N*m} \cdot \frac{9.5}{48.1\,\text{m} \cdot 1.21\,\text{m}}$$

12.2) Elastic Modulus of Rock given Deflection due to Shear on Arch Dam Formula

Evaluate Formula

Formula

$$E = F_s \cdot \frac{K_3}{\delta}$$

Example with Units

$$10.0731\,\text{N/m}^2 = 48.5\,\text{N} \cdot \frac{9.99}{48.1\,\text{m}}$$

12.3) Elastic Modulus of Rock given Deflection due to Thrust on Arch Dam Formula

Evaluate Formula

Formula

$$E = F \cdot \frac{K_2}{\delta}$$

Example with Units

$$13.3442\,\text{N/m}^2 = 63.55\,\text{N} \cdot \frac{10.1}{48.1\,\text{m}}$$

12.4) Elastic Modulus of Rock given Rotation due to Moment on Arch Dam Formula

Evaluate Formula

Formula

$$E = M_t \cdot \frac{K_1}{\Phi \cdot T \cdot t}$$

Example with Units

$$10.7348\,\text{N/m}^2 = 54.5\,\text{N*m} \cdot \frac{10.01}{35\,\text{rad} \cdot 1.21\,\text{m} \cdot 1.2\,\text{m}}$$

12.5) Elastic Modulus of Rock given Rotation due to Shear on Arch Dam Formula

Evaluate Formula

Formula

$$E = F_s \cdot \frac{K_5}{\Phi \cdot T}$$

Example with Units

$$10.8796\,\text{N/m}^2 = 48.5\,\text{N} \cdot \frac{9.5}{35\,\text{rad} \cdot 1.21\,\text{m}}$$

12.6) Elastic Modulus of Rock given Rotation due to Twist on Arch Dam Formula

Evaluate Formula

Formula

$$E = M \cdot \frac{K_4}{\Phi \cdot T^2}$$

Example with Units

$$9.9724\,\text{N/m}^2 = 51\,\text{N*m} \cdot \frac{10.02}{35\,\text{rad} \cdot 1.21\,\text{m}^2}$$

13) Moments acting on Arch Dam Formulas

13.1) Moment at Abutments of Arch Dam Formula

Evaluate Formula

Formula

$$M_t = r \cdot \left(\left(p \cdot r \right) - F \right) \cdot \left(\frac{\sin\left(A \right)}{A} - \cos\left(A \right) \right)$$

Example with Units

$$99.7591\,\text{N*m} = 5.5\,\text{m} \cdot \left(\left(8 \cdot 5.5\,\text{m} \right) - 63.55\,\text{N} \right) \cdot \left(\frac{\sin\left(31\,\text{rad} \right)}{31\,\text{rad}} - \cos\left(31\,\text{rad} \right) \right)$$

13.2) Moment at Crown of Arch Dam Formula

Evaluate Formula

Formula

$$M_t = -r \cdot \left(\left(p \cdot r \right) - F \right) \cdot \left(1 - \left(\frac{\sin\left(A \right)}{A} \right) \right)$$

Example with Units

$$108.9264\,\text{N*m} = -5.5\,\text{m} \cdot \left(\left(8 \cdot 5.5\,\text{m} \right) - 63.55\,\text{N} \right) \cdot \left(1 - \left(\frac{\sin\left(31\,\text{rad} \right)}{31\,\text{rad}} \right) \right)$$

13.3) Moments given Deflection due to Moments on Arch Dam Formula

Evaluate Formula

Formula

$$M_t = \delta \cdot \frac{E \cdot t}{K_5}$$

Example with Units

$$61.9731\,\text{N*m} = 48.1\,\text{m} \cdot \frac{10.2\,\text{N/m}^2 \cdot 1.2\,\text{m}}{9.5}$$

13.4) Moments given Extrados Stresses on Arch Dam Formula

Evaluate Formula

Formula

$$M_t = \sigma_e \cdot t \cdot t + F \cdot \frac{t}{6}$$

Example with Units

$$48.71\,\text{N*m} = 25\,\text{N/m}^2 \cdot 1.2\,\text{m} \cdot 1.2\,\text{m} + 63.55\,\text{N} \cdot \frac{1.2\,\text{m}}{6}$$

13.5) Moments given Intrados Stresses on Arch Dam Formula

Evaluate Formula

Formula

$$M_t = \frac{S \cdot t \cdot t - F \cdot t}{6}$$

Example with Units

$$47.29\,\text{N*m} = \frac{250\,\text{N/m}^2 \cdot 1.2\,\text{m} \cdot 1.2\,\text{m} - 63.55\,\text{N} \cdot 1.2\,\text{m}}{6}$$

13.6) Moments given Rotation due to Moment on Arch Dam Formula

Evaluate Formula

Formula

$$M_t = \frac{\Phi \cdot \left(E \cdot t \cdot t \right)}{K_1}$$

Example with Units

$$51.3566\,\text{N*m} = \frac{35\,\text{rad} \cdot \left(10.2\,\text{N/m}^2 \cdot 1.2\,\text{m} \cdot 1.2\,\text{m} \right)}{10.01}$$

13.7) Moments given Rotation due to Twist on Arch Dam Formula

Evaluate Formula

Formula

$$M = \left(E \cdot t^2 \right) \cdot \frac{\Phi}{K_4}$$

Example with Units

$$51.3054\,\text{N*m} = \left(10.2\,\text{N/m}^2 \cdot 1.2\,\text{m}^2 \right) \cdot \frac{35\,\text{rad}}{10.02}$$

14) Normal Radial Pressure of Arch Dams Formulas

14.1) Normal Radial Pressure at centerline given Moment at Abutments of Arch Dam Formula

Evaluate Formula

Formula

$$P_v = \frac{F_C \cdot r \cdot \left(\left(\frac{\sin(\theta)}{\theta}\right) - \cos(\theta)\right) - (M_t)}{(r^2) \cdot \left(\left(\frac{\sin(\theta)}{\theta}\right) - \cos(\theta)\right)}$$

Example with Units

$$21.7979\,\text{kPa/m}^2 = \frac{120\,\text{kN} \cdot 5.5\,\text{m} \cdot \left(\left(\frac{\sin(30°)}{30°}\right) - \cos(30°)\right) - (54.5\,\text{N*m})}{(5.5\,\text{m}^2) \cdot \left(\left(\frac{\sin(30°)}{30°}\right) - \cos(30°)\right)}$$

14.2) Normal Radial Pressure at centerline given Moment at Crown of Arch Dam Formula

Evaluate Formula

Formula

$$P_v = \frac{F_C \cdot r \cdot \left(1 - \left(\frac{\sin(\theta)}{\theta}\right)\right) - (M_t)}{(r^2) \cdot \left(1 - \left(\frac{\sin(\theta)}{\theta}\right)\right)}$$

Example with Units

$$21.7782\,\text{kPa/m}^2 = \frac{120\,\text{kN} \cdot 5.5\,\text{m} \cdot \left(1 - \left(\frac{\sin(30°)}{30°}\right)\right) - (54.5\,\text{N*m})}{(5.5\,\text{m}^2) \cdot \left(1 - \left(\frac{\sin(30°)}{30°}\right)\right)}$$

14.3) Normal Radial Pressure at centerline given Thrust at Abutments of Arch Dam Formula

Evaluate Formula

Formula

$$P_v = \left(\frac{P + F \cdot \cos(\theta)}{r - (r \cdot \cos(\theta))}\right)$$

Example with Units

$$21.7884\,\text{kPa/m}^2 = \left(\frac{16\,\text{kN/m} + 63.55\,\text{N} \cdot \cos(30°)}{5.5\,\text{m} - (5.5\,\text{m} \cdot \cos(30°))}\right)$$

14.4) Normal Radial Pressure at centerline given Thrust at Crown of Arch Dam Formula

Evaluate Formula

Formula

$$P_v = \frac{F_C}{(r) \cdot \left(1 - \left(2 \cdot \theta \cdot \frac{\sin\left(\theta \cdot \frac{\left(\frac{t}{7}\right)^2}{12}\right)}{D}\right)\right)}$$

Example with Units

$$21.8229\,\text{kPa/m}^2 = \frac{120\,\text{kN}}{(5.5\,\text{m}) \cdot \left(1 - \left(2 \cdot 30° \cdot \frac{\sin\left(30° \cdot \frac{\left(\frac{1.2\,\text{m}}{5.5\,\text{m}}\right)^2}{12}\right)}{9.999\,\text{m}}\right)\right)}$$

15) Radial Thickness of Element Formulas

15.1) Radial Thickness of Element given Deflection due to Moments on Arch Dam Formula

Evaluate Formula

Formula

$$t = M_t \cdot \frac{K_5}{E \cdot \delta}$$

Example with Units

$$1.0553\,\text{m} = 54.5\,\text{N*m} \cdot \frac{9.5}{10.2\,\text{N/m}^2 \cdot 48.1\,\text{m}}$$

15.2) Radial Thickness of Element given Rotation due to moment on Arch Dam Formula

Evaluate Formula

Formula

$$t = \left(M_t \cdot \frac{K_1}{E \cdot \Phi}\right)^{0.5}$$

Example with Units

$$1.2362\,\text{m} = \left(54.5\,\text{N*m} \cdot \frac{10.01}{10.2\,\text{N/m}^2 \cdot 35\,\text{rad}}\right)^{0.5}$$

15.3) Radial Thickness of Element given Rotation due to Shear on Arch Dam Formula

Evaluate Formula

Formula

$$t = F_s \cdot \frac{K_5}{E \cdot \Phi}$$

Example with Units

$$1.2906\,\text{m} = 48.5\,\text{N} \cdot \frac{9.5}{10.2\,\text{N/m}^2 \cdot 35\,\text{rad}}$$

15.4) Radial Thickness of Element given Rotation due to Twist on Arch Dam Formula

Evaluate Formula

Formula

$$t = \left(M \cdot \frac{K_4}{E \cdot \Phi} \right)^{0.5}$$

Example with Units

$$1.1964\,\text{m} = \left(51\,\text{N*m} \cdot \frac{10.02}{10.2\,\text{N/m}^2 \cdot 35\,\text{rad}} \right)^{0.5}$$

16) Thrust on Arch Dam Formulas

16.1) Thrust at Abutments of Arch Dam Formula

Evaluate Formula

Formula

$$P = P_v \cdot r - \left(P_v \cdot r - F \right) \cdot \cos\left(\theta \right)$$

Example with Units

$$16.0449\,\text{kN/m} = 21.7\,\text{kPa/m}^2 \cdot 5.5\,\text{m} - \left(21.7\,\text{kPa/m}^2 \cdot 5.5\,\text{m} - 63.55\,\text{N} \right) \cdot \cos\left(30° \right)$$

16.2) Thrust at Crown of Arch Dam Formula

Evaluate Formula

Formula

$$F = \left(p \cdot r \right) \cdot \left(1 - \left(2 \cdot \theta \cdot \frac{\sin\left(\theta \cdot \frac{\left(\frac{T_b}{r} \right)^2}{12} \right)}{D} \right) \right)$$

Example with Units

$$43.9888\,\text{N} = \left(8 \cdot 5.5\,\text{m} \right) \cdot \left(1 - \left(2 \cdot 30° \cdot \frac{\sin\left(30° \cdot \frac{\left(\frac{1.3\,\text{m}}{5.5\,\text{m}} \right)^2}{12} \right)}{9.999\,\text{m}} \right) \right)$$

16.3) Thrust at Crown of Arch Dam given Moment at Abutments Formula

Evaluate Formula

Formula

$$F = \frac{M_t}{r \cdot \left(\frac{\sin\left(\theta \right)}{\theta - \left(\cos\left(\theta \right) \right)} \right)} + p \cdot r$$

Example with Units

$$37.2137\,\text{N} = \frac{54.5\,\text{N*m}}{5.5\,\text{m} \cdot \left(\frac{\sin\left(30° \right)}{30° - \left(\cos\left(30° \right) \right)} \right)} + 8 \cdot 5.5\,\text{m}$$

16.4) Thrust given Deflection due to Thrust on Arch Dam Formula

Evaluate Formula

Formula

$$F = \delta \cdot \frac{E}{K_2}$$

Example with Units

$$48.5762\,\text{N} = 48.1\,\text{m} \cdot \frac{10.2\,\text{N/m}^2}{10.1}$$

16.5) Thrust given Extrados Stresses on Arch Dam Formula

Evaluate Formula

Formula

$$F = S \cdot T_b + 6 \cdot \frac{M_t}{T_b^2}$$

Example with Units

$$193.8161\,\text{N} = 250\,\text{N/m}^2 \cdot 1.3\,\text{m} + 6 \cdot \frac{54.5\,\text{N*m}}{1.3\,\text{m}^2}$$

16.6) Thrust given Intrados Stresses on Arch Dam Formula

Evaluate Formula

Formula

$$F = S \cdot T_b - 6 \cdot \frac{M_t}{T_b}$$

Example with Units

$$73.4615\,\text{N} = 250\,\text{N/m}^2 \cdot 1.3\,\text{m} - 6 \cdot \frac{54.5\,\text{N*m}}{1.3\,\text{m}}$$

Variables used in list of Arch Dams Formulas above

- **A** Angle between Crown and Abundant Radii *(Radian)*
- **D** Diameter *(Meter)*
- **E** Elastic Modulus of Rock *(Newton per Square Meter)*
- **F** Thrust of Abutments *(Newton)*
- F_C Thrust at Crown *(Kilonewton)*
- F_s Shear Force *(Newton)*
- K_1 Constant K1
- K_2 Constant K2
- K_3 Constant K3
- K_4 Constant K4
- K_5 Constant K5
- **M** Cantilever Twisting Moment *(Newton Meter)*
- M_t Moment acting on Arch Dam *(Newton Meter)*
- **p** Normal Radial Pressure
- **P** Thrust from Water *(Kilonewton per Meter)*
- P_v Radial Pressure *(Kilopascal per Square Meter)*
- **r** Radius to Center Line of Arch *(Meter)*
- **S** Intrados Stresses *(Newton per Square Meter)*
- **t** Horizontal Thickness of an Arch *(Meter)*
- **T** Thickness of Circular Arch *(Meter)*
- T_b Base Thickness *(Meter)*
- **δ** Deflection due to Moments on Arch Dam *(Meter)*
- **θ** Theta *(Degree)*
- σ_e Extrados Stress *(Newton per Square Meter)*
- **Φ** Angle of Rotation *(Radian)*

Constants, Functions, Measurements used in list of Arch Dams Formulas above

- 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: **Pressure** in Newton per Square Meter (N/m²)
  Pressure Unit Conversion
- Measurement: **Energy** in Newton Meter (N*m)
  Energy Unit Conversion
- Measurement: **Force** in Newton (N), Kilonewton (kN)
  Force Unit Conversion
- Measurement: **Angle** in Degree (°), Radian (rad)
  Angle Unit Conversion
- Measurement: **Surface Tension** in Kilonewton per Meter (kN/m)
  Surface Tension Unit Conversion
- Measurement: **Torque** in Newton Meter (N*m)
  Torque Unit Conversion
- Measurement: **Radial Pressure** in Kilopascal per Square Meter (kPa/m²)
  Radial Pressure Unit Conversion
- Measurement: **Stress** in Newton per Square Meter (N/m²)
  Stress Unit Conversion

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