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Arch Dams Formulas

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List of 45 Arch Dams Formulas

Arch Dams

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

Open Calculator

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

ex $$29.95684° = a\cos\left(\frac{16\text{kN/m} - 21.7\text{kPa/m}^2 \cdot 5.5\text{m}}{-21.7\text{kPa/m}^2 \cdot 5.5\text{m} + 63.55\text{N}}\right)$$

2) Extrados Stresses on Arch Dam

Open Calculator

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

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

3) Intrados Stresses on Arch Dam

Open Calculator

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

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

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

Open Calculator

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

ex $$5.484554\text{m} = \frac{\frac{16\text{kN/m} - 63.55\text{N} \cdot \cos(30°)}{1 - \cos(30°)}}{21.7\text{kPa/m}^2}$$

5) Rotation due to Moment on Arch Dam

Open Calculator

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

ex $$37.14222\text{rad} = 54.5\text{N*m} \cdot \frac{10.01}{10.2\text{N/m}^2 \cdot 1.2\text{m} \cdot 1.2\text{m}}$$

6) Rotation due to Shear on Arch Dam

Open Calculator

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

ex $$37.64297\text{rad} = 48.5\text{N} \cdot \frac{9.5}{10.2\text{N/m}^2 \cdot 1.2\text{m}}$$

7) Rotation due to Twist on Arch Dam

Open Calculator

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

ex $$34.79167\text{rad} = 51\text{N*m} \cdot \frac{10.02}{10.2\text{N/m}^2 \cdot (1.2\text{m})^2}$$

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

Open Calculator

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

ex $$49.11111\text{N} = 48.1\text{m} \cdot \frac{10.2\text{N/m}^2}{9.99}$$

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

Open Calculator

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

ex $$45.09474\text{N} = 35\text{rad} \cdot \frac{10.2\text{N/m}^2 \cdot 1.2\text{m}}{9.5}$$

Constant Thickness on Arch Dam

10) Constant K1 given Rotation due to Moment on Arch Dam

Open Calculator

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

ex $$9.432661 = \frac{35\text{rad} \cdot (10.2\text{N/m}^2 \cdot 1.2\text{m} \cdot 1.2\text{m})}{54.5\text{N*m}}$$

11) Constant K2 given Deflection due to Thrust on Arch Dam

Open Calculator

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

ex $$7.72022 = 48.1\text{m} \cdot \frac{10.2\text{N/m}^2}{63.55\text{N}}$$

12) Constant K3 given Deflection due to Shear on Arch Dam

Open Calculator

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

ex $$10.11588 = 48.1\text{m} \cdot \frac{10.2\text{N/m}^2}{48.5\text{N}}$$

13) Constant K4 given Rotation due to Twist on Arch Dam

Open Calculator

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

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

14) Constant K5 given Deflection due to Moments on Arch Dam

Open Calculator

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

ex $$10.80264 = 48.1\text{m} \cdot \frac{10.2\text{N/m}^2 \cdot 1.2\text{m}}{54.5\text{N*m}}$$

15) Constant K5 given Rotation due to Shear on Arch Dam

Open Calculator

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

ex $$8.83299 = 35\text{rad} \cdot \frac{10.2\text{N/m}^2 \cdot 1.2\text{m}}{48.5\text{N}}$$

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Deflection on Arch Dams

16) Deflection due to Moments on Arch Dam

Open Calculator

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

ex $$42.29984\text{m} = 54.5\text{N*m} \cdot \frac{9.5}{10.2\text{N/m}^2 \cdot 1.2\text{m}}$$

17) Deflection due to Shear on Arch Dam

Open Calculator

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

ex $$47.50147\text{m} = 48.5\text{N} \cdot \frac{9.99}{10.2\text{N/m}^2}$$

18) Deflection due to Thrust on Arch Dam

Open Calculator

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

ex $$62.92696\text{m} = 63.55\text{N} \cdot \frac{10.1}{10.2\text{N/m}^2}$$

Elastic Modulus of Rock

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

Open Calculator

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

ex $$8.895895\text{N/m}^2 = 54.5\text{N*m} \cdot \frac{9.5}{48.1\text{m} \cdot 1.21\text{m}}$$

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

Open Calculator

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

$$10.07308 \text{N/m}^2 = 48.5 \text{N} \cdot \frac{9.99}{48.1 \text{m}}$$

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

Open Calculator

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

$$13.34418 \text{N/m}^2 = 63.55 \text{N} \cdot \frac{10.1}{48.1 \text{m}}$$

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

Open Calculator

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

$$10.73485 \text{N/m}^2 = 54.5 \text{N*m} \cdot \frac{10.01}{35 \text{rad} \cdot 1.21 \text{m} \cdot 1.2 \text{m}}$$

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

Open Calculator

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

$$10.87957 \text{N/m}^2 = 48.5 \text{N} \cdot \frac{9.5}{35 \text{rad} \cdot 1.21 \text{m}}$$

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

Open Calculator

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

$$9.972387\text{N/m}^2 = 51\text{N*m} \cdot \frac{10.02}{35\text{rad} \cdot (1.21\text{m})^2}$$

Moments acting on Arch Dam

25) Moment at Abutments of Arch Dam

Open Calculator

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

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

26) Moment at Crown of Arch Dam

Open Calculator

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

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

27) Moments given Deflection due to Moments on Arch Dam

Open Calculator

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

$$61.97305\text{N*m} = 48.1\text{m} \cdot \frac{10.2\text{N/m}^2 \cdot 1.2\text{m}}{9.5}$$

28) Moments given Extrados Stresses on Arch Dam

Open Calculator

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

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

29) Moments given Intrados Stresses on Arch Dam

Open Calculator

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

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

30) Moments given Rotation due to Moment on Arch Dam

Open Calculator

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

$$51.35664\text{N*m} = \frac{35\text{rad} \cdot (10.2\text{N/m}^2 \cdot 1.2\text{m} \cdot 1.2\text{m})}{10.01}$$

31) Moments given Rotation due to Twist on Arch Dam

Open Calculator

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

$$51.30539\text{N*m} = \left(10.2\text{N/m}^2 \cdot (1.2\text{m})^2\right) \cdot \frac{35\text{rad}}{10.02}$$

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Normal Radial Pressure of Arch Dams

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

Open Calculator

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

ex $$21.79792\text{kPa/m}^2 = \frac{120\text{kN} \cdot 5.5\text{m} \cdot \left(\left(\frac{\sin(30^\circ)}{30^\circ} \right) - \cos(30^\circ) \right) - (54.5\text{N*m})}{\left((5.5\text{m})^2 \right) \cdot \left(\left(\frac{\sin(30^\circ)}{30^\circ} \right) - \cos(30^\circ) \right)}$$

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

Open Calculator

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

ex $$21.77821\text{kPa/m}^2 = \frac{120\text{kN} \cdot 5.5\text{m} \cdot \left(1 - \left(\frac{\sin(30^\circ)}{30^\circ} \right) \right) - (54.5\text{N*m})}{\left((5.5\text{m})^2 \right) \cdot \left(1 - \left(\frac{\sin(30^\circ)}{30^\circ} \right) \right)}$$

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

Open Calculator

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

ex $$21.78844\text{kPa/m}^2 = \left(\frac{16\text{kN/m} + 63.55\text{N} \cdot \cos(30^\circ)}{5.5\text{m} - (5.5\text{m} \cdot \cos(30^\circ))} \right)$$

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

Open Calculator

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

$$21.82293\text{kPa/m}^2 = \frac{120\text{kN}}{(5.5\text{m}) \cdot \left(1 - \left(2 \cdot 30° \cdot \frac{\sin\left(30° \cdot \frac{\left(\frac{1.2\text{m}}{5.5\text{m}}\right)^2}{12}\right)}{9.999\text{m}}\right)\right)}$$

Radial Thickness of Element

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

Open Calculator

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

$$1.055297\text{m} = 54.5\text{N*m} \cdot \frac{9.5}{10.2\text{N/m}^2 \cdot 48.1\text{m}}$$

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

Open Calculator

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

$$1.236178\text{m} = \left(54.5\text{N*m} \cdot \frac{10.01}{10.2\text{N/m}^2 \cdot 35\text{rad}}\right)^{0.5}$$

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

Open Calculator

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

ex $$1.290616\text{m} = 48.5\text{N} \cdot \frac{9.5}{10.2\text{N/m}^2 \cdot 35\text{rad}}$$

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

Open Calculator

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

ex $$1.196423\text{m} = \left(51\text{N*m} \cdot \frac{10.02}{10.2\text{N/m}^2 \cdot 35\text{rad}} \right)^{0.5}$$

Thrust on Arch Dam

40) Thrust at Abutments of Arch Dam

Open Calculator

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

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

41) Thrust at Crown of Arch Dam

Open Calculator

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

$$43.98877N = (8 \cdot 5.5m) \cdot \left(1 - \left(2 \cdot 30° \cdot \frac{\sin\left(30° \cdot \frac{\left(\frac{1.3m}{5.5m}\right)^2}{12}\right)}{9.999m}\right)\right)$$

42) Thrust at Crown of Arch Dam given Moment at Abutments

Open Calculator

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

$$37.21373N = \frac{54.5N*m}{5.5m \cdot \left(\frac{\sin(30°)}{30° - (\cos(30°))}\right)} + 8 \cdot 5.5m$$

43) Thrust given Deflection due to Thrust on Arch Dam

Open Calculator

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

$$48.57624N = 48.1m \cdot \frac{10.2N/m^2}{10.1}$$

44) Thrust given Extrados Stresses on Arch Dam

Open Calculator

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

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

45) Thrust given Intrados Stresses on Arch Dam

Open Calculator

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

$$73.46154\text{N} = 250\text{N/m}^2 \cdot 1.3\text{m} - 6 \cdot \frac{54.5\text{N*m}}{1.3\text{m}}$$

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Variables Used

- **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

- Function: **acos**, acos(Number)
  Inverse trigonometric cosine function
- Function: **cos**, cos(Angle)
  Trigonometric cosine function
- Function: **sin**, sin(Angle)
  Trigonometric sine function
- 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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