Arch Dams Formulas...

1/17





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

$$heta = a \cos \left(rac{\mathrm{P} - \mathrm{P_v} \cdot \mathrm{r}}{-\mathrm{P_v} \cdot \mathrm{r} + \mathrm{F}}
ight)$$

Open Calculator

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

2) Extrados Stresses on Arch Dam

$$extbf{S} = \left(rac{ ext{F}}{ ext{t}}
ight) - \left(6 \cdot rac{ ext{M}_{ ext{t}}}{ ext{t}^2}
ight)$$

Open Calculator

$$oxed{ex} -174.125 ext{N/m}^2 = \left(rac{63.55 ext{N}}{1.2 ext{m}}
ight) - \left(6 \cdot rac{54.5 ext{N*m}}{\left(1.2 ext{m}
ight)^2}
ight)$$

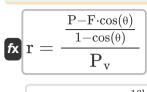
3) Intrados Stresses on Arch Dam

$$\mathbf{E} \mathbf{S} = \left(rac{\mathbf{F}}{\mathbf{t}}
ight) + \left(6 \cdot rac{\mathbf{M_t}}{\mathbf{t}^2}
ight)$$

$$oxed{ex} 280.0417 \mathrm{N/m^2} = \left(rac{63.55 \mathrm{N}}{1.2 \mathrm{m}}
ight) + \left(6 \cdot rac{54.5 \mathrm{N^*m}}{\left(1.2 \mathrm{m}
ight)^2}
ight)$$



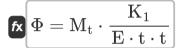
4) Radius to centerline given Thrust at Abutments of Arch Dam



Open Calculator 🗗

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

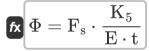
5) Rotation due to Moment on Arch Dam



Open Calculator 🚰

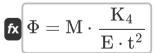
ex 37.14222rad = 54.5N*m · $\frac{10.01}{10.2$ N/m² · 1.2m · 1.2m

6) Rotation due to Shear on Arch Dam



Open Calculator 🗗

7) Rotation due to Twist on Arch Dam 🛂



Open Calculator

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



Open Calculator

Open Calculator

Open Calculator

Open Calculator 🚰

. . . .

- 8) Shear Force given Deflection due to Shear on Arch Dam
- $\mathbf{F}_{\mathrm{s}} = \delta \cdot rac{\mathrm{E}}{\mathrm{K}_{3}}$
- $49.11111N = 48.1 \text{m} \cdot \frac{10.2 \text{N/m}^2}{9.99}$
- 9.99
- 9) Shear Force given Rotation due to Shear on Arch Dam
- $\mathbf{F}_{\mathrm{s}}=\Phi\cdotrac{\mathbf{E}\cdot\mathbf{t}}{\mathbf{K}_{5}}$ ex $45.09474\mathrm{N}=35\mathrm{rad}\cdotrac{10.2\mathrm{N/m^{2}\cdot1.2m}}{9.5}$
- Constant Thickness on Arch Dam
- Constant Thickness on Arch Dain B
- $\mathbf{K}_1 = rac{\Phi \cdot (\mathbf{E} \cdot \mathbf{t} \cdot \mathbf{t})}{\mathbf{M}_L}$
- 11) Constant K2 given Deflection due to Thrust on Arch Dam

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

- $K_2 = \delta \cdot rac{E}{F}$



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

 $\mathbf{K}_3 = \delta \cdot rac{\mathrm{E}}{\mathrm{F_s}}$

Open Calculator

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

 $\mathbf{K}_4 = \left(\mathrm{E}\cdot\mathrm{t}^2
ight)\cdotrac{\Phi}{\mathrm{M}}$

Open Calculator 🖸

 $oxed{egin{aligned} \mathbf{ex} \left[10.08 = \left(10.2 \mathrm{N/m^2} \cdot \left(1.2 \mathrm{m}
ight)^2
ight) \cdot rac{35 \mathrm{rad}}{51 \mathrm{N^* m}}
ight]} \end{aligned}}$

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

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

Open Calculator 🖸

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

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

 $\mathbf{K} \left[\mathrm{K}_5 = \Phi \cdot rac{\mathrm{E} \cdot \mathrm{t}}{\mathrm{F}_\mathrm{s}}
ight]$

Open Calculator

 $oxed{ex} 8.83299 = 35 \mathrm{rad} \cdot rac{10.2 \mathrm{N/m^2 \cdot 1.2 m}}{48.5 \mathrm{N}}$



Deflection on Arch Dams 🗗

16) Deflection due to Moments on Arch Dam

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

Open Calculator

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

17) Deflection due to Shear on Arch Dam

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

Open Calculator

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

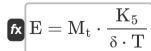
18) Deflection due to Thrust on Arch Dam

 $\delta = \mathbf{F} \cdot rac{\mathbf{K}_2}{\mathbf{E}}$

Open Calculator 🗗

Elastic Modulus of Rock

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



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

Open Calculator

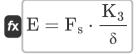
 $oxed{ex} 8.895895 ext{N/m}^2 = 54.5 ext{N*m} \cdot rac{9.5}{48.1 ext{m} \cdot 1.21 ext{m}}$







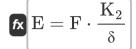
20) Elastic Modulus of Rock given Deflection due to Shear on Arch Dam



Open Calculator 🗗

 $\text{ex} \ 10.07308 \text{N/m}^{_2} = 48.5 \text{N} \cdot \frac{9.99}{48.1 \text{m}}$

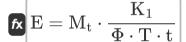
21) Elastic Modulus of Rock given Deflection due to Thrust on Arch Dam



Open Calculator

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

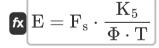
22) Elastic Modulus of Rock given Rotation due to Moment on Arch Dam



Open Calculator

 $ext{ex} \left[10.73485 ext{N/m}^2 = 54.5 ext{N*m} \cdot rac{10.01}{35 ext{rad} \cdot 1.21 ext{m} \cdot 1.2 ext{m}}
ight]$

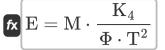
23) Elastic Modulus of Rock given Rotation due to Shear on Arch Dam



$$ext{ex} \ 10.87957 ext{N/m}^2 = 48.5 ext{N} \cdot rac{9.5}{35 ext{rad} \cdot 1.21 ext{m}}$$



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



Open Calculator

 $= 2.972387 \text{N/m}^2 = 51 \text{N*m} \cdot \frac{10.02}{35 \text{rad} \cdot (1.21 \text{m})^2}$

Moments acting on Arch Dam 🗗

25) Moment at Abutments of Arch Dam

 $\mathbf{M}_{\mathrm{t}} = \mathrm{r} \cdot ((\mathrm{p} \cdot \mathrm{r}) - \mathrm{F}) \cdot \left(rac{\sin(\mathrm{A})}{\mathrm{A}} - \cos(\mathrm{A})
ight)$

26) Moment at Crown of Arch Dam

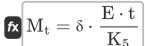
 $\mathbf{M}_{\mathrm{t}} = -\mathbf{r} \cdot ((\mathbf{p} \cdot \mathbf{r}) - \mathbf{F}) \cdot \left(1 - \left(\frac{\sin(\mathbf{A})}{\mathbf{A}}\right)\right)$

Open Calculator 2

Open Calculator

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

27) Moments given Deflection due to Moments on Arch Dam 🛂



Open Calculator

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





28) Moments given Extrados Stresses on Arch Dam 🚰

 $M_{\mathrm{t}} = \sigma_{\mathrm{e}} \cdot \mathrm{t} \cdot \mathrm{t} + \mathrm{F} \cdot rac{\mathrm{t}}{6}$

Open Calculator

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

29) Moments given Intrados Stresses on Arch Dam 💪

 $\mathbf{M}_{\mathrm{t}} = rac{\mathbf{S} \cdot \mathbf{t} \cdot \mathbf{t} - \mathbf{F} \cdot \mathbf{t}}{6}$

Open Calculator

30) Moments given Rotation due to Moment on Arch Dam

 $\mathbf{K} \left[\mathrm{M_t} = rac{\Phi \cdot (\mathrm{E} \cdot \mathrm{t} \cdot \mathrm{t})}{\mathrm{K_1}}
ight]$

Open Calculator

ex 51.35664N*m = $\frac{35$ rad · (10.2N/m² · 1.2m · 1.2m)}{10.01}

31) Moments given Rotation due to Twist on Arch Dam

 $\mathbf{M} = \left(\mathrm{E} \cdot \mathrm{t}^2
ight) \cdot rac{\Phi}{\mathrm{K}_4}$

Open Calculator 🖸

 $ext{ex} \left[51.30539 ext{N*m} = \left(10.2 ext{N/m}^2 \cdot (1.2 ext{m})^2
ight) \cdot rac{35 ext{rad}}{10.02}
ight]$



Normal Radial Pressure of Arch Dams &

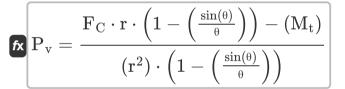
32) Normal Radial Pressure at centerline given Moment at Abutments of Arch Dam

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

Open Calculator 🗗

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

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



Open Calculator 🚰

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

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

$$\mathbf{F}_{\mathrm{v}} = \left(rac{\mathrm{P} + \mathrm{F} \cdot \mathrm{cos}(\mathbf{ heta})}{\mathrm{r} - (\mathrm{r} \cdot \mathrm{cos}(\mathbf{ heta}))}
ight)$$

$$ext{ex} \left[21.78844 ext{kPa/m}^2 = \left(rac{16 ext{kN/m} + 63.55 ext{N} \cdot \cos(30\degree)}{5.5 ext{m} - (5.5 ext{m} \cdot \cos(30\degree))}
ight)
ight]$$





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

Open Calculator

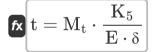
Open Calculator 2

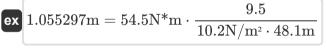
Open Calculator

$$\mathbf{F}_{\mathrm{C}} = rac{\mathrm{F}_{\mathrm{C}}}{\left(\mathrm{r}
ight) \cdot \left(1 - \left(2 \cdot heta \cdot rac{\sin\left(heta \cdot rac{\left(rac{t}{\mathrm{r}}
ight)^{2}}{12}
ight)}{\mathrm{D}}
ight)
ight)}$$

Radial Thickness of Element

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





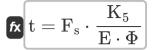


$$\mathbf{K} = \left(\mathbf{M}_{\mathrm{t}} \cdot rac{\mathbf{K}_{1}}{\mathbf{E} \cdot \mathbf{\Phi}}
ight)^{0.5}$$

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



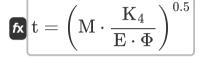
38) Radial Thickness of Element given Rotation due to Shear on Arch Dam



Open Calculator 🗗

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

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



Open Calculator

 $oxed{f x} 1.196423 {
m m} = \left(51 {
m N*m} \cdot rac{10.02}{10.2 {
m N/m^2} \cdot 35 {
m rad}}
ight)^{0.5}$

Thrust on Arch Dam

40) Thrust at Abutments of Arch Dam



Open Calculator

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

 $\mathbf{F} = (\mathbf{p} \cdot \mathbf{r}) \cdot \left(1 - \left(2 \cdot \mathbf{ heta} \cdot rac{\sin\left(\mathbf{ heta} \cdot rac{\left(rac{\mathrm{T_b}}{\mathrm{r}}
ight)^2}{12}
ight)}{\mathrm{D}}
ight)
ight)$

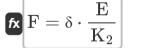
Open Calculator 🗗

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

 $\mathbf{F} = rac{\mathrm{M_t}}{\mathrm{r} \cdot \left(rac{\sin(heta)}{ heta - (\cos(heta))}
ight)} + \mathrm{p} \cdot \mathrm{r}$

Open Calculator 🗗

43) Thrust given Deflection due to Thrust on Arch Dam

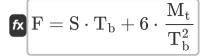


Open Calculator 🗗

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



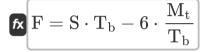
44) Thrust given Extrados Stresses on Arch Dam



Open Calculator

$$ext{ex} 193.8161 ext{N} = 250 ext{N}/ ext{m}^2 \cdot 1.3 ext{m} + 6 \cdot rac{54.5 ext{N*m}}{\left(1.3 ext{m}
ight)^2}$$

45) Thrust given Intrados Stresses on Arch Dam



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



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)
- K₁ Constant K1
- K₂ Constant K2
- K₃ Constant K3
- K₄ Constant K4
- K₅ 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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