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Buttress Dams Formulas

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List of 33 Buttress Dams Formulas

Buttress Dams

Buttress Dams using law of Trapezoid

1) Distance from Centroid for Maximum Intensity in horizontal plane on Buttress Dam

$$\text{fx } Y_t = \left(\frac{\left(\sigma_i - \left(\frac{p}{A_{cs}} \right) \right) \cdot I_H}{M_b} \right)$$

[Open Calculator !\[\]\(de95854c7ee024cfadc48187bbb781b2_img.jpg\)](#)

$$\text{ex } 20.02903\text{m} = \left(\frac{\left(1200\text{Pa} - \left(\frac{15\text{kN}}{13\text{m}^2} \right) \right) \cdot 23\text{m}^4}{53\text{N} \cdot \text{m}} \right)$$

2) Maximum Intensity of Vertical Force in horizontal plane on Buttress Dam

$$\text{fx } \sigma_i = \left(\frac{p}{A_{cs}} \right) + \left(\frac{M_b \cdot Y_t}{I_H} \right)$$

[Open Calculator !\[\]\(6a9b39b98eb945faa14c645ec99e4eaa_img.jpg\)](#)

$$\text{ex } 1200.394\text{Pa} = \left(\frac{15\text{kN}}{13\text{m}^2} \right) + \left(\frac{53\text{N} \cdot \text{m} \cdot 20.2\text{m}}{23\text{m}^4} \right)$$



3) Minimum Intensity in horizontal plane on Buttress Dam

$$\text{fx } \sigma_i = \left(\frac{p}{A_{cs}} \right) - \left(\frac{M_b \cdot Y_t}{I_H} \right)$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$\text{ex } 1107.298\text{Pa} = \left(\frac{15\text{kN}}{13\text{m}^2} \right) - \left(\frac{53\text{N}^*\text{m} \cdot 20.2\text{m}}{23\text{m}^4} \right)$$

4) Moment for Maximum Intensity in horizontal plane on Buttress Dam

$$\text{fx } M = \left(\sigma - \left(\frac{p}{A_{cs}} \right) \right) \cdot \frac{I_H}{Y_t}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$\text{ex } 169.4783\text{kN}^*\text{m} = \left(150\text{kPa} - \left(\frac{15\text{kN}}{13\text{m}^2} \right) \right) \cdot \frac{23\text{m}^4}{20.2\text{m}}$$

5) Moment for Minimum Intensity in horizontal plane on Buttress Dam

$$\text{fx } M = \left(\sigma - \left(\frac{L_{\text{Vertical}}}{A_{cs}} \right) \right) \cdot \frac{I_H}{Y_t}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$\text{ex } 166.5004\text{kN}^*\text{m} = \left(150\text{kPa} - \left(\frac{49\text{kN}}{13\text{m}^2} \right) \right) \cdot \frac{23\text{m}^4}{20.2\text{m}}$$

6) Moment of Buttress dam in horizontal plane using stress

$$\text{fx } M = \left(\sigma + \left(\frac{L_{\text{Vertical}}}{A_{cs}} \right) \right) \cdot \frac{I_H}{Y_t}$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$\text{ex } 175.0838\text{kN}^*\text{m} = \left(150\text{kPa} + \left(\frac{49\text{kN}}{13\text{m}^2} \right) \right) \cdot \frac{23\text{m}^4}{20.2\text{m}}$$



7) Moment of Inertia for Minimum Intensity in horizontal plane on Buttress Dam

[Open Calculator !\[\]\(dfbd6b3763a6d1d9afaa974f64e2e4b5_img.jpg\)](#)

$$\text{fx } I_H = \left(\frac{M_b \cdot Y_t}{\sigma_i - \left(\frac{p}{A_{cs}} \right)} \right)$$

$$\text{ex } 23.19633\text{m}^4 = \left(\frac{53\text{N} \cdot \text{m} \cdot 20.2\text{m}}{1200\text{Pa} - \left(\frac{15\text{kN}}{13\text{m}^2} \right)} \right)$$

8) Sectional Area of Base for Maximum Intensity in horizontal plane on Buttress Dam

[Open Calculator !\[\]\(ec9132f1d27c8919987d92907322654d_img.jpg\)](#)

$$\text{fx } A_{cs} = \frac{p}{\sigma_i - \left(\frac{M_b \cdot Y_t}{I_H} \right)}$$

$$\text{ex } 13.00444\text{m}^2 = \frac{15\text{kN}}{1200\text{Pa} - \left(\frac{53\text{N} \cdot \text{m} \cdot 20.2\text{m}}{23\text{m}^4} \right)}$$

9) Sectional Area of base for Minimum Intensity in horizontal plane on Buttress Dam

[Open Calculator !\[\]\(758ebdf4629c903da74c2e079717ae32_img.jpg\)](#)

$$\text{fx } A_{cs} = \frac{p}{\sigma_i + \left(\frac{M_b \cdot Y_t}{I_H} \right)}$$

$$\text{ex } 12.03323\text{m}^2 = \frac{15\text{kN}}{1200\text{Pa} + \left(\frac{53\text{N} \cdot \text{m} \cdot 20.2\text{m}}{23\text{m}^4} \right)}$$



10) Total Vertical Load for Maximum Intensity in horizontal plane on Buttress Dam

$$\text{fx } p = \left(\sigma_i - \left(\frac{M_b \cdot Y_t}{I_H} \right) \right) \cdot A_{cs}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$\text{ex } 14.99488\text{kN} = \left(1200\text{Pa} - \left(\frac{53\text{N}^*\text{m} \cdot 20.2\text{m}}{23\text{m}^4} \right) \right) \cdot 13\text{m}^2$$

11) Total Vertical Load for Minimum Intensity in horizontal plane on Buttress Dam

$$\text{fx } p = \left(\sigma_i + \left(\frac{M_b \cdot Y_t}{I_H} \right) \right) \cdot A_{cs}$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$\text{ex } 16.20512\text{kN} = \left(1200\text{Pa} + \left(\frac{53\text{N}^*\text{m} \cdot 20.2\text{m}}{23\text{m}^4} \right) \right) \cdot 13\text{m}^2$$

Dams on Soft or Porous Foundations

Dams on Soft or Porous Foundations by Darcy's law

12) Discharge given Hydraulic Gradient per unit head for Dams on Soft Foundations

$$\text{fx } Q_t = k \cdot H_{\text{Water}} \cdot \frac{N}{B}$$

[Open Calculator !\[\]\(799877f5c2f906134441300079881630_img.jpg\)](#)

$$\text{ex } 0.46\text{m}^3/\text{s} = 10\text{cm}/\text{s} \cdot 2.3\text{m} \cdot \frac{4}{2}$$



13) Equipotential Lines given discharge for Dams on Soft Foundations

$$\text{fx } H_{\text{Water}} = \frac{Q_t \cdot B}{k \cdot N}$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)

$$\text{ex } 2.3\text{m} = \frac{0.46\text{m}^3/\text{s} \cdot 2}{10\text{cm}/\text{s} \cdot 4}$$

14) Equipotential Lines given Hydraulic Gradient per unit head for Dams on Soft Foundations

$$\text{fx } N = i \cdot B$$

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5_img.jpg\)](#)

$$\text{ex } 4.04 = 2.02 \cdot 2$$

15) Hydraulic Gradient per unit head for Dams on Soft Foundations

$$\text{fx } i = \frac{N}{B}$$

[Open Calculator !\[\]\(ab4e2b3fc7e7887b7a72f548aa6f5e60_img.jpg\)](#)

$$\text{ex } 2 = \frac{4}{2}$$

16) Length of Conduit after using Area of Pipe in Discharge

$$\text{fx } L_{\text{pipe}} = C_1 \cdot \frac{H_f}{V_{\text{max}}}$$

[Open Calculator !\[\]\(5abce1a84a655b073239ab33e1199487_img.jpg\)](#)

$$\text{ex } 1.5\text{m} = 9 \cdot \frac{5\text{m}}{30\text{m}/\text{s}}$$



17) Length of Conduit given Neutral Stress per unit area for Dams on Soft Foundations

$$fx \quad L_n = \frac{h}{\left(\frac{\sigma_{\text{Neutralstress}}}{D \cdot W} - 1 \right)}$$

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5_img.jpg\)](#)

$$ex \quad 2.90079m = \frac{15.6m}{\left(\frac{187.7kN/m^2}{3m \cdot 9.81kN/m^3} - 1 \right)}$$

18) Maximum Velocity given New Material Coefficient C 2 for Dams on Soft Foundations

$$fx \quad V_{\max} = \frac{C_1}{C_2}$$

[Open Calculator !\[\]\(2b376d1a92330ab09dad2665d2f89bf5_img.jpg\)](#)

$$ex \quad 30m/s = \frac{9}{0.3}$$

19) Minimum Safe Length of Travel path under Dams on Soft or Porous Foundations

$$fx \quad L_n = C_2 \cdot H_f$$

[Open Calculator !\[\]\(c444627dab9fee9a1550c053ffaaaae2_img.jpg\)](#)

$$ex \quad 1.5m = 0.3 \cdot 5m$$



20) Neutral Stress per unit area for Dams on Soft Foundations

$$\text{fx } \sigma_{\text{Neutralstress}} = D \cdot W \cdot \left(1 + \frac{h}{L_n} \right)$$

[Open Calculator !\[\]\(6605b201d6f14d9b3bcb8ab5f274d107_img.jpg\)](#)

$$\text{ex } 187.7431 \text{ kN/m}^2 = 3 \text{ m} \cdot 9.81 \text{ kN/m}^3 \cdot \left(1 + \frac{15.6 \text{ m}}{2.9 \text{ m}} \right)$$

21) New Material Coefficient C2 for Dams on Soft or Porous Foundations

$$\text{fx } C_2 = \frac{C_1}{V_{\text{max}}}$$

[Open Calculator !\[\]\(e8fb589d58dad1692debababa5e928b6_img.jpg\)](#)

$$\text{ex } 0.3 = \frac{9}{30 \text{ m/s}}$$

22) Number of Beds given discharge for Dams on Soft Foundations

$$\text{fx } B = k \cdot H_{\text{Water}} \cdot \frac{N}{Q_t}$$

[Open Calculator !\[\]\(4688aadfd656ded00cd6bdfae55089a9_img.jpg\)](#)

$$\text{ex } 2 = 10 \text{ cm/s} \cdot 2.3 \text{ m} \cdot \frac{4}{0.46 \text{ m}^3/\text{s}}$$



23) Number of Beds given Hydraulic Gradient per unit head for Dams on Soft Foundations

$$fx \quad B = \frac{N}{i}$$

[Open Calculator !\[\]\(71ceb62b681518c82e95d615e7265d66_img.jpg\)](#)

$$ex \quad 1.980198 = \frac{4}{2.02}$$

24) Permeability given Hydraulic gradient per unit head for Dams on Soft Foundations

$$fx \quad k = \frac{Q_t \cdot B}{H_{Water} \cdot N}$$

[Open Calculator !\[\]\(fc3a57079704ef1b99671c8cafae23be_img.jpg\)](#)

$$ex \quad 10\text{cm/s} = \frac{0.46\text{m}^3/\text{s} \cdot 2}{2.3\text{m} \cdot 4}$$

25) Saturation for Total Pressure per unit Area for Dams on Soft Foundations

$$fx \quad S = \left(P_T \cdot \frac{1 + e}{D \cdot W} \right) - e$$

[Open Calculator !\[\]\(d5831b2ac75eb48b4c49d27e61d24c03_img.jpg\)](#)

$$ex \quad 6.649134 = \left(105\text{Pa} \cdot \frac{1 + 1.2}{3\text{m} \cdot 9.81\text{kN/m}^3} \right) - 1.2$$



26) Specific Gravity of Water given Neutral stress per unit area for Dams on Soft Foundations

[Open Calculator !\[\]\(6e934896f25e6ce1b0dbb50c23abc197_img.jpg\)](#)

$$\text{fx } W = \frac{\sigma_{\text{Neutralstress}}}{D \cdot \left(1 + \frac{h}{L_n}\right)}$$

$$\text{ex } 9.807748 \text{ kN/m}^3 = \frac{187.7 \text{ kN/m}^2}{3 \text{ m} \cdot \left(1 + \frac{15.6 \text{ m}}{2.9 \text{ m}}\right)}$$

27) Total Pressure per unit Area for Dams on Soft Foundations

[Open Calculator !\[\]\(f80254b170d0ecdc443847276e625120_img.jpg\)](#)

$$\text{fx } P_0 = D \cdot W \cdot \left(\frac{S + e}{1 + e}\right)$$

$$\text{ex } 109.6936 \text{ Pa} = 3 \text{ m} \cdot 9.81 \text{ kN/m}^3 \cdot \left(\frac{7 + 1.2}{1 + 1.2}\right)$$

28) Velocity given Length of Conduit after using Area of Pipe in Discharge

[Open Calculator !\[\]\(ac13c516668a3b529e385da83084b241_img.jpg\)](#)

$$\text{fx } V_{\text{max}} = C_1 \cdot \frac{H_f}{L_{\text{pipe}}}$$

$$\text{ex } 40.90909 \text{ m/s} = 9 \cdot \frac{5 \text{ m}}{1.1 \text{ m}}$$



29) Void Ratio given Total Pressure per unit Area for Dams on Soft Foundations

[Open Calculator !\[\]\(0cc5c4c18dd72a91e21b90220aef9c5d_img.jpg\)](#)

$$\text{fx } e = \frac{S - \left(\frac{P_0}{D \cdot W} \right)}{\left(\frac{P_0}{D \cdot W} \right) - 1}$$

$$\text{ex } 1.20257 = \frac{7 - \left(\frac{109.6 \text{Pa}}{3\text{m} \cdot 9.81 \text{kN/m}^3} \right)}{\left(\frac{109.6 \text{Pa}}{3\text{m} \cdot 9.81 \text{kN/m}^3} \right) - 1}$$

Hydraulic Head

30) Depth below Surface for Total Pressure per unit Area for Dams on Soft Foundations

[Open Calculator !\[\]\(4d25d87d94191bbe34f0046ad604e903_img.jpg\)](#)

$$\text{fx } D = \frac{P_T}{W \cdot \left(\frac{S+e}{1+e} \right)}$$

$$\text{ex } 2.871634\text{m} = \frac{105 \text{Pa}}{9.81 \text{kN/m}^3 \cdot \left(\frac{7+1.2}{1+1.2} \right)}$$



31) Depth below Surface given Neutral Stress per unit Area for Dams on Soft Foundations

$$\text{fx } D = \frac{\sigma_{\min}}{W \cdot \left(1 + \frac{h}{L_{\text{Travelpath}}}\right)}$$

[Open Calculator !\[\]\(65669ef2a9341eca7c5ba6092e766555_img.jpg\)](#)

$$\text{ex } 3.009967\text{m} = \frac{106.3\text{N/m}^2}{9.81\text{kN/m}^3 \cdot \left(1 + \frac{15.6\text{m}}{6\text{m}}\right)}$$

32) Head given Hydraulic Gradient per unit Head for Dams on Soft Foundations

$$\text{fx } H_{\text{Water}} = \frac{Q_t}{k \cdot N}$$

[Open Calculator !\[\]\(eaac180de418db4eae4b4cefebda75e8_img.jpg\)](#)

$$\text{ex } 1.15\text{m} = \frac{0.46\text{m}^3/\text{s}}{10\text{cm/s} \cdot 4}$$

33) Head given Neutral Stress per unit Area for Dams on Soft Foundations

$$\text{fx } h = \left(\frac{\sigma_{\min}}{D \cdot W} - 1\right) \cdot L_{\text{Travelpath}}$$

[Open Calculator !\[\]\(43fda5baa5446493352974e4b4060607_img.jpg\)](#)

$$\text{ex } 15.67176\text{m} = \left(\frac{106.3\text{N/m}^2}{3\text{m} \cdot 9.81\text{kN/m}^3} - 1\right) \cdot 6\text{m}$$



Variables Used

- **A_{cs}** Cross-Sectional Area of Base (*Square Meter*)
- **B** Number of Beds
- **C_1** Material Coefficient
- **C_2** New Material Coefficient C_2
- **D** Depth of Dam (*Meter*)
- **e** Void Ratio
- **h** Height of Dam (*Meter*)
- **H_f** Head under Flow (*Meter*)
- **H_{Water}** Head of Water (*Meter*)
- **i** Hydraulic Gradient to Head Loss
- **I_H** Moment of Inertia of Horizontal Section (*Meter⁴*)
- **k** Coefficient of Permeability of Soil (*Centimeter per Second*)
- **L_n** Minimum Safe Length of Travel path (*Meter*)
- **L_{pipe}** Length of Pipe (*Meter*)
- **$L_{Travelpath}$** Length of Travel path (*Meter*)
- **$L_{Vertical}$** Vertical Load on Member (*Kilonewton*)
- **M** Moment of Buttress Dams (*Kilonewton Meter*)
- **M_b** Bending Moment (*Newton Meter*)
- **N** Equipotential Lines
- **p** Load on Buttress Dams (*Kilonewton*)
- **P_0** Total Pressure at given Point (*Pascal*)
- **P_T** Total Pressure (*Pascal*)



- Q_t Discharge from Dam (Cubic Meter per Second)
- S Degree of Saturation
- $V_{\max}$ Maximum Velocity (Meter per Second)
- W Specific Weight of Water in KN per cubic meter (Kilonewton per Cubic Meter)
- Y_t Distance from Centroidal (Meter)
- σ Stress on Buttress Dams (Kilopascal)
- σ_i Intensity of Normal Stress (Pascal)
- $\sigma_{\min}$ Minimum Stress (Newton per Square Meter)
- $\sigma_{\text{Neutralstress}}$ Neutral Stress (Kilonewton per Square Meter)



Constants, Functions, Measurements used

- **Measurement: Length** in Meter (m)
Length Unit Conversion 
- **Measurement: Area** in Square Meter (m^2)
Area Unit Conversion 
- **Measurement: Pressure** in Pascal (Pa), Kilopascal (kPa), Kilonewton per Square Meter (kN/m^2), Newton per Square Meter (N/m^2)
Pressure Unit Conversion 
- **Measurement: Speed** in Centimeter per Second (cm/s), Meter per Second (m/s)
Speed Unit Conversion 
- **Measurement: Force** in Kilonewton (kN)
Force Unit Conversion 
- **Measurement: Volumetric Flow Rate** in Cubic Meter per Second (m^3/s)
Volumetric Flow Rate Unit Conversion 
- **Measurement: Moment of Force** in Newton Meter ($\text{N}\cdot\text{m}$), Kilonewton Meter ($\text{kN}\cdot\text{m}$)
Moment of Force Unit Conversion 
- **Measurement: Specific Weight** in Kilonewton per Cubic Meter (kN/m^3)
Specific Weight Unit Conversion 
- **Measurement: Second Moment of Area** in Meter⁴ (m^4)
Second Moment of Area Unit Conversion 



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- [Arch Dams Formulas](#) 
- [Buttress Dams Formulas](#) 
- [Earth Dam and Gravity Dam Formulas](#) 

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