Crack Width and Deflection of Prestress Concrete Members Formulas

List of 40 Crack Width and Deflection of Prestress Concrete Members Formulas

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Calculation of Crack Width

1) Average Strain at Selected Level given Crack Width

Open Calculator

fx $$\varepsilon_m = \frac{W_{cr} \cdot \left(1 + \left(2 \cdot \frac{acr - C_{min}}{h - x}\right)\right)}{3 \cdot acr}$$

ex $$0.0005 = \frac{0.49mm \cdot \left(1 + \left(2 \cdot \frac{2.51cm - 9.48cm}{20.1cm - 50mm}\right)\right)}{3 \cdot 2.51cm}$$

2) Center to Center Spacing given Shortest Distance

Open Calculator

fx $$s = 2 \cdot \sqrt{\left(acr + \left(\frac{D}{2}\right)\right)^2 - \left(d'^2\right)}$$

ex $$54.10324cm = 2 \cdot \sqrt{\left(2.51cm + \left(\frac{0.5m}{2}\right)\right)^2 - \left((50.01mm)^2\right)}$$

3) Crack Width on Surface of Section

Open Calculator

fx $$W_{cr} = \frac{3 \cdot acr \cdot \varepsilon_m}{1 + \left(2 \cdot \frac{acr - C_{min}}{h - x}\right)}$$

ex $$0.490099mm = \frac{3 \cdot 2.51cm \cdot 0.0005}{1 + \left(2 \cdot \frac{2.51cm - 9.48cm}{20.1cm - 50mm}\right)}$$

4) Depth of Neutral Axis given Crack Width

Open Calculator

fx $$x = h - \left(2 \cdot \frac{acr - C_{min}}{3 \cdot acr \cdot \varepsilon} - 1\right)$$

ex $$3052.077\text{mm} = 20.1\text{cm} - \left(2 \cdot \frac{2.51\text{cm} - 9.48\text{cm}}{3 \cdot 2.51\text{cm} \cdot 1.0001} - 1\right)$$

5) Diameter of Longitudinal Bar given Shortest Distance

Open Calculator

fx $$D = \left(\sqrt{\left(\frac{z}{2}\right)^2 + d'^2} - acr\right) \cdot 2$$

ex $$0.04982\text{m} = \left(\sqrt{\left(\frac{40\text{A}}{2}\right)^2 + (50.01\text{mm})^2} - 2.51\text{cm}\right) \cdot 2$$

6) Effective Cover given Shortest Distance

Open Calculator

fx $$d' = \sqrt{\left(acr + \left(\frac{D}{2}\right)\right)^2 - \left(\frac{z}{2}\right)^2}$$

ex $$275.1\text{mm} = \sqrt{\left(2.51\text{cm} + \left(\frac{0.5\text{m}}{2}\right)\right)^2 - \left(\frac{40\text{A}}{2}\right)^2}$$

7) Minimum Clear Cover given Crack Width

Open Calculator

fx $$C_{min} = acr - \frac{\left(\left(\frac{3 \cdot acr \cdot \varepsilon_m}{W_{cr}}\right) - 1\right) \cdot (h - x)}{2}$$

ex $$9.479883\text{cm} = 2.51\text{cm} - \frac{\left(\left(\frac{3 \cdot 2.51\text{cm} \cdot 0.0005}{0.49\text{mm}}\right) - 1\right) \cdot (20.1\text{cm} - 50\text{mm})}{2}$$

Evaluation of Average Strain and Neutral Axis Depth

8) Area of Prestressing Steel given Tension Force

Open Calculator

fx $$As = \frac{N_u}{E_p \cdot \varepsilon}$$

ex $$26.31316\text{mm}^2 = \frac{1000\text{N}}{38\text{kg/cm}^3 \cdot 1.0001}$$

9) Average Strain under Tension

Open Calculator

fx $$\varepsilon_m = \varepsilon_1 - \frac{W_{cr} \cdot (h - x) \cdot (D_{CC} - x)}{3 \cdot E_s \cdot A_s \cdot (L_{eff} - x)}$$

ex $$0.000514 = 0.000514 - \frac{0.49\text{mm} \cdot (12.01\text{m} - 50\text{mm}) \cdot (4.5\text{m} - 50\text{mm})}{3 \cdot 200000\text{MPa} \cdot 500\text{mm}^2 \cdot (50.25\text{m} - 50\text{mm})}$$

10) Compression Force for Prestressed Section

Open Calculator

fx $$C_c = As \cdot E_p \cdot \varepsilon$$

ex $$767.6768\text{N} = 20.2\text{mm}^2 \cdot 38\text{kg/cm}^3 \cdot 1.0001$$

11) Couple Force of Cross Section

Open Calculator

fx $$C = 0.5 \cdot E_c \cdot \varepsilon_c \cdot x \cdot W_{cr}$$

ex $$0.00325\text{kN} = 0.5 \cdot 0.157\text{MPa} \cdot 1.69 \cdot 50\text{mm} \cdot 0.49\text{mm}$$

12) Depth of Neutral Axis given Couple Force of Cross Section

Open Calculator

fx $$x = \frac{C}{0.5 \cdot E_c \cdot \varepsilon_c \cdot W_{cr}}$$

ex $$430.7305\text{mm} = \frac{0.028\text{kN}}{0.5 \cdot 0.157\text{MPa} \cdot 1.69 \cdot 0.49\text{mm}}$$

13) Height of Crack Width at Soffit given Average Strain

Open Calculator

fx $$h = \left(\frac{(\varepsilon_1 - \varepsilon_m) \cdot (3 \cdot E_s \cdot A_s \cdot (d - x))}{W_{cr} \cdot (D_{CC} - x)} \right) + x$$

ex $$67415.78\text{m} = \left(\frac{(0.000514 - 0.0005) \cdot (3 \cdot 200000\text{MPa} \cdot 500\text{mm}^2 \cdot (85\text{mm} - 50\text{mm}))}{0.49\text{mm} \cdot (4.5\text{m} - 50\text{mm})} \right) + 50\text{mm}$$

14) Modulus of Elasticity of Concrete given Couple Force of Cross-Section

Open Calculator

fx $$E_c = \frac{C}{0.5 \cdot \varepsilon_c \cdot x \cdot W_{cr}}$$

ex $$1.352494\text{MPa} = \frac{0.028\text{kN}}{0.5 \cdot 1.69 \cdot 50\text{mm} \cdot 0.49\text{mm}}$$

15) Modulus of Elasticity of Prestressed Steel given Compression Force

Open Calculator

fx $$E_p = \frac{C_c}{As \cdot \varepsilon}$$

ex $$37.125\text{kg/cm}^3 = \frac{750\text{N}}{20.2\text{mm}^2 \cdot 1.0001}$$

16) Strain at Selected Level given Average Strain under Tension

Open Calculator

fx $$\varepsilon_1 = \varepsilon_m + \frac{W_{cr} \cdot (h - x) \cdot (D_{CC} - x)}{3 \cdot E_s \cdot A_s \cdot (L_{eff} - x)}$$

ex $$0.0005 = 0.0005 + \frac{0.49\text{mm} \cdot (12.01\text{m} - 50\text{mm}) \cdot (4.5\text{m} - 50\text{mm})}{3 \cdot 200000\text{MPa} \cdot 500\text{mm}^2 \cdot (50.25\text{m} - 50\text{mm})}$$

17) Strain given Couple Force of Cross Section

Open Calculator

fx $$\varepsilon_c = \frac{C}{0.5 \cdot E_c \cdot x \cdot W_{cr}}$$

ex $$14.55869 = \frac{0.028\text{kN}}{0.5 \cdot 0.157\text{MPa} \cdot 50\text{mm} \cdot 0.49\text{mm}}$$

18) Strain in Longitudinal Reinforcement given Tension Force

Open Calculator

fx $$\varepsilon s = \frac{N_u}{A_s \cdot Es}$$

ex $$10 = \frac{1000N}{500mm^2 \cdot 200000}$$

19) Strain in Prestressed Steel given Tension Force

Open Calculator

fx $$\varepsilon = \frac{N_u}{As \cdot E_p}$$

ex $$1.302762 = \frac{1000N}{20.2mm^2 \cdot 38kg/cm^3}$$

20) Width of Section given Couple Force of Cross Section

Open Calculator

fx $$W_{cr} = \frac{C}{0.5 \cdot E_c \cdot \varepsilon \cdot x}$$

ex $$7.133045mm = \frac{0.028kN}{0.5 \cdot 0.157MPa \cdot 1.0001 \cdot 50mm}$$

Deflection

21) Deflection due to Self Weight given Short Term Deflection at Transfer

Open Calculator

fx $$\Delta sw = \Delta po + \Delta st$$

ex $$5cm = 2.5cm + 2.50cm$$

22) Short Term Deflection at Transfer

Open Calculator

fx $$\Delta st = -\Delta po + \Delta sw$$

ex $$2.6cm = -2.5cm + 5.1cm$$

Deflection due to Prestressing Force

23) Deflection due to Prestressing for Parabolic Tendon

Open Calculator

fx $$\delta = \left(\frac{5}{384}\right) \cdot \left(\frac{W_{up} \cdot L^4}{E \cdot I_A}\right)$$

ex $$48.08571\text{m} = \left(\frac{5}{384}\right) \cdot \left(\frac{0.842\text{kN/m} \cdot (5\text{m})^4}{15\text{Pa} \cdot 9.5\text{m}^4}\right)$$

24) Deflection due to Prestressing for Singly Harped Tendon

Open Calculator

fx $$\delta = \frac{Ft \cdot L^3}{48 \cdot E \cdot I_p}$$

ex $$48.08642\text{m} = \frac{311.6\text{N} \cdot (5\text{m})^3}{48 \cdot 15\text{Pa} \cdot 1.125\text{kg·m}^2}$$

25) Deflection due to Prestressing Force before Losses when Short Term Deflection at Transfer

Open Calculator

fx $$\Delta po = \Delta sw - \Delta st$$

ex $$2.6\text{cm} = 5.1\text{cm} - 2.50\text{cm}$$

26) Deflection due to Prestressing given Doubly Harped Tendon

Open Calculator

fx $$\delta = \frac{a \cdot \left(a^2\right) \cdot Ft \cdot L^3}{24 \cdot E \cdot I_p}$$

ex $$49.24049\text{m} = \frac{0.8 \cdot \left((0.8)^2\right) \cdot 311.6\text{N} \cdot (5\text{m})^3}{24 \cdot 15\text{Pa} \cdot 1.125\text{kg·m}^2}$$

27) Flexural Rigidity given Deflection due to Prestressing for Doubly Harped Tendon

Open Calculator

fx $$EI = \frac{a \cdot (a^2) \cdot Ft \cdot L^3}{24 \cdot \delta}$$

ex $$17.27512\text{N*m}^2 = \frac{0.8 \cdot \left((0.8)^2\right) \cdot 311.6\text{N} \cdot (5\text{m})^3}{24 \cdot 48.1\text{m}}$$

28) Flexural Rigidity given Deflection due to Prestressing for Parabolic Tendon

Open Calculator

fx $$EI = \left(\frac{5}{384}\right) \cdot \left(\frac{W_{up} \cdot L^4}{\delta}\right)$$

ex $$0.014246\text{N*m}^2 = \left(\frac{5}{384}\right) \cdot \left(\frac{0.842\text{kN/m} \cdot (5\text{m})^4}{48.1\text{m}}\right)$$

29) Flexural Rigidity given Deflection due to Prestressing for Singly Harped Tendon

Open Calculator

fx $$EI = \frac{Ft \cdot L^3}{48 \cdot \delta}$$

ex $$16.87024\text{N*m}^2 = \frac{311.6\text{N} \cdot (5\text{m})^3}{48 \cdot 48.1\text{m}}$$

30) Length of Span given Deflection due to Prestressing for Doubly Harped Tendon

Open Calculator

fx $$L = \left(\frac{\delta \cdot 48 \cdot E \cdot I_p}{a \cdot (4 - 3 \cdot a^2) \cdot Ft}\right)^{\frac{1}{3}}$$

ex $$4.219812\text{m} = \left(\frac{48.1\text{m} \cdot 48 \cdot 15\text{Pa} \cdot 1.125\text{kg·m}^2}{0.8 \cdot \left(4 - 3 \cdot (0.8)^2\right) \cdot 311.6\text{N}}\right)^{\frac{1}{3}}$$

31) Length of Span given Deflection due to Prestressing for Singly Harped Tendon

Open Calculator

fx $$L = \left(\frac{\delta \cdot 48 \cdot E \cdot I_p}{Ft} \right)^{\frac{1}{3}}$$

ex $$5.000471\text{m} = \left(\frac{48.1\text{m} \cdot 48 \cdot 15\text{Pa} \cdot 1.125\text{kg·m}^2}{311.6\text{N}} \right)^{\frac{1}{3}}$$

32) Moment of Inertia for Deflection due to Prestressing for Parabolic Tendon

Open Calculator

fx $$I_p = \left(\frac{5}{384} \right) \cdot \left(\frac{W_{up} \cdot L^4}{e} \right)$$

ex $$137.0443\text{kg·m}^2 = \left(\frac{5}{384} \right) \cdot \left(\frac{0.842\text{kN/m} \cdot (5\text{m})^4}{50\text{Pa}} \right)$$

33) Moment of Inertia for Deflection due to Prestressing in Doubly Harped Tendon

Open Calculator

fx $$I_p = \frac{a \cdot (a^2) \cdot Ft \cdot L^3}{48 \cdot e \cdot \delta}$$

ex $$0.172751\text{kg·m}^2 = \frac{0.8 \cdot \left((0.8)^2 \right) \cdot 311.6\text{N} \cdot (5\text{m})^3}{48 \cdot 50\text{Pa} \cdot 48.1\text{m}}$$

34) Moment of Inertia for Deflection due to Prestressing of Singly Harped Tendon

Open Calculator

fx $$I_p = \frac{Ft \cdot L^3}{48 \cdot e \cdot \delta}$$

ex $$0.337405\text{kg·m}^2 = \frac{311.6\text{N} \cdot (5\text{m})^3}{48 \cdot 50\text{Pa} \cdot 48.1\text{m}}$$

35) Uplift Thrust given Deflection due to Prestressing for Doubly Harped Tendon

Open Calculator

$$Ft = \frac{\delta \cdot 24 \cdot E \cdot I_p}{a \cdot (3 - 4 \cdot a^2) \cdot L^3}$$

$$442.7386N = \frac{48.1m \cdot 24 \cdot 15Pa \cdot 1.125kg{\cdot}m^2}{0.8 \cdot \left(3 - 4 \cdot (0.8)^2\right) \cdot (5m)^3}$$

36) Uplift Thrust given Deflection due to Prestressing for Singly Harped Tendon

Open Calculator

$$Ft = \frac{\delta \cdot 48 \cdot E \cdot I_p}{L^3}$$

$$311.688N = \frac{48.1m \cdot 48 \cdot 15Pa \cdot 1.125kg{\cdot}m^2}{(5m)^3}$$

37) Uplift Thrust when Deflection due to Prestressing for Parabolic Tendon

Open Calculator

$$W_{up} = \frac{\delta \cdot 384 \cdot E \cdot I_A}{5 \cdot L^4}$$

$$0.84225kN/m = \frac{48.1m \cdot 384 \cdot 15Pa \cdot 9.5m^4}{5 \cdot (5m)^4}$$

38) Young's Modulus given Deflection due to Prestressing for Doubly Harped Tendon

Open Calculator

$$E = \frac{a \cdot (3 - 4 \cdot a^2) \cdot Ft \cdot L^3}{48 \cdot \delta \cdot I_p}$$

$$5.278509Pa = \frac{0.8 \cdot \left(3 - 4 \cdot (0.8)^2\right) \cdot 311.6N \cdot (5m)^3}{48 \cdot 48.1m \cdot 1.125kg{\cdot}m^2}$$

39) Young's Modulus given Deflection due to Prestressing for Parabolic Tendon

Open Calculator

fx $$E = \left(\frac{5}{384}\right) \cdot \left(\frac{W_{up} \cdot L^4}{\delta \cdot I_A}\right)$$

ex $$14.99554\text{Pa} = \left(\frac{5}{384}\right) \cdot \left(\frac{0.842\text{kN/m} \cdot (5\text{m})^4}{48.1\text{m} \cdot 9.5\text{m}^4}\right)$$

40) Young's Modulus given Deflection due to Prestressing for Singly Harped Tendon

Open Calculator

fx $$E = \frac{Ft \cdot L^3}{48 \cdot \delta \cdot I_p}$$

ex $$14.99576\text{Pa} = \frac{311.6\text{N} \cdot (5\text{m})^3}{48 \cdot 48.1\text{m} \cdot 1.125\text{kg·m}^2}$$

Variables Used

- **a** Part of Span Length
- **A_s** Area of Reinforcement *(Square Millimeter)*
- **acr** Shortest Distance *(Centimeter)*
- **As** Area of Prestressing Steel *(Square Millimeter)*
- **C** Couple Force *(Kilonewton)*
- **C_c** Total Compression on Concrete *(Newton)*
- **C_{min}** Minimum Clear Cover *(Centimeter)*
- **d** Effective Depth of Reinforcement *(Millimeter)*
- **d'** Effective Cover *(Millimeter)*
- **D** Diameter of Longitudinal Bar *(Meter)*
- **D_{CC}** Distance from Compression to Crack Width *(Meter)*
- **e** Elastic Modulus *(Pascal)*
- **E** Young's Modulus *(Pascal)*
- **E_c** Modulus of Elasticity of Concrete *(Megapascal)*
- **E_p** Prestressed Young's Modulus *(Kilogram per Cubic Centimeter)*
- **E_s** Modulus of Elasticity of Steel Reinforcement *(Megapascal)*
- **EI** Flexural Rigidity *(Newton Square Meter)*
- **Es** Modulus of Elasticity of Steel
- **Ft** Thrust Force *(Newton)*
- **h** Total Depth *(Centimeter)*
- **h** Height of Crack *(Meter)*
- **I_A** Second Moment of Area *(Meter^4)*
- **I_p** Moment of Inertia in Prestress *(Kilogram Square Meter)*
- **L** Span Length *(Meter)*
- **L_{eff}** Effective Length *(Meter)*
- **N_u** Tension Force *(Newton)*
- **s** Center to Center Spacing *(Centimeter)*
- **W_{cr}** Crack Width *(Millimeter)*
- **W_{up}** Upward Thrust *(Kilonewton per Meter)*
- **x** Depth of Neutral Axis *(Millimeter)*
- **z** Center-to-center Distance *(Angstrom)*

- **δ** Deflection due to Moments on Arch Dam *(Meter)*
- **Δpo** Deflection due to Prestressing Force *(Centimeter)*
- **Δst** Short Term Deflection *(Centimeter)*
- **Δsw** Deflection due to Self Weight *(Centimeter)*
- **ε** Strain
- **ε_1** Strain at Selected Level
- **ε_c** Strain in Concrete
- **ε_m** Average Strain
- **εs** Strain in Longitudinal Reinforcement

Constants, Functions, Measurements used

- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Millimeter (mm), Centimeter (cm), Meter (m), Angstrom (A)
  Length Unit Conversion
- Measurement: **Area** in Square Millimeter (mm²)
  Area Unit Conversion
- Measurement: **Pressure** in Megapascal (MPa), Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Force** in Newton (N), Kilonewton (kN)
  Force Unit Conversion
- Measurement: **Surface Tension** in Kilonewton per Meter (kN/m)
  Surface Tension Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Centimeter (kg/cm³)
  Density Unit Conversion
- Measurement: **Moment of Inertia** in Kilogram Square Meter (kg·m²)
  Moment of Inertia Unit Conversion
- Measurement: **Second Moment of Area** in Meter⁴ (m⁴)
  Second Moment of Area Unit Conversion
- Measurement: **Flexural Rigidity** in Newton Square Meter (N*m²)
  Flexural Rigidity Unit Conversion

Check other formula lists

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