



Crack Width and Deflection of Prestress Concrete Members Formulas

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Examples!

Conversions!

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

Crack Width and Deflection of Prestress Concrete Members &

Calculation of Crack Width

1) Average Strain at Selected Level given Crack Width

$$\epsilon_{
m m} = rac{{
m W_{cr}} \cdot \left(1 + \left(2 \cdot rac{{
m acr} - {
m C_{min}}}{{
m h} - {
m x}}
ight)
ight)}}{3 \cdot {
m acr}}$$

2) Center to Center Spacing given Shortest Distance

$$\mathbf{f} \mathbf{s} = 2 \cdot \sqrt{\left(\mathrm{acr} + \left(rac{\mathrm{D}}{2}
ight)
ight)^2 - \left(\mathrm{d}^{2}
ight)^2}$$

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

3) Crack Width on Surface of Section

$$W_{
m cr} = rac{3 \cdot {
m acr} \cdot arepsilon_{
m m}}{1 + \left(2 \cdot rac{{
m acr} - {
m C}_{
m min}}{{
m h} - {
m x}}
ight)}$$

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

Open Calculator

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Open Calculator



4) Depth of Neutral Axis given Crack Width

$$\mathbf{x} = \mathbf{h} - \left(2 \cdot \frac{\mathrm{acr} - \mathrm{C}_{\min}}{3 \cdot \mathrm{acr} \cdot \epsilon} - 1\right)$$

Open Calculator

5) Diameter of Longitudinal Bar given Shortest Distance

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

Open Calculator

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

6) Effective Cover given Shortest Distance

$$\mathrm{d}' = \sqrt{\left(\mathrm{acr} + \left(rac{\mathrm{D}}{2}
ight)
ight)^2 - \left(rac{\mathrm{z}}{2}
ight)^2}$$

Open Calculator

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

7) Minimum Clear Cover given Crack Width

$$ag{K} C_{\min} = rc - rac{\left(\left(rac{3 \cdot rc \cdot arepsilon_{
m m}}{W_{
m cr}}
ight) - 1
ight) \cdot (h - x)}{2}$$



Evaluation of Average Strain and Neutral Axis Depth

8) Area of Prestressing Steel given Tension Force

$$ag{As} = rac{ ext{N}_{ ext{u}}}{ ext{E}_{ ext{p}} \cdot \epsilon}$$

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

9) Average Strain under Tension

$$\epsilon_{
m m} = \epsilon_1 - rac{W_{
m cr} \cdot (h-x) \cdot (D_{
m CC} - x)}{3 \cdot E_{
m s} \cdot A_{
m s} \cdot (L_{
m eff} - x)}$$

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

10) Compression Force for Prestressed Section

$$ag{C_{
m c} = {
m As} \cdot {
m E_p} \cdot \epsilon}$$

11) Couple Force of Cross Section

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

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

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

fx
$$\mathbf{x} = rac{\mathbf{C}}{0.5 \cdot \mathbf{E_c} \cdot \mathbf{e_c} \cdot \mathbf{W_{cr}}}$$



13) Height of Crack Width at Soffit given Average Strain

 $\mathbf{h} = \left(rac{\left(\epsilon_1 - \epsilon_{\mathrm{m}}
ight)\cdot\left(3\cdot E_{\mathrm{s}}\cdot A_{\mathrm{s}}\cdot\left(\mathrm{d} - \mathrm{x}
ight)
ight)}{W_{\mathrm{CP}}\cdot\left(D_{\mathrm{CC}} - \mathrm{x}
ight)}
ight) + \mathrm{x}$

Open Calculator

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

fx $E_{
m c} = rac{C}{0.5 \cdot \epsilon_{
m c} \cdot {
m x} \cdot W_{
m cr}}$

Open Calculator

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

15) Modulus of Elasticity of Prestressed Steel given Compression Force

 $\mathbf{E}_{\mathrm{p}} = rac{C_{\mathrm{c}}}{As \cdot \epsilon}$

Open Calculator 🚰

 $m ex \left[37.125 kg/cm^3 = rac{750 N}{20.2 mm^2 \cdot 1.0001}
ight]$

16) Strain at Selected Level given Average Strain under Tension 🖸

 $\epsilon_{
m M} = \epsilon_{
m m} + rac{{
m W_{cr} \cdot (h-x) \cdot (D_{CC}-x)}}{3 \cdot {
m E_s \cdot A_s \cdot (L_{eff}-x)}}$

Open Calculator 🗗

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

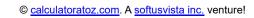
17) Strain given Couple Force of Cross Section

 $\epsilon_{c} = \frac{C}{0.5 \cdot E_{c} \cdot x \cdot W_{cr}}$

Open Calculator

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

fx $\epsilon ext{S} = rac{ ext{N}_{ ext{u}}}{ ext{A}_{ ext{s}} \cdot ext{Es}}$

Open Calculator

19) Strain in Prestressed Steel given Tension Force

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

Open Calculator 🗗

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

20) Width of Section given Couple Force of Cross Section

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

Open Calculator

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

Deflection 🗗

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

fx $\Delta \mathrm{sw} = \Delta \mathrm{po} + \Delta \mathrm{st}$

Open Calculator 🗗

$$= 2.5 \text{cm} + 2.50 \text{cm}$$

22) Short Term Deflection at Transfer

fx $\Delta \mathrm{st} = -\Delta \mathrm{po} + \Delta \mathrm{sw}$

Open Calculator

$$2.6 \text{cm} = -2.5 \text{cm} + 5.1 \text{cm}$$



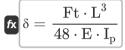
Deflection due to Prestressing Force

23) Deflection due to Prestressing for Parabolic Tendon

$$\delta = \left(rac{5}{384}
ight) \cdot \left(rac{\mathrm{W_{up} \cdot L^4}}{\mathrm{E \cdot I_A}}
ight)$$

Open Calculator 🗗

24) Deflection due to Prestressing for Singly Harped Tendon



Open Calculator

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

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

$$\Delta ext{fx} \Delta ext{po} = \Delta ext{sw} - \Delta ext{st}$$

Open Calculator

$$2.6 cm = 5.1 cm - 2.50 cm$$

26) Deflection due to Prestressing given Doubly Harped Tendon

$$\delta = rac{\mathrm{a}\cdot\left(\mathrm{a}^2
ight)\cdot\mathrm{Ft}\cdot\mathrm{L}^3}{24\cdot\mathrm{E}\cdot\mathrm{I}_\mathrm{p}}$$

$$= 249.24049 m = \frac{0.8 \cdot \left((0.8)^2 \right) \cdot 311.6 N \cdot (5m)^3}{24 \cdot 15 Pa \cdot 1.125 kg \cdot m^2}$$



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

Open Calculator 2

Open Calculator 🚰

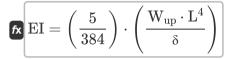
Open Calculator

Open Calculator 🚰

$$ag{EI} = rac{\mathrm{a} \cdot \left(\mathrm{a}^2
ight) \cdot \mathrm{Ft} \cdot \mathrm{L}^3}{24 \cdot \delta}$$

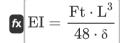
$$\boxed{ 17.27512 \text{N*m}^2 = \frac{0.8 \cdot \left((0.8)^2 \right) \cdot 311.6 \text{N} \cdot (5\text{m})^3}{24 \cdot 48.1 \text{m}} }$$

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



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



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

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

$$\mathbf{L} = \left(rac{\delta \cdot 48 \cdot \mathrm{E} \cdot \mathrm{I_p}}{\mathrm{a} \cdot (4 - 3 \cdot \mathrm{a}^2) \cdot \mathrm{Ft}}
ight)^{rac{1}{3}}$$



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

 $L = \left(rac{\delta \cdot 48 \cdot E \cdot I_p}{Ft}
ight)^{rac{1}{3}}$

Open Calculator

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

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

$$\mathbf{K} \mathbf{I}_{\mathrm{p}} = \left(rac{5}{384}
ight) \cdot \left(rac{\mathbf{W}_{\mathrm{up}} \cdot \mathbf{L}^4}{\mathrm{e}}
ight)$$

Open Calculator

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

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

$$\mathbf{f}_{\mathbf{k}} egin{aligned} I_{\mathrm{p}} &= rac{\mathrm{a} \cdot \left(\mathrm{a}^{2}
ight) \cdot \mathrm{Ft} \cdot \mathrm{L}^{3}}{48 \cdot \mathrm{e} \cdot \delta} \end{aligned}$$

Open Calculator 🗗

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

$$I_{
m p}=rac{{
m Ft}\cdot {
m L}^3}{48\cdot {
m e}\cdot \delta}$$

Open Calculator

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



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

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

Open Calculator

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

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

Open Calculator

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

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

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

Open Calculator

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

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

 $\mathbf{E} = rac{\mathbf{a} \cdot \left(3 - 4 \cdot \mathbf{a}^2
ight) \cdot \mathrm{Ft} \cdot \mathrm{L}^3}{48 \cdot \delta \cdot \mathrm{I_p}}$

Open Calculator 🗗

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



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



Open Calculator 2

Open Calculator G

$${f E} = \left(rac{5}{384}
ight) \cdot \left(rac{{
m W}_{
m up} \cdot {
m L}^4}{\delta \cdot {
m I}_{
m A}}
ight)$$

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

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

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



Variables Used

- a Part of Span Length
- As 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)
- Ec Modulus of Elasticity of Concrete (Megapascal)
- Ep Prestressed Young's Modulus (Kilogram per Cubic Centimeter)
- Es Modulus of Elasticity of Steel Reinforcement (Megapascal)
- El Flexural Rigidity (Newton Square Meter)
- Es Modulus of Elasticity of Steel
- Ft Thrust Force (Newton)
- **h** Total Depth (Centimeter)
- h Height of Crack (Meter)
- IA Second Moment of Area (Meter4)
- Ip Moment of Inertia in Prestress (Kilogram Square Meter)
- L Span Length (Meter)
- Leff Effective Length (Meter)
- N_{II} Tension Force (Newton)
- S Center to Center Spacing (Centimeter)
- Wcr 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)
- **Ast** Short Term Deflection (Centimeter)
- **Asw** Deflection due to Self Weight (Centimeter)
- E Strain
- ε₁ Strain at Selected Level
- ε_c Strain in Concrete
- ε_m Average Strain
- ES 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

- Analysis of Prestressing and Bending Stresses Formulas
- Crack Width and Deflection of Prestress
 Concrete Members Formulas
- General Principles of Prestressed Concrete Formulas
- Transmission of Prestress Formulas

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