Deflection Calculation to AS 3600 (Simply Suported Beam)

PROJECT : Corcon Test in China

BEAM : Corcon 300-120

Data

$f_c := 32$	MPa	$D := 470$	mm	$A_{st} := 402$	mm^2
$\rho := 2400$	kgm^{-3}	$b_{eff} := 1200$	mm	$d_{st} := 418$	mm
$f_y := 500$	MPa	$L_{eff} := 9$	m	$I_g := 2110 \cdot 10^6$	mm^4
$E_s := 200000$	MPa	$A_{sc} := 230$	mm^2	$y_t := 358$	mm
$A_g := 206 \cdot 10^3$	mm^2	$u_e := 3215$	mm	(Perimeter length of the member)	

Load Data

Dead Load	$w_d := 4.96$	kN/m	(Including self weight)
Live Load	$w_l := 2.93$	kN/m	
Short term factor	$\psi_s := 0.7$		(Reference AS 1170.1)
Long term factor	$\psi_l := 0.4$		

(a) Short term deflection calculation

Elastic Modulus of concrete $E_c := 0.043 \cdot \rho^{1.5} \cdot \sqrt{f_c}$ $E_c = 28599.6$ MPa

Modular Ratio $n := \frac{E_s}{E_c}$ $n = 6.993$

Tensile strength of concrete $f_{cf} := 0.6 \cdot f_c^{\frac{1}{2}}$ $f_{cf} = 3.394$ MPa

Cracking Moment $M_{cr} := \frac{f_{cf} \cdot I_g \cdot 10^{-6}}{y_t}$ $M_{cr} = 20$ kNm

Assume that the neutral axis of the cracked section lies in the flange, find the dn

$d_n := 30$ (Initial gaues)

$d_n := \text{root}\left[0.5 b_{eff} \cdot d_n^2 - n \cdot A_{st} \cdot (d_{st} - d_n), d_n\right]$

$d_n = 42$ mm

Find the second moment of inertia of the cracked section

$I_{cr} := \frac{b_{eff} \cdot d_n^3}{3} + n \cdot A_{st} \cdot (d_{st} - d_n)^2$ $I_{cr} = 4.3 \times 10^8$ mm^4

Short term Load $w_t := w_d + \psi_s \cdot w_l$ $w_t = 7.011$ kN/m

Long term Load $w_g := w_d + \psi_l \cdot w_l$ $w_g = 6.132$ kN/m

Service moment $M_s := w_t \cdot \frac{L_{eff}^2}{8}$ $M_s = 70.986$ kNm

The effective moment of inertia $I_{eff} := I_{cr} + (I_g - I_{cr}) \cdot \left(\frac{M_{cr}}{M_s}\right)^3$ $I_{eff} = 4.647 \times 10^8$ mm^4

Mid span deflection $\Delta_s := \frac{5}{384} \cdot \left[\frac{w_t \cdot (L_{eff} \cdot 10^3)^4}{E_c \cdot I_{eff}}\right]$ $\Delta_s = 45.063$ mm

(b) Long Term Deflection Calculation (method as per AS3600)

The hypothetical thickness of the member $t_h := 2 \cdot \frac{A_g}{u_e}$ $t_h = 128.1$ mm

From Table 6.1.7.2(AS3600) $\varepsilon_{cs} := 713 \cdot 10^{-6}$

At mid span: $\frac{A_{sc}}{A_{st}} = 0.572$

The shrinkage curvature: $\kappa_{sh} := \frac{1.15 \cdot \varepsilon_{cs}}{d_{st}} \cdot \left(1 - \frac{A_{sc}}{A_{st}}\right)$ $\kappa_{sh} = 8.393 \times 10^{-7}$ mm^{-1}

Therefore Deflection due to shrinkage $\Delta_{sh} := 0.125 \cdot \kappa_{sh} \cdot (L_{eff} \cdot 10^3)^2$ $\Delta_{sh} = 8.5$ mm

The Deflection due to long term sustained load $\Delta_{e.sus} := \frac{w_g}{w_t} \cdot \Delta_s$ $\Delta_{e.sus} = 39.4$ mm

At mid-span: $\rho n := \frac{A_{st}}{b_{eff} \cdot d_{st}} \cdot n$ $\rho n = 5.605 \times 10^{-3}$

From Table 6.1.8.2 of AS 3600, with $t_h = 128.1$ mm $\phi_{cc} := 1.8$

Creep deflection $\Delta_c := \frac{[1 - 6 \cdot \rho n \cdot (1 - 6 \cdot \rho n)]}{3 \cdot \left(1 + \frac{A_{sc}}{A_{st}}\right)} \cdot \phi_{cc} \cdot \Delta_{e.sus}$ $\Delta_c = 14.6$ mm

Total Deflection $\Delta_{TOTAL} := \Delta_s + \Delta_{sh} + \Delta_c$ $\Delta_{TOTAL} = 68.1$ mm

Deflection Calculation to AS 3600 (Simply Suported Beam)

PROJECT : Corcon Test in China

BEAM : Corcon 250-100

Data

$f_c := 32$	MPa	$D := 400$	mm	$A_{st} := 402$	mm^2
$\rho := 2400$	kgm^{-3}	$b_{eff} := 1200$	mm	$d_{st} := 366$	mm
$f_y := 500$	MPa	$L_{eff} := 7.5$	m	$I_g := 1308 \cdot 10^6$	mm^4
$E_s := 200000$	MPa	$A_{sc} := 230$	mm^2	$y_t := 305$	mm
$A_g := 177 \cdot 10^3$	mm^2	$u_e := 3200$	mm	(Perimeter length of the member)	

Load Data

Dead Load	$w_d := 4.24$	kN/m	(Including self weight)
Live Load	$w_l := 4.71$	kN/m	
Short term factor	$\psi_s := 0.7$		(Reference AS 1170.1)
Long term factor	$\psi_l := 0.4$		

(a) Short term deflection calculation

Elastic Modulus of concrete	$E_c := 0.043 \cdot \rho^{1.5} \cdot \sqrt{f_c}$	$E_c = 28599.6$	MPa
Modular Ratio	$n := \frac{E_s}{E_c}$	$n = 6.993$	
Tensile strength of concrete	$f_{cf} := 0.6 \cdot f_c^{\frac{1}{2}}$	$f_{cf} = 3.394$	MPa
Cracking Moment	$M_{cr} := \frac{f_{cf} \cdot I_g \cdot 10^{-6}}{y_t}$	$M_{cr} = 14.6$	kNm

Assume that the neutral axis of the cracked section lies in the flange, find the dn

$d_n := 25$ (Initial gaues)

$d_n := \text{root}\left[0.5 b_{eff} \cdot d_n^2 - n \cdot A_{st} \cdot (d_{st} - d_n), d_n\right]$

$d_n = 39.1$ mm

Find the second moment of inertia of the cracked section

$I_{cr} := \frac{b_{eff} \cdot d_n^3}{3} + n \cdot A_{st} \cdot (d_{st} - d_n)^2$ $\quad I_{cr} = 3.2 \times 10^8$ mm^4

Short term Load $w_t := w_d + \psi_s \cdot w_l$ $w_t = 7.537$ kN/m

Long term Load $w_g := w_d + \psi_l \cdot w_l$ $w_g = 6.124$ kN/m

Service moment $M_s := w_t \cdot \frac{L_{eff}^2}{8}$ $M_s = 52.995$ kNm

The effective moment of inertia $I_{eff} := I_{cr} + (I_g - I_{cr}) \cdot \left(\frac{M_{cr}}{M_s}\right)^3$ $I_{eff} = 3.447 \times 10^8$ mm^4

Mid span deflection $\Delta_s := \frac{5}{384} \cdot \left[\frac{w_t \cdot (L_{eff} \cdot 10^3)^4}{E_c \cdot I_{eff}}\right]$ $\Delta_s = 31.497$ mm

(b) Long Term Deflection Calculation (method as per AS3600)

The hypothetical thickness of the member $t_h := 2 \cdot \frac{A_g}{u_e}$ $t_h = 110.6$ mm

From Table 6.1.7.2(AS3600) $\varepsilon_{cs} := 743 \cdot 10^{-6}$

At mid span: $\frac{A_{sc}}{A_{st}} = 0.572$

The shrinkage curvature: $\kappa_{sh} := \frac{1.15 \cdot \varepsilon_{cs}}{d_{st}} \cdot \left(1 - \frac{A_{sc}}{A_{st}}\right)$ $\kappa_{sh} = 9.989 \times 10^{-7}$ mm^{-1}

Therefore Deflection due to shrinkage $\Delta_{sh} := 0.125 \cdot \kappa_{sh} \cdot (L_{eff} \cdot 10^3)^2$ $\Delta_{sh} = 7$ mm

The Deflection due to long term sustained load $\Delta_{e.sus} := \frac{w_g}{w_t} \cdot \Delta_s$ $\Delta_{e.sus} = 25.6$ mm

At mid-span: $\rho n := \frac{A_{st}}{b_{eff} \cdot d_{st}} \cdot n$ $\rho n = 6.401 \times 10^{-3}$

From Table 6.1.8.2 of AS 3600, with $t_h = 110.6$ mm $\phi_{cc} := 1.87$

Creep deflection $\Delta_c := \frac{[1 - 6 \cdot \rho n \cdot (1 - 6 \cdot \rho n)]}{3 \cdot \left(1 + \frac{A_{sc}}{A_{st}}\right)} \cdot \phi_{cc} \cdot \Delta_{e.sus}$ $\Delta_c = 9.8$ mm

Total Deflection $\Delta_{TOTAL} := \Delta_s + \Delta_{sh} + \Delta_c$ $\Delta_{TOTAL} = 48.3$ mm

Deflection Calculation to AS 3600 (Simply Suported Beam)

PROJECT : Corcon Test in China

BEAM : Corcon 150-85

Data

$f_c := 32$	MPa	$D := 285$	mm	$A_{st} := 402$	mm^2
$\rho := 2400$	kgm^{-3}	$b_{eff} := 1200$	mm	$d_{st} := 251$	mm
$f_y := 500$	MPa	$L_{eff} := 6$	m	$I_g := 507 \cdot 10^6$	mm^4
$E_s := 200000$	MPa	$A_{sc} := 230$	mm^2	$y_t := 212$	mm
$A_g := 147 \cdot 10^3$	mm^2	$u_e := 2970$	mm	(Perimeter length of the member)	

Load Data

Dead Load	$w_d := 3.53$	kN/m	(Including self weight)
Live Load	$w_l := 6.08$	kN/m	
Short term factor	$\psi_s := 0.7$		(Reference AS 1170.1)
Long term factor	$\psi_l := 0.4$		

(a) Short term deflection calculation

Elastic Modulus of concrete $E_c := 0.043 \cdot \rho^{1.5} \cdot \sqrt{f_c}$ $E_c = 28599.6$ MPa

Modular Ratio $n := \frac{E_s}{E_c}$ $n = 6.993$

Tensile strength of concrete $f_{cf} := 0.6 \cdot f_c^{\frac{1}{2}}$ $f_{cf} = 3.394$ MPa

Cracking Moment $M_{cr} := \frac{f_{cf} \cdot I_g \cdot 10^{-6}}{y_t}$ $M_{cr} = 8.1$ kNm

Assume that the neutral axis of the cracked section lies in the flange, find the dn

$d_n := 25$ (Initial gaues)

$d_n := \text{root}\left[0.5 b_{eff} \cdot d_n^2 - n \cdot A_{st} \cdot (d_{st} - d_n), d_n\right]$

$d_n = 32$ mm

Find the second moment of inertia of the cracked section

$I_{cr} := \frac{b_{eff} \cdot d_n^3}{3} + n \cdot A_{st} \cdot (d_{st} - d_n)^2$ $I_{cr} = 1.5 \times 10^8$ mm^4

Short term Load $w_t := w_d + \psi_s \cdot w_l$ $w_t = 7.786$ kN/m

Long term Load $w_g := w_d + \psi_l \cdot w_l$ $w_g = 5.962$ kN/m

Service moment $M_s := w_t \cdot \frac{L_{eff}^2}{8}$ $M_s = 35.037$ kNm

The effective moment of inertia $I_{eff} := I_{cr} + (I_g - I_{cr}) \cdot \left(\frac{M_{cr}}{M_s}\right)^3$ $I_{eff} = 1.524 \times 10^8$ mm^4

Mid span deflection $\Delta_s := \frac{5}{384} \cdot \left[\frac{w_t \cdot (L_{eff} \cdot 10^3)^4}{E_c \cdot I_{eff}}\right]$ $\Delta_s = 30.145$ mm

(b) Long Term Deflection Calculation (method as per AS3600)

The hypothetical thickness of the member $t_h := 2 \cdot \frac{A_g}{u_e}$ $t_h = 99$ mm

From Table 6.1.7.2(AS3600) $\varepsilon_{cs} := 760 \cdot 10^{-6}$

At mid span: $\frac{A_{sc}}{A_{st}} = 0.572$

The shrinkage curvature: $\kappa_{sh} := \frac{1.15 \cdot \varepsilon_{cs}}{d_{st}} \cdot \left(1 - \frac{A_{sc}}{A_{st}}\right)$ $\kappa_{sh} = 1.49 \times 10^{-6}$ mm^{-1}

Therefore Deflection due to shrinkage $\Delta_{sh} := 0.125 \cdot \kappa_{sh} \cdot (L_{eff} \cdot 10^3)^2$ $\Delta_{sh} = 6.7$ mm

The Deflection due to long term sustained load $\Delta_{e.sus} := \frac{w_g}{w_t} \cdot \Delta_s$ $\Delta_{e.sus} = 23.1$ mm

At mid-span: $\rho n := \frac{A_{st}}{b_{eff} \cdot d_{st}} \cdot n$ $\rho n = 9.333 \times 10^{-3}$

From Table 6.1.8.2 of AS 3600, with $t_h = 99$ mm $\phi_{cc} := 1.9$

Creep deflection $\Delta_c := \frac{[1 - 6 \cdot \rho n \cdot (1 - 6 \cdot \rho n)]}{3 \cdot \left(1 + \frac{A_{sc}}{A_{st}}\right)} \cdot \phi_{cc} \cdot \Delta_{e.sus}$ $\Delta_c = 8.8$ mm

Total Deflection $\Delta_{TOTAL} := \Delta_s + \Delta_{sh} + \Delta_c$ $\Delta_{TOTAL} = 45.7$ mm

Deflection Calculation to AS 3600 (Simply Suported Beam)

PROJECT : Corcon Test in China

BEAM : Corcon 90-50

Data

$f_c := 32$	MPa	$D := 190$	mm	$A_{st} := 226$	mm^2
$\rho := 2400$	kgm^{-3}	$b_{eff} := 1200$	mm	$d_{st} := 164$	mm
$f_y := 500$	MPa	$L_{eff} := 4.5$	m	$I_g := 156 \cdot 10^6$	mm^4
$E_s := 200000$	MPa	$A_{sc} := 230$	mm^2	$y_t := 140$	mm
$A_g := 98 \cdot 10^3$	mm^2	$u_e := 2780$	mm	(Perimeter length of the member)	

Load Data

Dead Load	$w_d := 2.35$	kN/m	(Including self weight)
Live Load	$w_l := 3.78$	kN/m	
Short term factor	$\psi_s := 0.7$		(Reference AS 1170.1)
Long term factor	$\psi_l := 0.4$		

(a) Short term deflection calculation

Elastic Modulus of concrete $E_c := 0.043 \cdot \rho^{1.5} \cdot \sqrt{f_c}$ $E_c = 28599.6$ MPa

Modular Ratio $n := \frac{E_s}{E_c}$ $n = 6.993$

Tensile strength of concrete $f_{cf} := 0.6 \cdot f_c^{\frac{1}{2}}$ $f_{cf} = 3.394$ MPa

Cracking Moment $M_{cr} := \frac{f_{cf} \cdot I_g \cdot 10^{-6}}{y_t}$ $M_{cr} = 3.8$ kNm

Assume that the neutral axis of the cracked section lies in the flange, find the dn

$d_n := 25$ (Initial gaues)

$d_n := \text{root}\left[0.5 b_{eff} \cdot d_n^2 - n \cdot A_{st} \cdot (d_{st} - d_n), d_n\right]$

$d_n = 19.5$ mm

Find the second moment of inertia of the cracked section

$I_{cr} := \frac{b_{eff} \cdot d_n^3}{3} + n \cdot A_{st} \cdot (d_{st} - d_n)^2$ $I_{cr} = 3.6 \times 10^7$ mm^4

Short term Load $w_t := w_d + \psi_s \cdot w_l$ $w_t = 4.996$ kN/m

Long term Load $w_g := w_d + \psi_l \cdot w_l$ $w_g = 3.862$ kN/m

Service moment $M_s := w_t \cdot \frac{L_{eff}^2}{8}$ $M_s = 12.646$ kNm

The effective moment of inertia $I_{eff} := I_{cr} + (I_g - I_{cr}) \cdot \left(\frac{M_{cr}}{M_s}\right)^3$ $I_{eff} = 3.918 \times 10^7$ mm^4

Mid span deflection $\Delta_s := \frac{5}{384} \cdot \left[\frac{w_t \cdot (L_{eff} \cdot 10^3)^4}{E_c \cdot I_{eff}}\right]$ $\Delta_s = 23.808$ mm

(b) Long Term Deflection Calculation (method as per AS3600)

The hypothetical thickness of the member $t_h := 2 \cdot \frac{A_g}{u_e}$ $t_h = 70.5$ mm

From Table 6.1.7.2(AS3600) $\varepsilon_{cs} := 842 \cdot 10^{-6}$

At mid span: $\frac{A_{sc}}{A_{st}} = 1.018$

The shrinkage curvature: $\kappa_{sh} := \frac{1.15 \cdot \varepsilon_{cs}}{d_{st}} \cdot \left(1 - \frac{A_{sc}}{A_{st}}\right)$ $\kappa_{sh} = -1.045 \times 10^{-7}\ mm^{-1}$

Therefore Deflection due to shrinkage $\Delta_{sh} := 0.125 \cdot \kappa_{sh} \cdot (L_{eff} \cdot 10^3)^2$ $\Delta_{sh} = -0.3$ mm

The Deflection due to long term sustained load $\Delta_{e.sus} := \frac{w_g}{w_t} \cdot \Delta_s$ $\Delta_{e.sus} = 18.4$ mm

At mid-span: $\rho n := \frac{A_{st}}{b_{eff} \cdot d_{st}} \cdot n$ $\rho n = 8.031 \times 10^{-3}$

From Table 6.1.8.2 of AS 3600, with $t_h = 70.5$ mm $\phi_{cc} := 2.08$

Creep deflection $\Delta_c := \frac{[1 - 6 \cdot \rho n \cdot (1 - 6 \cdot \rho n)]}{3 \cdot \left(1 + \frac{A_{sc}}{A_{st}}\right)} \cdot \phi_{cc} \cdot \Delta_{e.sus}$ $\Delta_c = 6$ mm

Total Deflection $\Delta_{TOTAL} := \Delta_s + \Delta_{sh} + \Delta_c$ $\Delta_{TOTAL} = 29.6$ mm

Deflection Calculation to AS 3600 (Simply Suported Beam)

PROJECT : Corcon Test in China

BEAM : Corcon 00-65

Data

$f_c := 32$	MPa	$D := 115$	mm	$A_{st} := 226$	mm^2
$\rho := 2400$	kgm^{-3}	$b_{eff} := 1200$	mm	$d_{st} := 89$	mm
$f_y := 500$	MPa	$L_{eff} := 3$	m	$I_g := 85 \cdot 10^6$	mm^4
$E_s := 200000$	MPa	$A_{sc} := 230$	mm^2	$y_t := 69$	mm
$A_g := 105 \cdot 10^3$	mm^2	$u_e := 2630$	mm	(Perimeter length of the member)	

Load Data

Dead Load	$w_d := 2.53$	kN/m	(Including self weight)
Live Load	$w_l := 6.58$	kN/m	
Short term factor	$\psi_s := 0.7$	(Reference AS 1170.1)	
Long term factor	$\psi_l := 0.4$		

(a) Short term deflection calculation

Elastic Modulus of concrete	$E_c := 0.043 \cdot \rho^{1.5} \cdot \sqrt{f_c}$	$E_c = 28599.6$	MPa
Modular Ratio	$n := \frac{E_s}{E_c}$	$n = 6.993$	
Tensile strength of concrete	$f_{cf} := 0.6 \cdot f_c^{\frac{1}{2}}$	$f_{cf} = 3.394$	MPa
Cracking Moment	$M_{cr} := \frac{f_{cf} \cdot I_g \cdot 10^{-6}}{y_t}$	$M_{cr} = 4.2$	kNm

Assume that the neutral axis of the cracked section lies in the flange, find the dn

$d_n := 25$ (Initial gaues)

$d_n := \text{root}\left[0.5 b_{eff} \cdot d_n^2 - n \cdot A_{st} \cdot (d_{st} - d_n), d_n\right]$

$d_n = 14.1$ mm

Find the second moment of inertia of the cracked section

$I_{cr} := \frac{b_{eff} \cdot d_n^3}{3} + n \cdot A_{st} \cdot (d_{st} - d_n)^2$ $\quad I_{cr} = 10 \times 10^6$ mm^4

Short term Load $w_t := w_d + \psi_s \cdot w_l$ $w_t = 7.136$ kN/m

Long term Load $w_g := w_d + \psi_l \cdot w_l$ $w_g = 5.162$ kN/m

Service moment $M_s := w_t \cdot \frac{L_{eff}^2}{8}$ $M_s = 8.028$ kNm

The effective moment of inertia $I_{eff} := I_{cr} + (I_g - I_{cr}) \cdot \left(\frac{M_{cr}}{M_s}\right)^3$ $I_{eff} = 2.058 \times 10^7$ mm^4

Mid span deflection $\Delta_s := \frac{5}{384} \cdot \left[\frac{w_t \cdot (L_{eff} \cdot 10^3)^4}{E_c \cdot I_{eff}}\right]$ $\Delta_s = 12.784$ mm

(b) Long Term Deflection Calculation (method as per AS3600)

The hypothetical thickness of the member $t_h := 2 \cdot \frac{A_g}{u_e}$ $t_h = 79.8$ mm

From Table 6.1.7.2(AS3600) $\varepsilon_{cs} := 816 \cdot 10^{-6}$

At mid span: $\frac{A_{sc}}{A_{st}} = 1.018$

The shrinkage curvature: $\kappa_{sh} := \frac{1.15 \cdot \varepsilon_{cs}}{d_{st}} \cdot \left(1 - \frac{A_{sc}}{A_{st}}\right)$ $\kappa_{sh} = -1.866 \times 10^{-7}\ mm^{-1}$

Therefore Deflection due to shrinkage $\Delta_{sh} := 0.125 \cdot \kappa_{sh} \cdot (L_{eff} \cdot 10^3)^2$ $\Delta_{sh} = -0.2$ mm

The Deflection due to long term sustained load $\Delta_{e.sus} := \frac{w_g}{w_t} \cdot \Delta_s$ $\Delta_{e.sus} = 9.2$ mm

At mid-span: $\rho n := \frac{A_{st}}{b_{eff} \cdot d_{st}} \cdot n$ $\rho n = 0.015$

From Table 6.1.8.2 of AS 3600, with $t_h = 79.8$ mm $\phi_{cc} := 2.02$

Creep deflection $\Delta_c := \frac{[1 - 6 \cdot \rho n \cdot (1 - 6 \cdot \rho n)]}{3 \cdot \left(1 + \frac{A_{sc}}{A_{st}}\right)} \cdot \phi_{cc} \cdot \Delta_{e.sus}$ $\Delta_c = 2.8$ mm

Total Deflection $\Delta_{TOTAL} := \Delta_s + \Delta_{sh} + \Delta_c$ $\Delta_{TOTAL} = 15.4$ mm