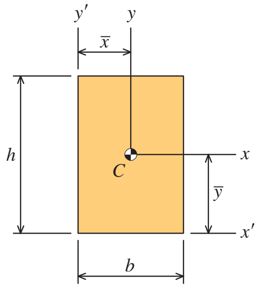
Table A.1 Properties of Plane Figures

1. Rectangle



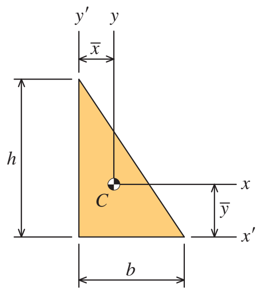
$$A = bh$$

$$\bar{y} = \frac{h}{2} \qquad I_x = \frac{bh^3}{12}$$

$$\bar{x} = \frac{b}{2} \qquad I_y = \frac{hb^3}{12}$$

$$I_{x'} = \frac{bh^3}{3} \qquad I_{y'} = \frac{hb^3}{3}$$

2. Right Triangle



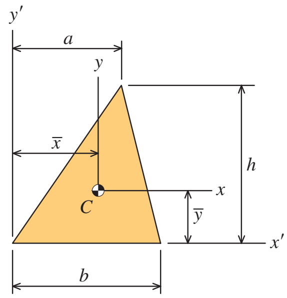
$$A = \frac{bh}{2}$$

$$\bar{y} = \frac{h}{3} \qquad I_x = \frac{bh^3}{36}$$

$$\bar{x} = \frac{b}{3} \qquad I_y = \frac{hb^3}{36}$$

$$I_{x'} = \frac{bh^3}{12} \qquad I_{y'} = \frac{hb^3}{12}$$

3. Triangle



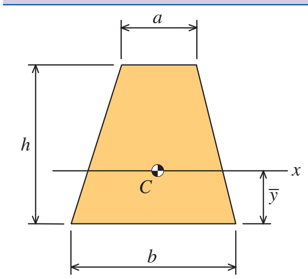
$$A = \frac{bh}{2}$$

$$\bar{y} = \frac{h}{3} \qquad I_x = \frac{bh^3}{36}$$

$$\bar{x} = \frac{(a+b)}{3} \qquad I_y = \frac{bh}{36}(a^2 - ab + b^2)$$

$$I_{x'} = \frac{bh^3}{12}$$

4. Trapezoid

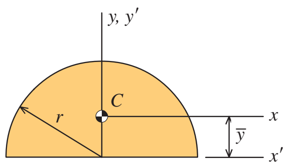


$$A = \frac{(a+b)h}{2}$$

$$\bar{y} = \frac{1}{3}\left(\frac{2a+b}{a+b}\right)h$$

$$I_x = \frac{h^3}{36(a+b)}(a^2 + 4ab + b^2)$$

5. Semicircle

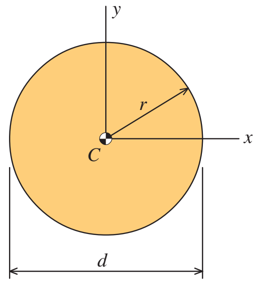


$$A = \frac{\pi r^2}{2}$$

$$\bar{y} = \frac{4r}{3\pi} \qquad I_x = \left(\frac{\pi}{8} - \frac{8}{9\pi}\right)r^4$$

$$I_{x'} = I_{y'} = \frac{\pi r^4}{8}$$

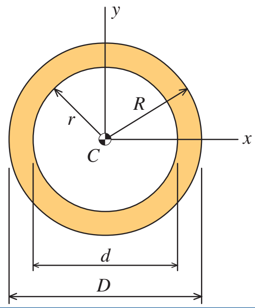
6. Circle



$$A = \pi r^2 = \frac{\pi d^2}{4}$$

$$I_x = I_y = \frac{\pi r^4}{4} = \frac{\pi d^4}{64}$$

7. Hollow Circle

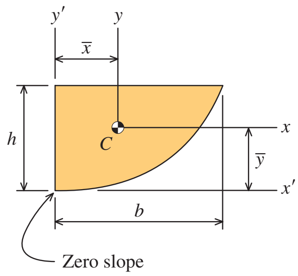


$$A = \pi(R^2 - r^2) = \frac{\pi}{4}(D^2 - d^2)$$

$$I_x = I_y = \frac{\pi}{4}(R^4 - r^4)$$

$$= \frac{\pi}{64}(D^4 - d^4)$$

8. Parabola

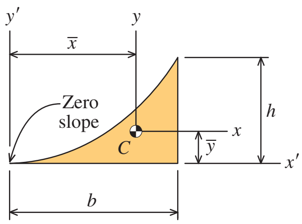


$$y' = \frac{h}{b^2}x'^2$$

$$A = \frac{2bh}{3}$$

$$\bar{x} = \frac{3b}{8} \qquad \bar{y} = \frac{3h}{5}$$

9. Parabolic Spandrel

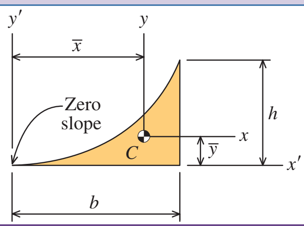


$$y' = \frac{h}{b^2}x'^2$$

$$A = \frac{bh}{3}$$

$$\bar{x} = \frac{3b}{4} \qquad \bar{y} = \frac{3h}{10}$$

10. General Spandrel



$$y' = \frac{h}{b^n}x'^n$$

$$A = \frac{bh}{n+1}$$

$$\bar{x} = \frac{n+1}{n+2}b \qquad \bar{y} = \frac{n+1}{4n+2}h$$

APPENDIX E

Fundamental Mechanics of Materials Equations

Common Greek letters

α	Alpha	μ	Mu
β	Beta	ν	Nu
γ	Gamma	π	Pi
Δ, δ	Delta	ρ	Rho
ε	Epsilon	Σ, σ	Sigma
θ	Theta	τ	Tau
κ	Kappa	ϕ	Phi
λ	Lambda	ω	Omega

Basic definitions

Average normal stress in an axial member

$$\sigma_{avg} = \frac{F}{A}$$

Average direct shear stress

$$\tau_{avg} = \frac{V}{A_V}$$

Average bearing stress

$$\sigma_b = \frac{F}{A_b}$$

Average normal strain in an axial member

$$\varepsilon_{long} = \frac{\Delta L}{L} = \frac{\delta}{L}$$

$$\varepsilon_{lat} = \frac{\Delta d}{d} \quad \text{or} \quad \frac{\Delta t}{t} \quad \text{or} \quad \frac{\Delta h}{h}$$

Average normal strain caused by temperature change

$$\varepsilon_T = \alpha\,\Delta T$$

Average shear strain

$$\gamma = \text{change in angle from } \frac{\pi}{2} \text{ rad}$$

Hooke's law (one-dimensional)

$$\sigma = E\varepsilon \quad \text{and} \quad \tau = G\gamma$$

Poisson's ratio

$$\nu = -\frac{\varepsilon_{lat}}{\varepsilon_{long}}$$

Relationship between E, G, and ν

$$G = \frac{E}{2(1+\nu)}$$

Definition of allowable stress

$$\sigma_{allow} = \frac{\sigma_{failure}}{FS} \quad \text{or} \quad \tau_{allow} = \frac{\tau_{failure}}{FS}$$

Factor of safety

$$FS = \frac{\sigma_{failure}}{\sigma_{actual}} \quad \text{or} \quad FS = \frac{\tau_{failure}}{\tau_{actual}}$$

Axial deformation

Deformation in axial members

$$\delta = \frac{FL}{AE} \quad \text{or} \quad \delta = \sum_i \frac{F_i L_i}{A_i E_i}$$

Force-temperature-deformation relationship

$$\delta = \frac{FL}{AE} + \alpha\,\Delta T\,L$$

Torsion

Maximum torsion shear stress in a circular shaft

$$\tau_{max} = \frac{Tc}{J}$$

where the polar moment of inertia J is defined as:

$$J = \frac{\pi}{2}[R^4 - r^4] = \frac{\pi}{32}[D^4 - d^4]$$

Angle of twist in a circular shaft

$$\phi = \frac{TL}{JG} \quad \text{or} \quad \phi = \sum_i \frac{T_i L_i}{J_i G_i}$$

Power transmission in a shaft

$$P = T\omega$$

Power units and conversion factors

$$1\text{ W} = \frac{1\text{ N}\cdot\text{m}}{\text{s}} \qquad 1\text{ hp} = \frac{550\text{ lb}\cdot\text{ft}}{\text{s}} = \frac{6{,}600\text{ lb}\cdot\text{in.}}{\text{s}}$$

$$1\text{ Hz} = \frac{1\text{ rev}}{\text{s}} \qquad 1\text{ rev} = 2\pi\text{ rad}$$

$$1\text{ rpm} = \frac{2\pi\text{ rad}}{60\text{ s}}$$

Gear relationships between gears A and B

$$\frac{T_A}{R_A} = \frac{T_B}{R_B} \qquad R_A\phi_A = -R_B\phi_B \qquad R_A\omega_A = R_B\omega_B$$

$$\text{Gear ratio} = \frac{R_A}{R_B} = \frac{D_A}{D_B} = \frac{N_A}{N_B}$$

Six rules for constructing shear-force and bending-moment diagrams

Rule 1: $\Delta V = P_0$

Rule 2: $\Delta V = V_2 - V_1 = \int_{x_1}^{x_2} w(x)\,dx$

Rule 3: $\frac{dV}{dx} = w(x)$

Rule 4: $\Delta M = M_2 - M_1 = \int_{x_1}^{x_2} V\,dx$

Rule 5: $\frac{dM}{dx} = V$

Rule 6: $\Delta M = -M_0$

Flexure

Flexural strain and stress

$$\varepsilon_x = -\frac{1}{\rho}y \qquad \sigma_x = -\frac{E}{\rho}y$$

Flexure Formula

$$\sigma_x = -\frac{My}{I_z} \qquad \text{or} \qquad \sigma_{\max} = \frac{Mc}{I} = \frac{M}{S} \quad \text{where } S = \frac{I}{c}$$

Transformed-section method for beams of two materials [where material (2) is transformed into an equivalent amount of material (1)]

$$n = \frac{E_2}{E_1} \qquad \sigma_{x1} = -\frac{My}{I_{\text{transformed}}} \qquad \sigma_{x2} = -n\frac{My}{I_{\text{transformed}}}$$

Bending due to eccentric axial load

$$\sigma_x = \frac{F}{A} - \frac{My}{I_z}$$

Unsymmetric bending of arbitrary cross sections

$$\sigma_x = \left[\frac{I_z z - I_{yz} y}{I_y I_z - I_{yz}^2}\right]M_y + \left[\frac{-I_y y + I_{yz} z}{I_y I_z - I_{yz}^2}\right]M_z$$

or

$$\sigma_x = -\frac{(M_z I_y + M_y I_{yz})y}{I_y I_z - I_{yz}^2} + \frac{(M_y I_z + M_z I_{yz})z}{I_y I_z - I_{yz}^2}$$

$$\tan\beta = \frac{M_y I_z + M_z I_{yz}}{M_z I_y + M_y I_{yz}}$$

Unsymmetric bending of symmetric cross sections

$$\sigma_x = \frac{M_y z}{I_y} - \frac{M_z y}{I_z} \qquad \tan\beta = \frac{M_y I_z}{M_z I_y}$$

Bending of curved bars

$$\sigma_x = -\frac{M(r_n - r)}{rA(r_c - r_n)} \qquad \text{where } r_n = \frac{A}{\int_A \frac{dA}{r}}$$

Horizontal shear stress associated with bending

$$\tau_H = \frac{VQ}{It} \qquad \text{where } Q = \Sigma \bar{y}_i A_i$$

Shear flow formula

$$q = \frac{VQ}{I}$$

Shear flow, fastener spacing, and fastener shear relationship

$$qs \le n_f V_f = n_f \tau_f A_f$$

For circular cross sections,

$$Q = \frac{2}{3}r^3 = \frac{1}{12}d^3 \qquad \text{(solid sections)}$$

$$Q = \frac{2}{3}[R^3 - r^3] = \frac{1}{12}[D^3 - d^3] \qquad \text{(hollow sections)}$$

Beam deflections

Elastic curve relations between w, V, M, θ, and v for constant EI

$$\text{Deflection} = v$$

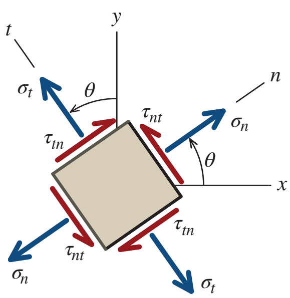
$$\text{Slope} = \frac{dv}{dx} = \theta \text{ (for small deflections)}$$

$$\text{Moment } M = EI\frac{d^2v}{dx^2}$$

$$\text{Shear } V = \frac{dM}{dx} = EI\frac{d^3v}{dx^3}$$

$$\text{Load } w = \frac{dV}{dx} = EI\frac{d^4v}{dx^4}$$

Plane stress transformations



Stresses on an arbitrary plane

$$\sigma_n = \sigma_x\cos^2\theta + \sigma_y\sin^2\theta + 2\tau_{xy}\sin\theta\cos\theta$$

$$\sigma_t = \sigma_x\sin^2\theta + \sigma_y\cos^2\theta - 2\tau_{xy}\sin\theta\cos\theta$$

$$\tau_{nt} = -(\sigma_x - \sigma_y)\sin\theta\cos\theta + \tau_{xy}(\cos^2\theta - \sin^2\theta)$$

or

$$\sigma_n = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2}\cos 2\theta + \tau_{xy}\sin 2\theta$$

$$\sigma_t = \frac{\sigma_x + \sigma_y}{2} - \frac{\sigma_x - \sigma_y}{2}\cos 2\theta - \tau_{xy}\sin 2\theta$$

$$\tau_{nt} = -\frac{\sigma_x - \sigma_y}{2}\sin 2\theta + \tau_{xy}\cos 2\theta$$

Principal stress magnitudes

$$\sigma_{p1,p2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

Orientation of principal planes

$$\tan 2\theta_p = \frac{2\tau_{xy}}{\sigma_x - \sigma_y}$$

Maximum in-plane shear stress magnitude

$$\tau_{\max} = \pm\sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} \qquad \text{or} \qquad \tau_{\max} = \frac{\sigma_{p1} - \sigma_{p2}}{2}$$

$$\sigma_{\text{avg}} = \frac{\sigma_x + \sigma_y}{2}$$

$$\tan 2\theta_s = -\frac{\sigma_x - \sigma_y}{2\tau_{xy}} \qquad \text{note: } \theta_s = \theta_p \pm 45°$$

Absolute maximum shear stress magnitude

$$\tau_{\text{abs max}} = \frac{\sigma_{\max} - \sigma_{\min}}{2}$$

Normal stress invariance

$$\sigma_x + \sigma_y = \sigma_n + \sigma_t = \sigma_{p1} + \sigma_{p2}$$

Plane strain transformations

Strain in arbitrary directions

$$\varepsilon_n = \varepsilon_x \cos^2\theta + \varepsilon_y \sin^2\theta + \gamma_{xy}\sin\theta\cos\theta$$

$$\varepsilon_t = \varepsilon_x \sin^2\theta + \varepsilon_y \cos^2\theta - \gamma_{xy}\sin\theta\cos\theta$$

$$\gamma_{nt} = -2(\varepsilon_x - \varepsilon_y)\sin\theta\cos\theta + \gamma_{xy}(\cos^2\theta - \sin^2\theta)$$

or

$$\varepsilon_n = \frac{\varepsilon_x + \varepsilon_y}{2} + \frac{\varepsilon_x - \varepsilon_y}{2}\cos 2\theta + \frac{\gamma_{xy}}{2}\sin 2\theta$$

$$\varepsilon_t = \frac{\varepsilon_x + \varepsilon_y}{2} - \frac{\varepsilon_x - \varepsilon_y}{2}\cos 2\theta - \frac{\gamma_{xy}}{2}\sin 2\theta$$

$$\gamma_{nt} = -(\varepsilon_x - \varepsilon_y)\sin 2\theta + \gamma_{xy}\cos 2\theta$$

Principal strain magnitudes

$$\varepsilon_{p1,p2} = \frac{\varepsilon_x + \varepsilon_y}{2} \pm \sqrt{\left(\frac{\varepsilon_x - \varepsilon_y}{2}\right)^2 + \left(\frac{\gamma_{xy}}{2}\right)^2}$$

Orientation of principal strains

$$\tan 2\theta_p = \frac{\gamma_{xy}}{\varepsilon_x - \varepsilon_y}$$

Maximum in-plane shear strain

$$\gamma_{\max} = \pm 2\sqrt{\left(\frac{\varepsilon_x - \varepsilon_y}{2}\right)^2 + \left(\frac{\gamma_{xy}}{2}\right)^2} \qquad \text{or} \qquad \gamma_{\max} = \varepsilon_{p1} - \varepsilon_{p2}$$

$$\varepsilon_{\text{avg}} = \frac{\varepsilon_x + \varepsilon_y}{2}$$

Normal strain invariance

$$\varepsilon_x + \varepsilon_y = \varepsilon_n + \varepsilon_t = \varepsilon_{p1} + \varepsilon_{p2}$$

Generalized Hooke's law

Normal stress/normal strain relationships

$$\varepsilon_x = \frac{1}{E}[\sigma_x - \nu(\sigma_y + \sigma_z)]$$

$$\varepsilon_y = \frac{1}{E}[\sigma_y - \nu(\sigma_x + \sigma_z)]$$

$$\varepsilon_z = \frac{1}{E}[\sigma_z - \nu(\sigma_x + \sigma_y)]$$

$$\sigma_x = \frac{E}{(1+\nu)(1-2\nu)}[(1-\nu)\varepsilon_x + \nu(\varepsilon_y + \varepsilon_z)]$$

$$\sigma_y = \frac{E}{(1+\nu)(1-2\nu)}[(1-\nu)\varepsilon_y + \nu(\varepsilon_x + \varepsilon_z)]$$

$$\sigma_z = \frac{E}{(1+\nu)(1-2\nu)}[(1-\nu)\varepsilon_z + \nu(\varepsilon_x + \varepsilon_y)]$$

Shear stress/shear strain relationships

$$\gamma_{xy} = \frac{1}{G}\tau_{xy}; \qquad \gamma_{yz} = \frac{1}{G}\tau_{yz}; \qquad \gamma_{zx} = \frac{1}{G}\tau_{zx}$$

where

$$G = \frac{E}{2(1+\nu)}$$

Volumetric strain or Dilatation

$$e = \frac{\Delta V}{V} = \varepsilon_x + \varepsilon_y + \varepsilon_z = \frac{1-2\nu}{E}(\sigma_x + \sigma_y + \sigma_z)$$

Bulk modulus

$$K = \frac{E}{3(1-2\nu)}$$

Normal stress/normal strain relationships for plane stress

$$\varepsilon_x = \frac{1}{E}(\sigma_x - \nu\sigma_y)$$

$$\varepsilon_y = \frac{1}{E}(\sigma_y - \nu\sigma_x)$$

$$\varepsilon_z = -\frac{\nu}{E}(\sigma_x + \sigma_y)$$

$$\varepsilon_z = -\frac{\nu}{1-\nu}(\varepsilon_x + \varepsilon_y)$$

or

$$\sigma_x = \frac{E}{1-\nu^2}(\varepsilon_x + \nu\varepsilon_y)$$

$$\sigma_y = \frac{E}{1-\nu^2}(\varepsilon_y + \nu\varepsilon_x)$$

Shear stress/shear strain relationships for plane stress

$$\gamma_{xy} = \frac{1}{G}\tau_{xy} \qquad \text{or} \qquad \tau_{xy} = G\gamma_{xy}$$

Thin-walled pressure vessels

Tangential stress and strain in spherical pressure vessel

$$\sigma_t = \frac{pr}{2t} = \frac{pd}{4t} \qquad \varepsilon_t = \frac{pr}{2tE}(1-\nu)$$

Longitudinal and circumferential stresses in cylindrical pressure vessels

$$\sigma_{\text{long}} = \frac{pr}{2t} = \frac{pd}{4t} \qquad \varepsilon_{\text{long}} = \frac{pr}{2tE}(1-2\nu)$$

$$\sigma_{\text{hoop}} = \frac{pr}{t} = \frac{pd}{2t} \qquad \varepsilon_{\text{hoop}} = \frac{pr}{2tE}(2-\nu)$$

Thick-walled pressure vessels

Radial stress in thick-walled cylinder

$$\sigma_r = \frac{a^2 p_i - b^2 p_o}{b^2 - a^2} - \frac{a^2 b^2 (p_i - p_o)}{(b^2 - a^2) r^2}$$

or

$$\sigma_r = \frac{a^2 p_i}{b^2 - a^2}\left(1 - \frac{b^2}{r^2}\right) - \frac{b^2 p_o}{b^2 - a^2}\left(1 - \frac{a^2}{r^2}\right)$$

Circumferential stress in thick-walled cylinder

$$\sigma_\theta = \frac{a^2 p_i - b^2 p_o}{b^2 - a^2} + \frac{a^2 b^2 (p_i - p_o)}{(b^2 - a^2) r^2}$$

or

$$\sigma_\theta = \frac{a^2 p_i}{b^2 - a^2}\left(1 + \frac{b^2}{r^2}\right) - \frac{b^2 p_o}{b^2 - a^2}\left(1 + \frac{a^2}{r^2}\right)$$

Maximum shear stress

$$\tau_{\max} = \frac{1}{2}(\sigma_\theta - \sigma_r) = \frac{a^2 b^2 (p_i - p_o)}{(b^2 - a^2) r^2}$$

Longitudinal normal stress in closed cylinder

$$\sigma_{\text{long}} = \frac{a^2 p_i - b^2 p_o}{b^2 - a^2}$$

Radial displacement for internal pressure only

$$\delta_r = \frac{a^2 p_i}{(b^2 - a^2) r E}\left[(1-\nu) r^2 + (1+\nu) b^2\right]$$

Radial displacement for external pressure only

$$\delta_r = -\frac{b^2 p_o}{(b^2 - a^2) r E}\left[(1-\nu) r^2 + (1+\nu) a^2\right]$$

Radial displacement for external pressure on solid cylinder

$$\delta_r = -\frac{(1-\nu) p_o r}{E}$$

Contact pressure for interference fit connection of thick cylinder onto a thick cylinder

$$p_c = \frac{E\delta (c^2 - b^2)(b^2 - a^2)}{2b^3 (c^2 - a^2)}$$

Contact pressure for interference fit connection of thick cylinder onto a solid cylinder

$$p_c = \frac{E\delta (c^2 - b^2)}{2bc^2}$$

Failure theories

Mises equivalent stress for plane stress

$$\sigma_M = \left[\sigma_{p1}^2 - \sigma_{p1}\sigma_{p2} + \sigma_{p2}^2\right]^{1/2} = \left[\sigma_x^2 - \sigma_x\sigma_y + \sigma_y^2 + 3\tau_{xy}^2\right]^{1/2}$$

Column buckling

Euler buckling load

$$P_{cr} = \frac{\pi^2 EI}{(KL)^2}$$

Euler buckling stress

$$\sigma_{cr} = \frac{\pi^2 E}{(KL/r)^2}$$

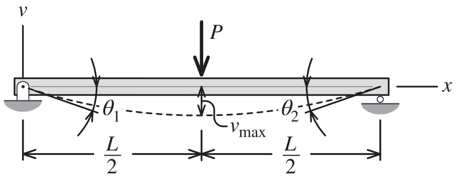
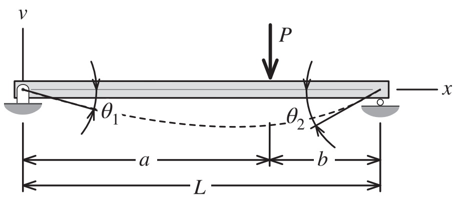
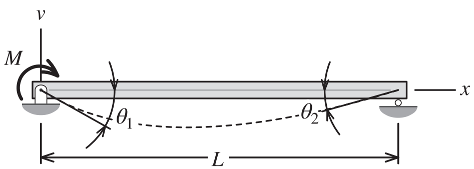
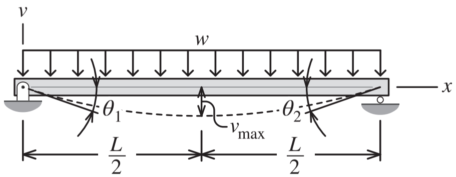
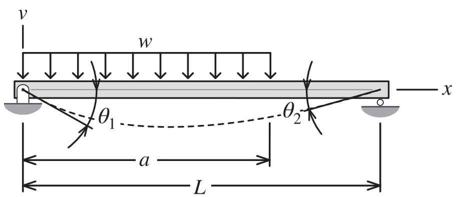
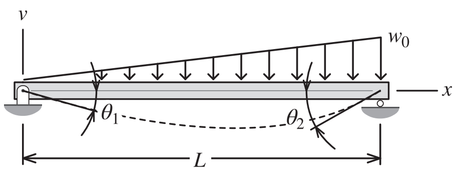
Radius of gyration

$$r^2 = \frac{I}{A}$$

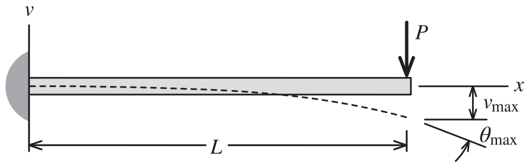
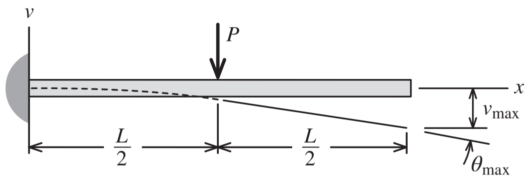
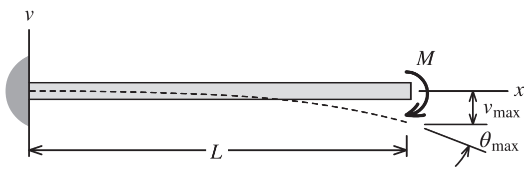
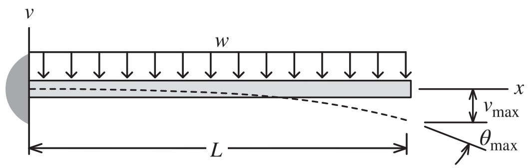
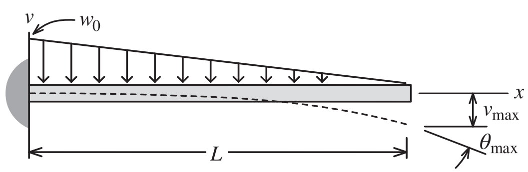
Secant formula

$$\sigma_{\max} = \frac{P}{A}\left[1 + \frac{ec}{r^2}\sec\left(\frac{KL}{2r}\sqrt{\frac{P}{EA}}\right)\right]$$

Simply Supported Beams

	Beam	Slope	Deflection	Elastic Curve
1		$\theta_1 = -\theta_2 = -\dfrac{PL^2}{16EI}$	$v_{max} = -\dfrac{PL^3}{48EI}$	$v = -\dfrac{Px}{48EI}(3L^2 - 4x^2)$ for $0 \le x \le \dfrac{L}{2}$
2		$\theta_1 = -\dfrac{Pb(L^2 - b^2)}{6LEI}$ $\theta_2 = +\dfrac{Pa(L^2 - a^2)}{6LEI}$	$v = -\dfrac{Pa^2b^2}{3LEI}$ at $x = a$	$v = -\dfrac{Pbx}{6LEI}(L^2 - b^2 - x^2)$ for $0 \le x \le a$
3		$\theta_1 = -\dfrac{ML}{3EI}$ $\theta_2 = +\dfrac{ML}{6EI}$	$v_{max} = -\dfrac{ML^2}{9\sqrt{3}\,EI}$ at $x = L\left(1 - \dfrac{\sqrt{3}}{3}\right)$	$v = -\dfrac{Mx}{6LEI}(2L^2 - 3Lx + x^2)$
4		$\theta_1 = -\theta_2 = -\dfrac{wL^3}{24EI}$	$v_{max} = -\dfrac{5wL^4}{384EI}$	$v = -\dfrac{wx}{24EI}(L^3 - 2Lx^2 + x^3)$
5		$\theta_1 = -\dfrac{wa^2}{24LEI}(2L - a)^2$ $\theta_2 = +\dfrac{wa^2}{24LEI}(2L^2 - a^2)$	$v = -\dfrac{wa^3}{24LEI}(4L^2 - 7aL + 3a^2)$ at $x = a$	$v = -\dfrac{wx}{24LEI}(Lx^3 - 4aLx^2 + 2a^2x^2$ $+ 4a^2L^2 - 4a^3L + a^4)$ for $0 \le x \le a$ $v = -\dfrac{wa^2}{24LEI}(2x^3 - 6Lx^2 + a^2x$ $+ 4L^2x - a^2L)$ for $a \le x \le L$
6		$\theta_1 = -\dfrac{7w_0L^3}{360EI}$ $\theta_2 = +\dfrac{w_0L^3}{45EI}$	$v_{max} = -0.00652\dfrac{w_0L^4}{EI}$ at $x = 0.5193L$	$v = -\dfrac{w_0x}{360LEI}(7L^4 - 10L^2x^2 + 3x^4)$

Cantilever Beams

	Beam	Slope	Deflection	Elastic Curve
7		$\theta_{max} = -\dfrac{PL^2}{2EI}$	$v_{max} = -\dfrac{PL^3}{3EI}$	$v = -\dfrac{Px^2}{6EI}(3L - x)$
8		$\theta_{max} = -\dfrac{PL^2}{8EI}$	$v_{max} = -\dfrac{5PL^3}{48EI}$	$v = -\dfrac{Px^2}{12EI}(3L - 2x)$ for $0 \le x \le \dfrac{L}{2}$ $v = -\dfrac{PL^2}{48EI}(6x - L)$ for $\dfrac{L}{2} \le x \le L$
9		$\theta_{max} = -\dfrac{ML}{EI}$	$v_{max} = -\dfrac{ML^2}{2EI}$	$v = -\dfrac{Mx^2}{2EI}$
10		$\theta_{max} = -\dfrac{wL^3}{6EI}$	$v_{max} = -\dfrac{wL^4}{8EI}$	$v = -\dfrac{wx^2}{24EI}(6L^2 - 4Lx + x^2)$
11		$\theta_{max} = -\dfrac{w_0L^3}{24EI}$	$v_{max} = -\dfrac{w_0L^4}{30EI}$	$v = -\dfrac{w_0x^2}{120LEI}(10L^3 - 10L^2x + 5Lx^2 - x^3)$