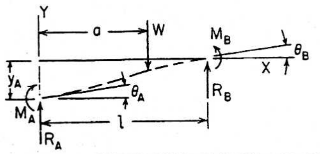
TABLE 3 Shear, moment, slope, and deflection formulas for elastic straight beams

NOTATION: W = load (force); w = unit load (force per unit length); M_o = applied couple (force-length); θ_o = externally created concentrated angular displacement (radians); Δ_o = externally created concentrated lateral displacement; T_1 and T_2 = temperatures on the top and bottom surfaces, respectively (degrees). R_A and R_B are the vertical end reactions at the left and right, respectively, and are positive upward. M_A and M_B are the reaction end moments at the left and right, respectively. All moments are positive when producing compression on the upper portion of the beam cross section. The transverse shear force V is positive when acting upward on the left end of a portion of the beam. All applied loads, couples, and displacements are positive as shown. All deflections are positive upward, and all slopes are positive when up and to the right. E is the modulus of elasticity of the beam material, and I is the area moment of inertia about the centroidal axis of the beam cross section. γ is the temperature coefficient of expansion (unit strain per degree)

1. Concentrated intermediate load



Transverse shear $= V = R_A - W\langle x-a\rangle^0$

Bending moment $= M = M_A + R_A x - W\langle x-a\rangle$

$$\text{Slope} = \theta = \theta_A + \frac{M_A x}{EI} + \frac{R_A x^2}{2EI} - \frac{W}{2EI}\langle x-a\rangle^2$$

$$\text{Deflection} = y = y_A + \theta_A x + \frac{M_A x^2}{2EI} + \frac{R_A x^3}{6EI} - \frac{W}{6EI}\langle x-a\rangle^3$$

(*Note:* see page 98 for a definition of the term $\langle x-a\rangle^n$.)

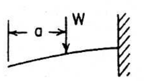
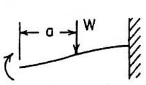
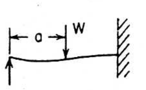
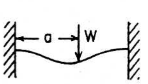
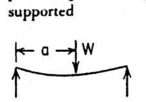
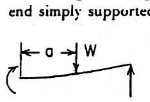
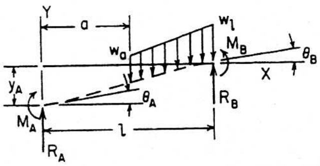
End restraints, reference no.	Boundary values	Selected maximum values of moments and deformations
1a. Left end free, right end fixed (cantilever) 	$R_A = 0 \quad M_A = 0 \quad \theta_A = \frac{W(l-a)^2}{2EI}$ $y_A = \frac{-W}{6EI}(2l^3 - 3l^2a + a^3)$ $R_B = W \quad M_B = -W(l-a)$ $\theta_B = 0 \quad y_B = 0$	Max $M = M_B$; max possible value $= -Wl$ when $a = 0$ Max $\theta = \theta_A$; max possible value $= \frac{Wl^2}{2EI}$ when $a = 0$ Max $y = y_A$; max possible value $= \frac{-Wl^3}{3EI}$ when $a = 0$
1b. Left end guided, right end fixed 	$R_A = 0 \quad M_A = \frac{W(l-a)^2}{2l} \quad \theta_A = 0$ $y_A = \frac{-W}{12EI}(l-a)^2(l+2a)$ $R_B = W \quad M_B = \frac{-W(l^2-a^2)}{2l}$ $\theta_B = 0 \quad y_B = 0$	Max $+M = M_A$; max possible value $= \frac{Wl}{2}$ when $a = 0$ Max $-M = M_B$; max possible value $= \frac{-Wl}{2}$ when $a = 0$ Max $y = y_A$; max possible value $= \frac{-Wl^3}{12EI}$ when $a = 0$
1c. Left end simply supported, right end fixed 	$R_A = \frac{W}{2l^3}(l-a)^2(2l+a) \quad M_A = 0$ $\theta_A = \frac{-Wa}{4EIl}(l-a)^2 \quad y_A = 0$ $R_B = \frac{Wa}{2l^3}(3l^2 - a^2) \quad \theta_B = 0$ $M_B = \frac{-Wa}{2l^2}(l^2 - a^2) \quad y_B = 0$	Max $+M = \frac{Wa}{2l^3}(l-a)^2(2l+a)$ at $x = a$; max possible value $= 0.174Wl$ when $a = 0.366l$ Max $-M = M_B$; max possible value $= -0.1924Wl$ when $a = 0.5773l$ Max $y = \frac{-Wa}{6EI}(l-a)^2\left(\frac{a}{2l+a}\right)^{1/2}$ at $x = l\left(\frac{a}{2l+a}\right)^{1/2}$ when $a > 0.414l$ Max $y = \frac{-Wa(l^2-a^2)^3}{3EI(3l^2-a^2)^2}$ at $x = \frac{l(l^2+a^2)}{3l^2-a^2}$ when $a < 0.414l$; max possible $y = -0.0098\frac{Wl^3}{EI}$ when $x = a = 0.414l$
1d. Left end fixed, right end fixed 	$R_A = \frac{W}{l^3}(l-a)^2(l+2a)$ $M_A = \frac{-Wa}{l^2}(l-a)^2$ $\theta_A = 0 \quad y_A = 0$ $R_B = \frac{Wa^2}{l^3}(3l - 2a)$ $M_B = \frac{-Wa^2}{l^2}(l-a)$ $\theta_B = 0 \quad y_B = 0$	Max $+M = \frac{2Wa^2}{l^3}(l-a)^2$ at $x = a$; max possible value $= \frac{Wl}{8}$ when $a = \frac{l}{2}$ Max $-M = M_A$ if $a < \frac{l}{2}$; max possible value $= -0.1481Wl$ when $a = \frac{l}{3}$ Max $y = \frac{-2W(l-a)^2a^3}{3EI(l+2a)^2}$ at $x = \frac{2al}{l+2a}$ if $a > \frac{l}{2}$; max possible value $= \frac{-Wl^3}{192EI}$ when $x = a = \frac{l}{2}$
1e. Left end simply supported, right end simply supported 	$R_A = \frac{W}{l}(l-a) \quad M_A = 0$ $\theta_A = \frac{-Wa}{6EIl}(2l-a)(l-a) \quad y_A = 0$ $R_B = \frac{Wa}{l} \quad M_B = 0$ $\theta_B = \frac{Wa}{6EIl}(l^2 - a^2) \quad y_B = 0$	Max $M = R_A a$ at $x = a$; max possible value $= \frac{Wl}{4}$ when $a = \frac{l}{2}$ Max $y = \frac{-Wa}{3EIl}\left(\frac{l^2-a^2}{3}\right)^{3/2}$ at $x = l - \left(\frac{l^2-a^2}{3}\right)^{1/2}$ when $a < \frac{l}{2}$; max possible value $= \frac{-Wl^3}{48EI}$ at $x = \frac{l}{2}$ when $a = \frac{l}{2}$ Max $\theta = \theta_A$ when $a < \frac{l}{2}$; max possible value $= -0.0642\frac{Wl^2}{EI}$ when $a = 0.423l$
1f. Left end guided, right end simply supported 	$R_A = 0 \quad M_A = W(l-a) \quad \theta_A = 0$ $y_A = \frac{-W(l-a)}{6EI}(2l^2 + 2al - a^2)$ $R_B = W \quad M_B = 0$ $\theta_B = \frac{W}{2EI}(l^2 - a^2) \quad y_B = 0$	Max $M = M_A$ for $0 < x < a$; max possible value $= Wl$ when $a = 0$ Max $\theta = \theta_B$; max possible value $= \frac{Wl^2}{2EI}$ when $a = 0$ Max $y = y_A$; max possible value $= \frac{-Wl^3}{3EI}$ when $a = 0$

TABLE 3 Shear, moment, slope, and deflection formulas for elastic straight beams (*Continued*)

2. Partial distributed load



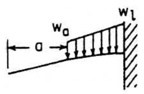
Transverse shear $= V = R_A - w_a\langle x-a\rangle - \dfrac{w_l - w_a}{2(l-a)}\langle x-a\rangle^2$

Bending moment $= M = M_A + R_A x - \dfrac{w_a}{2}\langle x-a\rangle^2 - \dfrac{w_l - w_a}{6(l-a)}\langle x-a\rangle^3$

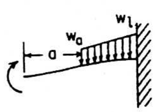
Slope $= \theta = \theta_A + \dfrac{M_A x}{EI} + \dfrac{R_A x^2}{2EI} - \dfrac{w_a}{6EI}\langle x-a\rangle^3 - \dfrac{w_l - w_a}{24EI(l-a)}\langle x-a\rangle^4$

Deflection $= y = y_A + \theta_A x + \dfrac{M_A x^2}{2EI} + \dfrac{R_A x^3}{6EI} - \dfrac{w_a}{24EI}\langle x-a\rangle^4 - \dfrac{(w_l - w_a)}{120EI(l-a)}\langle x-a\rangle^5$

End restraints, reference no.	Boundary values	Selected maximum values of moments and deformations

2a. Left end free, right end fixed (cantilever) 	$R_A = 0 \quad M_A = 0$
	$\theta_A = \dfrac{w_a}{6EI}(l-a)^3 + \dfrac{w_l - w_a}{24EI}(l-a)^3$
	$y_A = \dfrac{-w_a}{24EI}(l-a)^3(3l+a) - \dfrac{w_l - w_a}{120EI}(l-a)^3(4l+a)$
	$R_B = \dfrac{w_a + w_l}{2}(l-a)$
	$M_B = \dfrac{-w_a}{2}(l-a)^2 - \dfrac{w_l - w_a}{6}(l-a)^2$
	$\theta_B = 0 \quad y_B = 0$
		If $a = 0$ and $w_l = w_a$ (uniform load on entire span), then
		Max $M = M_B = \dfrac{-w_a l^2}{2}$ Max $\theta = \theta_A = \dfrac{w_a l^3}{6EI}$
		Max $y = y_A = \dfrac{-w_a l^4}{8EI}$
		If $a = 0$ and $w_a = 0$ (uniformly increasing load), then
		Max $M = M_B = \dfrac{-w_l l^2}{6}$ Max $\theta = \theta_A = \dfrac{w_l l^3}{24EI}$
		Max $y = y_A = \dfrac{-w_l l^4}{30EI}$
		If $a = 0$ and $w_l = 0$ (uniformly decreasing load), then
		Max $M = M_B = \dfrac{-w_a l^2}{3}$ Max $\theta = \theta_A = \dfrac{w_a l^3}{8EI}$
		Max $y = y_A = \dfrac{-11 w_a l^4}{120EI}$

End restraints, reference no.	Boundary values	Selected maximum values of moments and deformations

2b. Left end guided, right end fixed 	$R_A = 0 \quad \theta_A = 0$
	$M_A = \dfrac{w_a}{6l}(l-a)^3 + \dfrac{w_l - w_a}{24l}(l-a)^3$
	$y_A = \dfrac{-w_a}{24EI}(l-a)^3(l+a) - \dfrac{w_l - w_a}{240EI}(l-a)^3(3l+2a)$
	$R_B = \dfrac{w_a + w_l}{2}(l-a)$
	$M_B = \dfrac{-w_a}{6l}(l-a)^2(2l+a) - \dfrac{w_l - w_a}{24l}(l-a)^2(3l+a)$
	$\theta_B = 0 \quad y_B = 0$
		If $a = 0$ and $w_l = w_a$ (uniform load on entire span), then
		Max $-M = M_B = \dfrac{-w_a l^2}{3}$ Max $+M = M_A = \dfrac{w_a l^2}{6}$
		Max $y = y_A = \dfrac{-w_a l^4}{24EI}$
		If $a = 0$ and $w_a = 0$ (uniformly increasing load), then
		Max $-M = M_B = \dfrac{-w_l l^2}{8}$ Max $+M = M_A = \dfrac{w_l l^2}{24}$
		Max $y = y_A = \dfrac{-w_l l^4}{80EI}$
		If $a = 0$ and $w_l = 0$ (uniformly decreasing load), then
		Max $-M = M_B = \dfrac{-5w_a l^2}{24}$ Max $+M = M_A = \dfrac{w_a l^2}{8}$
		Max $y = y_A = \dfrac{-7w_a l^4}{240EI}$

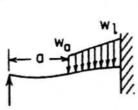
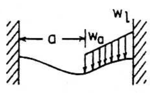
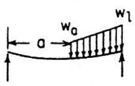
2c. Left end simply supported, right end fixed 	$R_A = \dfrac{w_a}{8l^3}(l-a)^3(3l+a) + \dfrac{w_l - w_a}{40l^3}(l-a)^3(4l+a)$
	$\theta_A = \dfrac{-w_a}{48EIl}(l-a)^3(l+3a) - \dfrac{w_l - w_a}{240EIl}(l-a)^3(2l+3a)$
	$M_A = 0 \quad y_A = 0$
	$R_B = \dfrac{w_a + w_l}{2}(l-a) - R_A$
	$M_B = R_A l - \dfrac{w_a}{2}(l-a)^2 - \dfrac{w_l - w_a}{6}(l-a)^2$
	$\theta_B = 0 \quad y_B = 0$
		If $a = 0$ and $w_l = w_a$ (uniform load on entire span), then
		$R_A = \frac{3}{8}w_a l$ $R_B = \frac{5}{8}w_a l$ Max $-M = M_B = \dfrac{-w_a l^2}{8}$
		Max $+M = \dfrac{9w_a l^2}{128}$ at $x = \frac{3}{8}l$ Max $\theta = \theta_A = \dfrac{-w_a l^3}{48EI}$
		Max $y = -0.0054\dfrac{w_a l^4}{EI}$ at $x = 0.4215l$
		If $a = 0$ and $w_a = 0$ (uniformly increasing load), then
		$R_A = \dfrac{w_l l}{10}$ $R_B = \dfrac{2w_l l}{5}$ Max $-M = M_B = \dfrac{-w_l l^2}{15}$
		Max $+M = 0.0298w_l l^2$ at $x = 0.4472l$ Max $\theta = \theta_A = \dfrac{-w_l l^3}{120EI}$
		Max $y = -0.00239\dfrac{w_l l^4}{EI}$ at $x = 0.4472l$
		If $a = 0$ and $w_l = 0$ (uniformly decreasing load), then
		$R_A = \frac{11}{40}w_a l$ $R_B = \frac{9}{40}w_a l$ Max $-M = M_B = \frac{-7}{120}w_a l^2$
		Max $+M = 0.0422w_a l^2$ at $x = 0.329l$
		Max $\theta = \theta_A = \dfrac{-w_a l^3}{80EI}$ Max $y = -0.00304\dfrac{w_a l^4}{EI}$ at $x = 0.4025l$

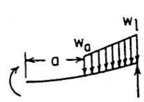
TABLE 3 Shear, moment, slope, and deflection formulas for elastic straight beams (*Continued*)

End restraints, reference no.	Boundary values	Selected maximum values of moments and deformations

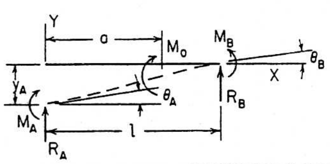
2d. Left end fixed, right end fixed

	$R_A = \frac{w_a}{2l^3}(l-a)^3(l+a) + \frac{w_l - w_a}{20l^3}(l-a)^3(3l+2a)$
	$M_A = \frac{-w_a}{12l^2}(l-a)^3(l+3a) - \frac{w_l - w_a}{60l^2}(l-a)^3(2l+3a)$
	$\theta_A = 0 \qquad y_A = 0$
	$R_B = \frac{w_a + w_l}{2}(l-a) - R_A$
	$M_B = R_A l + M_A - \frac{w_a}{2}(l-a)^2 - \frac{w_l - w_a}{6}(l-a)^2$
	$\theta_B = 0 \qquad y_B = 0$
		If $a = 0$ and $w_l = w_a$ (uniform load on entire span), then
		$\text{Max} - M = M_A = M_B = \frac{-w_a l^2}{12} \qquad \text{Max} + M = \frac{w_a l^2}{24}$ at $x = \frac{l}{2}$
		$\text{Max } y = \frac{-w_a l^4}{384EI}$ at $x = \frac{l}{2}$
		If $a = 0$ and $w_a = 0$ (uniformly increasing load), then
		$R_A = \frac{3w_l l}{20} \qquad M_A = \frac{-w_l l^2}{30} \qquad R_B = \frac{7w_l l}{20} \qquad \text{Max} - M = M_B = \frac{-w_l l^2}{20}$
		$\text{Max} + M = 0.0215 w_l l^2$ at $x = 0.548l$
		$\text{Max } y = -0.001309 \frac{w_l l^4}{EI}$ at $x = 0.525l$

2e. Left end simply supported, right end simply supported

	$R_A = \frac{w_a}{2l}(l-a)^2 + \frac{w_l - w_a}{6l}(l-a)^2$
	$M_A = 0 \qquad y_A = 0$
	$\theta_A = \frac{-w_a}{24EIl}(l-a)^2(l^2 + 2al - a^2)$
	$\qquad - \frac{w_l - w_a}{360EIl}(l-a)^2(7l^2 + 6al - 3a^2)$
	$R_B = \frac{w_a + w_l}{2}(l-a) - R_A$
	$\theta_B = \frac{w_a}{24EIl}(l^2 - a^2)^2$
	$\qquad + \frac{w_l - w_a}{360EIl}(l-a)^2(8l^2 + 9al + 3a^2)$
	$M_B = 0 \qquad y_B = 0$
		If $a = 0$ and $w_l = w_a$ (uniform load on entire span), then
		$R_A = R_B = \frac{w_a l}{2} \qquad \text{Max } M = \frac{w_a l^2}{8}$ at $x = \frac{l}{2}$
		$\text{Max } \theta = \theta_B = \frac{w_a l^3}{24EI} \qquad \text{Max } y = \frac{-5w_a l^4}{384EI}$ at $x = \frac{l}{2}$
		If $a = 0$ and $w_a = 0$ (uniformly increasing load), then
		$R_A = \frac{w_l l}{6} \qquad R_B = \frac{w_l l}{3} \qquad \text{Max } M = 0.0641 w_l l^2$ at $x = 0.5773l$
		$\theta_A = \frac{-7w_l l^3}{360EI} \qquad \theta_B = \frac{w_l l^3}{45EI}$
		$\text{Max } y = -0.00653 \frac{w_l l^4}{EI}$ at $x = 0.5195l$

End restraints, reference no.	Boundary values	Selected maximum values of moments and deformations

2f. Left end guided, right end simply supported

	$R_A = 0 \qquad \theta_A = 0$
	$M_A = \frac{w_a}{2}(l-a)^2 + \frac{w_l - w_a}{6}(l-a)^2$
	$y_A = \frac{-w_a}{24EI}(l-a)^2(5l^2 + 2al - a^2)$
	$\qquad - \frac{w_l - w_a}{120EI}(l-a)^2(9l^2 + 2al - a^2)$
	$R_B = \frac{w_a + w_l}{2}(l-a)$
	$\theta_B = \frac{w_a}{6EI}(l-a)^2(2l+a) + \frac{w_l - w_a}{24EI}(l-a)^2(3l+a)$
	$M_B = 0 \qquad y_B = 0$
		If $a = 0$ and $w_l = w_a$ (uniform load on entire span), then
		$\text{Max } M = M_A = \frac{w_a l^2}{2} \qquad \text{Max } \theta = \theta_B = \frac{w_a l^3}{3EI}$
		$\text{Max } y = y_A = \frac{-5w_a l^4}{24EI}$
		If $a = 0$ and $w_a = 0$ (uniformly increasing load), then
		$\text{Max } M = M_A = \frac{w_l l^2}{6} \qquad \text{Max } \theta = \theta_B = \frac{w_l l^3}{8EI}$
		$\text{Max } y = y_A = \frac{-3w_l l^4}{40EI}$
		If $a = 0$ and $w_l = 0$ (uniformly decreasing load), then
		$\text{Max } M = M_A = \frac{w_a l^2}{3} \qquad \text{Max } \theta = \theta_B = \frac{5w_a l^3}{24EI}$
		$\text{Max } y = y_A = \frac{-2w_a l^4}{15EI}$

3. Concentrated intermediate moment



Transverse shear $= V = R_A$

Bending moment $= M = M_A + R_A x + M_o \langle x - a \rangle^0$

Slope $= \theta = \theta_A + \frac{M_A x}{EI} + \frac{R_A x^2}{2EI} + \frac{M_o}{EI}\langle x - a \rangle$

Deflection $= y = y_A + \theta_A x + \frac{M_A x^2}{2EI} + \frac{R_A x^3}{6EI} + \frac{M_o}{2EI}\langle x - a \rangle^2$

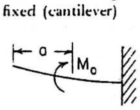
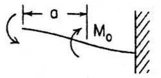
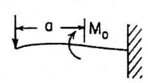
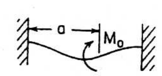
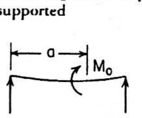
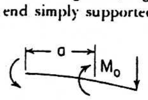
End restraints, reference no.	Boundary values	Selected maximum values of moments and deformations
3a. Left end free, right end fixed (cantilever) 	$R_A = 0 \qquad M_A = 0$ $\theta_A = \frac{-M_o(l-a)}{EI}$ $y_A = \frac{M_o(l^2 - a^2)}{2EI}$ $R_B = 0 \qquad M_B = M_o$ $\theta_B = 0 \qquad y_B = 0$	$\text{Max } M = M_o$ $\text{Max } \theta = \theta_A$; max possible value $= \frac{-M_o l}{EI}$ when $a = 0$ $\text{Max } y = y_A$; max possible value $= \frac{M_o l^2}{2EI}$ when $a = 0$

TABLE 3 Shear, moment, slope, and deflection formulas for elastic straight beams (*Continued*)

End restraints, reference no.	Boundary values	Selected maximum values of moments and deformations
3b. Left end guided, right end fixed 	$R_A = 0 \quad \theta_A = 0$ $M_A = \frac{-M_o(l-a)}{l}$ $y_A = \frac{M_o a(l-a)}{2EI}$ $R_B = 0 \quad \theta_B = 0$ $M_B = \frac{M_o a}{l} \quad y_B = 0$	Max $+M = M_B$; max possible value $= M_o$ when $a = l$ Max $-M = M_A$; max possible value $= -M_o$ when $a = 0$ Max $y = y_A$; max possible value $= \frac{M_o l^2}{8EI}$ when $a = \frac{l}{2}$
3c. Left end simply supported, right end fixed 	$R_A = \frac{-3M_o}{2l^3}(l^2 - a^2)$ $\theta_A = \frac{M_o}{4EIl}(l-a)(3a-l)$ $M_A = 0 \quad y_A = 0$ $R_B = \frac{3M_o}{2l^3}(l^2 - a^2)$ $M_B = \frac{M_o}{2l^2}(3a^2 - l^2)$ $\theta_B = 0 \quad y_B = 0$	Max $+M = M_o + R_A a$ just right of $x = a$; max possible value $= M_o$ when $a = 0$ or $a = l$; min possible value $= 0.423M_o$ when $a = 0.577l$ Max $-M = \frac{-3M_o a}{2l^3}(l^2 - a^2)$ just left of $x = a$ if $a > 0.282l$; max possible value $= -0.577M_o$ when $a = 0.577l$ Max $-M = \frac{-M_o}{2l^2}(l^2 - 3a^2)$ at B if $a < 0.282l$; max possible value $= -0.5M_o$ when $a = 0$ Max $+y = \frac{M_o(l-a)}{6\sqrt{3(l+a)}\,EI}(3a-l)^{3/2}$ at $x = l\sqrt{\frac{3a-l}{3l+3a}}$; max possible value $= 0.0257\frac{M_o l^2}{EI}$ at $x = 0.474l$ when $a = 0.721l$ $\left(\textit{Note:}\text{ There is no positive deflection if } a < \frac{l}{3}\right)$ Max $-y$ occurs at $x = \frac{2l^3}{3(l^2-a^2)}\left[1 - \frac{1}{2}\sqrt{1 - 6\left(\frac{a}{l}\right)^2 + 9\left(\frac{a}{l}\right)^4}\right]$; max possible value $= \frac{-M_o l^2}{27EI}$ at $x = \frac{l}{3}$ when $a = 0$
3d. Left end fixed, right end fixed 	$R_A = \frac{-6M_o a}{l^3}(l - a)$ $M_A = \frac{-M_o}{l^2}(l^2 - 4al + 3a^2)$ $\theta_A = 0 \quad y_A = 0$ $R_B = -R_A$ $M_B = \frac{M_o}{l^2}(3a^2 - 2al)$ $\theta_B = 0 \quad y_B = 0$	Max $+M = \frac{M_o}{l^3}(4al^2 - 9a^2 l + 6a^3)$ just right of $x = a$; max possible value $= M_o$ when $a = l$ Max $-M = \frac{M_o}{l^3}(4al^2 - 9a^2 l + 6a^3 - l^3)$ just left of $x = a$; max possible value $= -M_o$ when $a = 0$ Max $+y = \frac{2M_A^3}{3R_A^2 EI}$ at $x = \frac{l}{3a}(3a - l)$; max possible value $= 0.01617\frac{M_o l^2}{EI}$ at $x = 0.565l$ when $a = 0.767l$ $\left(\textit{Note:}\text{ There is no positive deflection if } a < \frac{l}{3}\right)$
3e. Left end simply supported, right end simply supported 	$R_A = \frac{-M_o}{l}$ $\theta_A = \frac{-M_o}{6EIl}(2l^2 - 6al + 3a^2)$ $M_A = 0 \quad y_A = 0$ $R_B = \frac{M_o}{l}$ $\theta_B = \frac{M_o}{6EIl}(l^2 - 3a^2)$ $M_B = 0 \quad y_B = 0$	Max $+M = \frac{M_o}{l}(l - a)$ just right of $x = a$; max possible value $= M_o$ when $a = 0$ Max $-M = \frac{-M_o a}{l}$ just left of $x = a$; max possible value $= -M_o$ when $a = l$ Max $+y = \frac{M_o(6al - 3a^2 - 2l^2)^{3/2}}{9\sqrt{3}EIl}$ at $x = (2al - a^2 - \frac{2}{3}l^2)^{1/2}$ when $a > 0.423$; max possible value $= 0.0642\frac{M_o l^2}{EI}$ at $x = 0.577l$ when $a = l$ (*Note:* There is no positive deflection if $a < 0.423l$)
3f. Left end guided, right end simply supported 	$R_A = 0 \quad \theta_A = 0$ $M_A = -M_o$ $y_A = \frac{M_o a}{2EI}(2l - a)$ $R_B = 0 \quad M_B = 0 \quad y_B = 0$ $\theta_B = \frac{-M_o a}{EI}$	Max $M = -M_o$ for $0 < x < a$ Max $\theta = \theta_B$; max possible value $= \frac{-M_o l}{EI}$ when $a = l$ Max $y = y_A$; max possible value $= \frac{M_o l^2}{2EI}$ when $a = l$