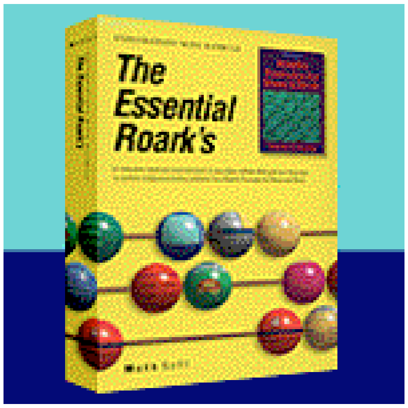
Explorations with Mathcad:

The Essential Roark's



Platform: Windows
Includes the Mathcad Engine; requires 4 MB hard disk space
Available for ground shipment

This Electronic Book is a condensed version of *Roark's Formulas for Stress and Strain (6th Edition)*. Designed for mechanical and civil engineering students, it focuses on the analysis of straight beams and bars. It includes complete implementations of the most useful tables of formulas from the book, as well as explanatory sections and well-documented example problems. It also includes some theory and explanation of principles not found in the original text or in our complete electronic version, *Roark's Formulas for Stress and Strain (6th Edition)*. The Essential Roark's puts thousands of live formulas at your fingertips, along with instructions on how to apply them to real design problems. The cases include relevant plots and over 250 "live" diagrams that can be altered to explore different results. All this means you'll be able to put the theory and equations to use right away.

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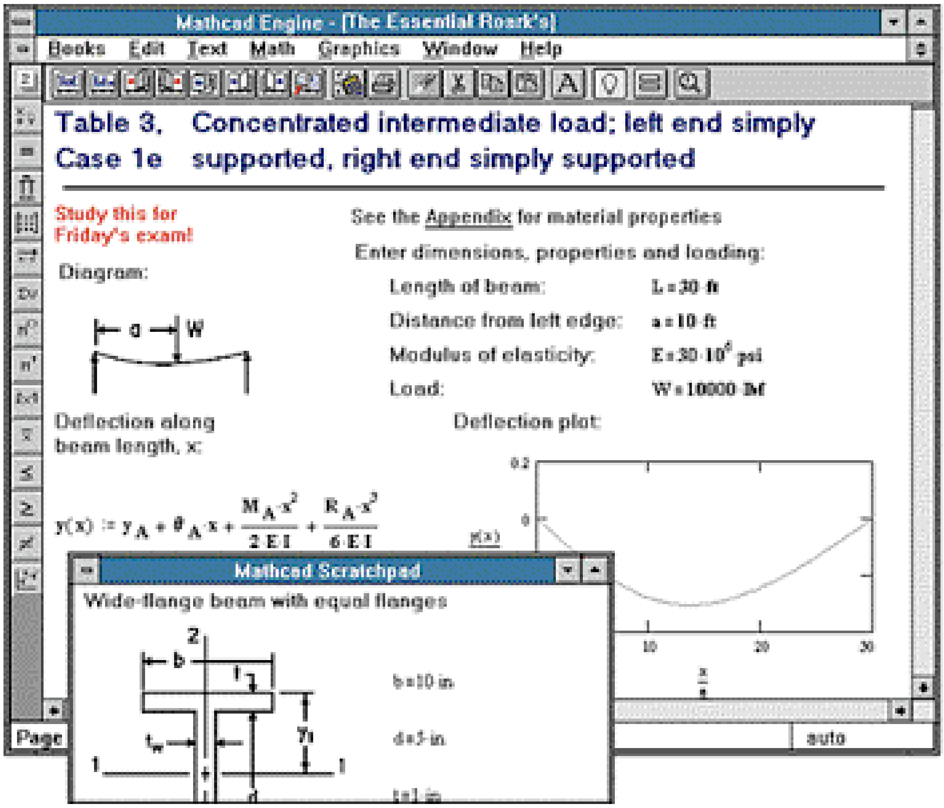

Deflection and stress analysis on a "T" section beam. Beam deflection diagram and cross-section shown.

Topics include: Moments of Inertia, Section Modulus, Shape Factors, Axially Loaded Bars, Composite Members, Trusses, Forces, Deflections, Moments, Stresses, Multiple Loads, Initial Displacements, Tubes and Shafts, Noncircular Members, Plastic Hinge Location, Collapse Loads, Column Buckling/Elastic Stability, and more.

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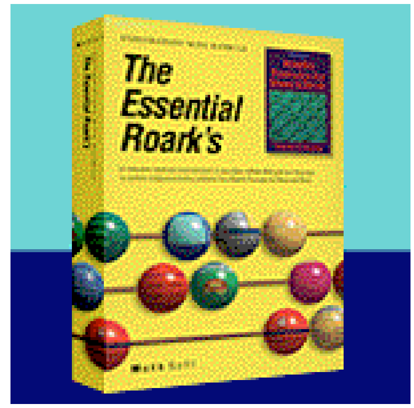

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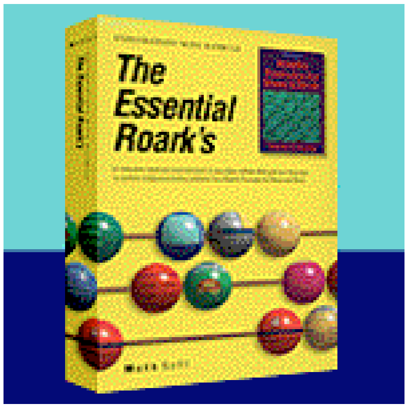

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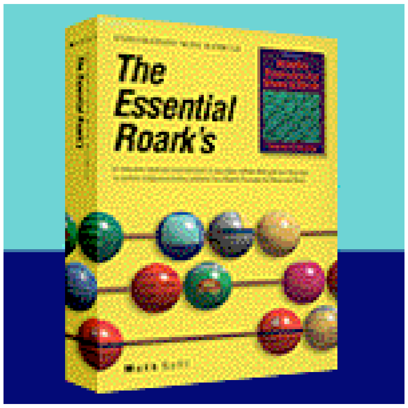
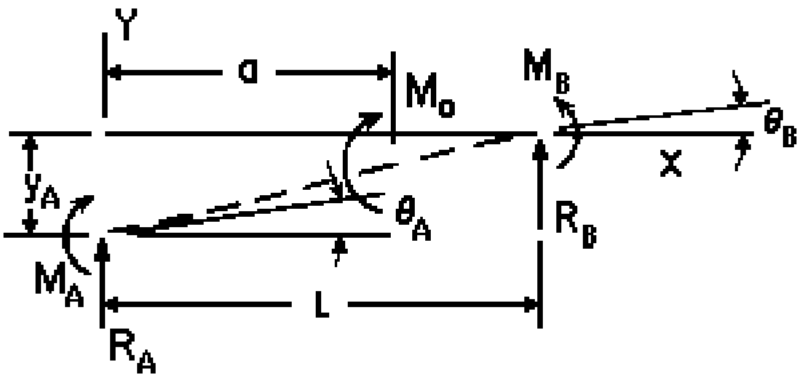


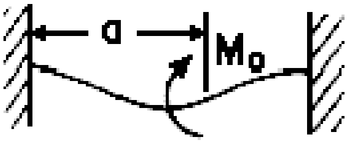
Table 3, Case 3d: Concentrated intermediate moment; left end fixed, right end fixed

(Table 3: Shear, moment, slope and deflection formulas for elastic straight beams)

Concentrated intermediate moment



Left end fixed, right end fixed



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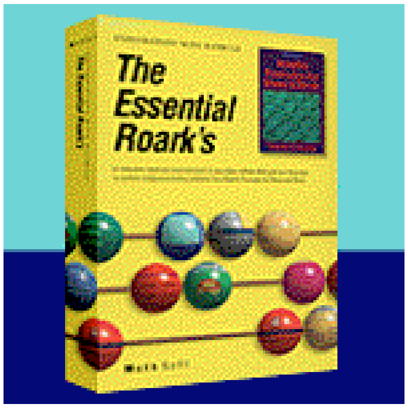

Enter dimensions, properties and loading:

Before progressing further, calculate the moment of inertia (I) for your cross section by flipping to Table 1. Enter the computed value below:

Area moment of inertia: $I \equiv 917.5 \cdot \mathrm{in}^4$

Length of beam: $L \equiv 30 \cdot \mathrm{ft}$

Distance from left edge to load: $a \equiv 10 \cdot \mathrm{ft}$

Modulus of elasticity: $E \equiv 30 \cdot 10^6 \cdot \dfrac{\mathrm{lbf}}{\mathrm{in}^2}$

Applied couple: $M_0 \equiv 200000 \cdot \mathrm{lbf} \cdot \mathrm{ft}$

Boundary values:

The following specify the reaction forces (R), moments (M), slopes (q) and deflections (y) at the left and right ends of the beam (denoted as A and B, respectively).

At the left end of the beam (fixed):

$$R_A := \frac{-6 \cdot M_0 \cdot a}{L^3} \cdot (L - a) \qquad R_A = -8.889 \cdot 10^3 \cdot \mathrm{lbf}$$

$$M_A := -\frac{M_0}{L^2} \cdot \left(L^2 - 4 \cdot a \cdot L + 3 \cdot a^2\right) \qquad M_A = 0 \cdot \mathrm{lbf} \cdot \mathrm{ft}$$

$$\theta_A := 0 \cdot \mathrm{deg} \qquad y_A := 0 \cdot \mathrm{in}$$

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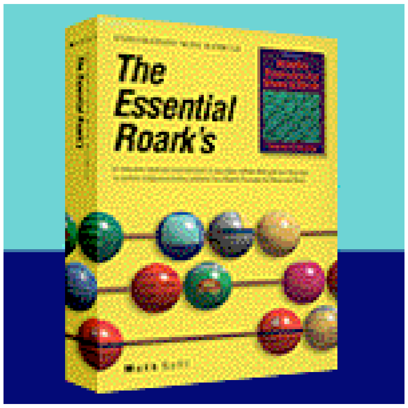

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At the right end of the beam (fixed):

$R_B := -R_A$

$M_B := \frac{M_0}{L^2} \cdot \left(3 \cdot a^2 - 2 \cdot a \cdot L\right)$ $\qquad M_B = -6.667 \cdot 10^4 \cdot lbf \cdot ft$

$\theta_B := 0 \cdot deg$ $\qquad y_B := 0 \cdot in$

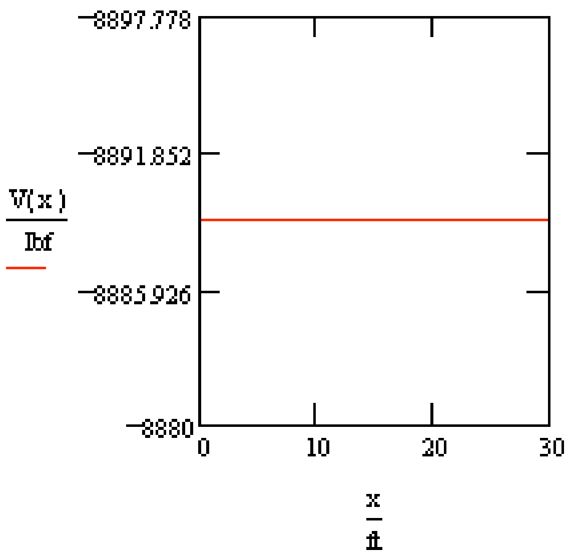
General formulas and graphs for transverse shear, bending moment, slope and deflection as a function of x:

$x := 0 \cdot L, .01 \cdot L .. L$ $\qquad$ x ranges from 0 to L, the length of the beam.

$x_1 := 15 \cdot ft$ $\qquad$ Define a point along the length of the beam.

Transverse shear:

$V(x) := R_A$ $\qquad V\left(x_1\right) = -8.889 \cdot 10^3 \cdot lbf$



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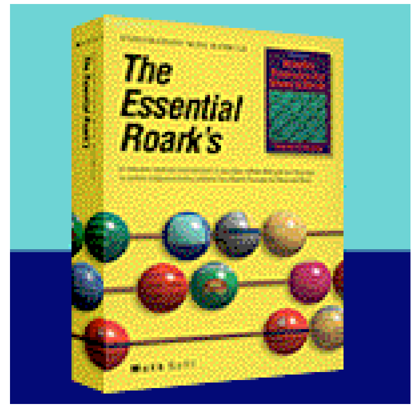
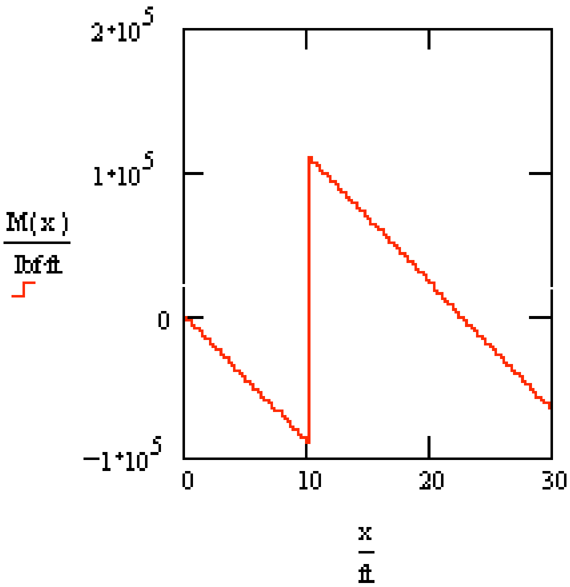


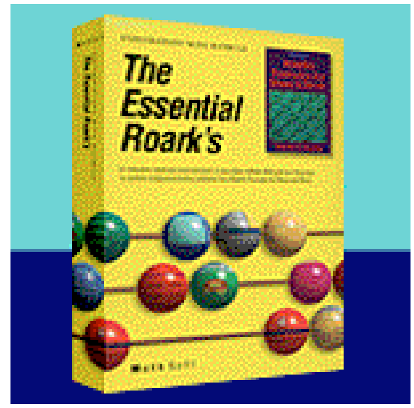
Bending moment:

$$M(x) := M_A + R_A \cdot x + M_0 \cdot (x > a) \qquad M(x_1) = 6.667 \cdot 10^4 \, \mathrm{lbf \cdot ft}$$



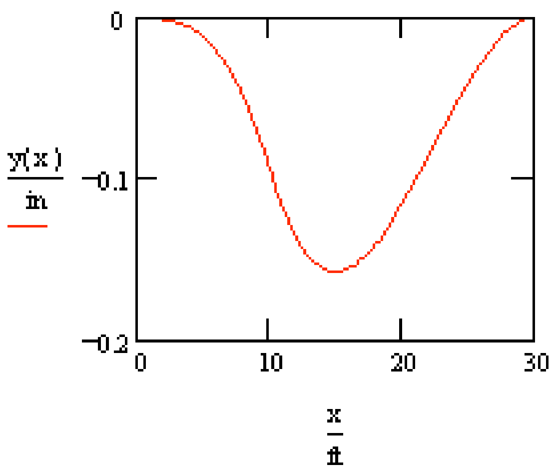
Slope:

$$\theta(x) := \theta_A + \frac{M_A \cdot x}{E \cdot I} + \frac{R_A \cdot x^2}{2 \cdot E \cdot I} + \frac{M_0}{E \cdot I} \cdot (x - a) \cdot (x > a) \qquad \theta(x_1) = 0 \cdot \mathrm{deg}$$



Deflection:

$$y(x) := y_A + \theta_A \cdot x + \frac{M_A \cdot x^2}{2 \cdot E \cdot I} + \frac{R_A \cdot x^3}{6 \cdot E \cdot I} + \frac{M_0}{2 \cdot E \cdot I} \cdot (x - a)^2 \cdot (x > a) \qquad y(x_1) = -0.157 \cdot in$$



Selected maximum values of moments and deformations:

Note: The signs in this section correspond to direction. The subscripts **maxpos/neg** refer to the maximum positive or negative value for the given parameters.

Just right of $x = a$,

$$M_{maxpos} := \frac{M_0}{L^3} \cdot \left(4 \cdot a \cdot L^2 - 9 \cdot a^2 \cdot L + 6 \cdot a^3\right) \qquad M_{maxpos} = 1.111 \cdot 10^5 \cdot lbf\,ft$$

Just left of $x = a$,

$$M_{maxneg} := \frac{M_0}{L^3} \cdot \left(4 \cdot a \cdot L^2 - 9 \cdot a^2 \cdot L + 6 \cdot a^3 - L^3\right) \qquad M_{maxneg} = -8.889 \cdot 10^4 \cdot lbf\,ft$$

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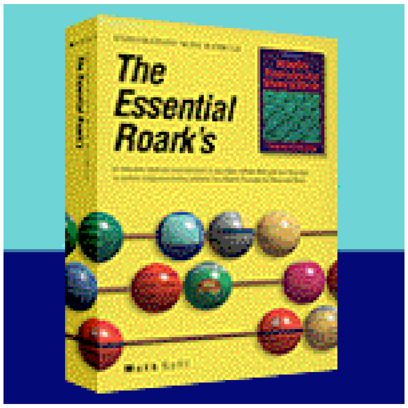

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At x = $\frac{L}{3\cdot a}\cdot(3\cdot a - L) = 0\cdot ft$

with no positive deflection if a < L/3,

$$y_{maxpos} := \frac{2\cdot {M_A}^3}{3\cdot {R_A}^2\cdot E\cdot I} \qquad y_{maxpos} = 0\cdot in$$

Note that if a < L/3, the displayed values of x and ymaxpos will be negative and invalid.

The subscripts **(p/n)maxval** refer to the maximum magnitude of the most positive or negative value for this case.

When a = L,

$$M_{pmaxval} := M_0 \qquad M_{pmaxval} = 2\cdot 10^5\cdot lbf\ ft$$

When a = 0,

$$M_{nmaxval} := -M_0 \qquad M_{nmaxval} = -2\cdot 10^5\cdot lbf\ ft$$

At x = 0.565 L and when a = 0.767 L,

$$y_{pmaxval} := 0.01617\cdot\frac{M_0\cdot L^2}{E\cdot I} \qquad y_{pmaxval} = 0.183\cdot in$$

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