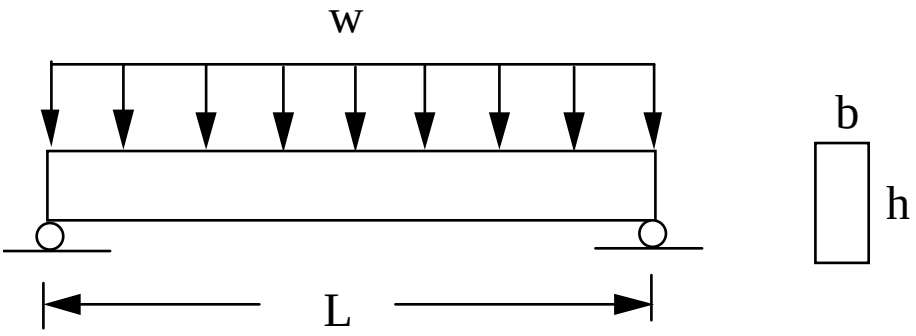
Strain Energy Problems

1. A bar of length L and cross sectional area A is loaded by an axial load P_1. What is the total the strain energy $U(P_1)$ of the bar? The same bar is loaded only by an axial load P_2. What is the total strain energy $U(P_2)$ of the bar? Now the same bar is loaded by both P_1 and P_2. What is the total strain energy $U(P_1 + P_2)$ of the bar? Why is $U(P_1 + P_2) \neq U(P_1) + U(P_2)$? Where did the additional strain energy come from?

2. Consider a simply supported beam of rectangular cross section that carries a uniform load, w lb/length. What is the ratio of the total strain energy due to shear stress in the beam to the strain energy due to the flexural stress?



3. For the beam of problem 2, show that the maximum strain energy density, $(u_0)_{\max}$, in the beam is given by

$$(u_0)_{\max} = \frac{45}{8}\frac{U}{V}$$

where *U* is the total strain energy of the beam and V is its total volume. Consider only the contributions due to the flexure stress.

4. A solid brass sphere ($E = 105\,GPa, \quad \nu = 1/3$) whose radius *r* = 150 mm is loaded by a pressure *p* which reduces its volume by 0.1%. Determine:

(a) the pressure, *p,*
(b) the strain energy *U* stored in the sphere (the volume $V = 4\pi r^3/3$ for a sphere)