3.1. Consider the bar in Fig. P3.1. Cross-sectional area $A_e = 1.2$ in.^{2}, and Young's modulus $E = 30 \times 10^6$ psi. If $q_1 = 0.02$ in., and $q_2 = 0.025$ in., determine (by hand calculation):

(a) The displacement at point P.
(b) The strain ϵ and stress σ.
(c) The element stiffness matrix.
(d) The strain energy in the element.

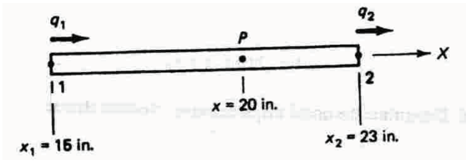
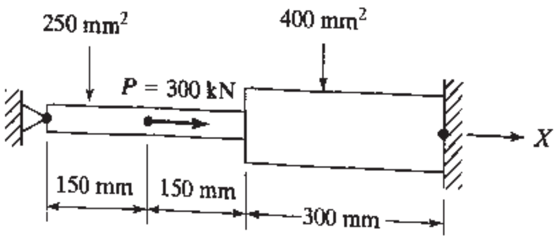


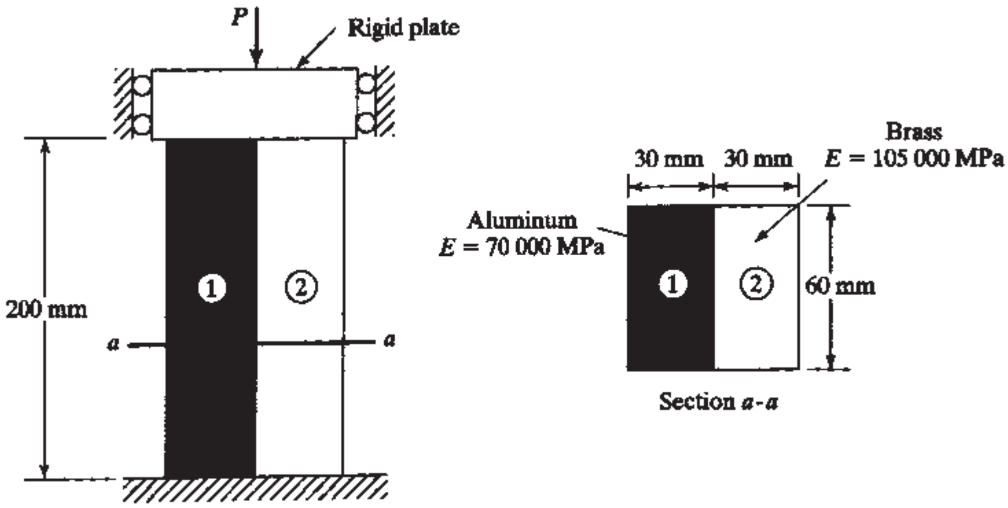
Figure P3.1

3.7. Consider the bar in Fig. 3.7 loaded as shown. Determine the nodal displacements, element stresses, and support reactions. Solve this problem by hand calculation, adopting the elimination method for handling boundary conditions. Verify your results using program FEM1D.

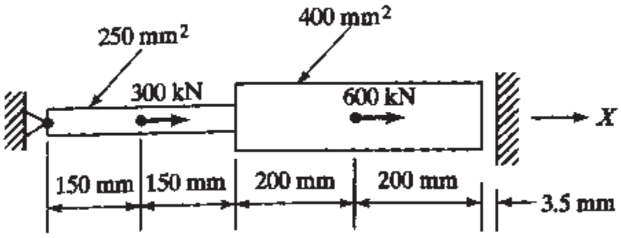


$E = 200 \times 10^9$ N/m^2
(1 kN = 1000 N)

3.9. An axial load $P = 385$ kN is applied to the composite block shown in Fig. P3.9. Determine the stress in each material. (*Hint:* You may name the nodes 1-2 for both the elements.)

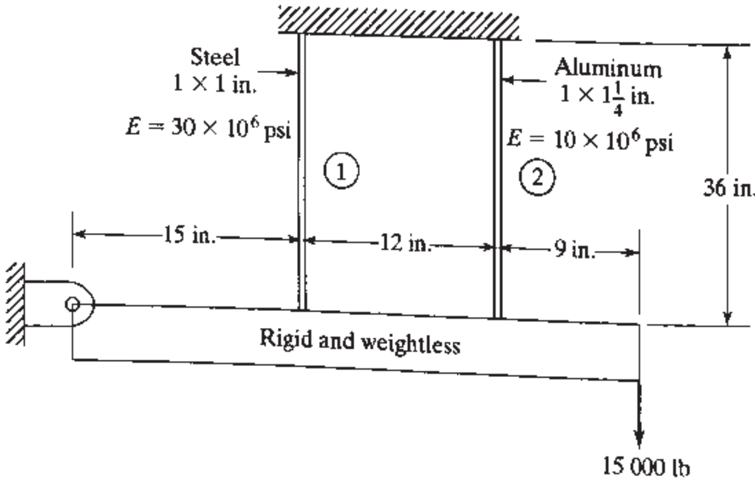


3.10. Consider the bar in Fig. P3.10. Determine the nodal displacements, element stresses, and support reactions.

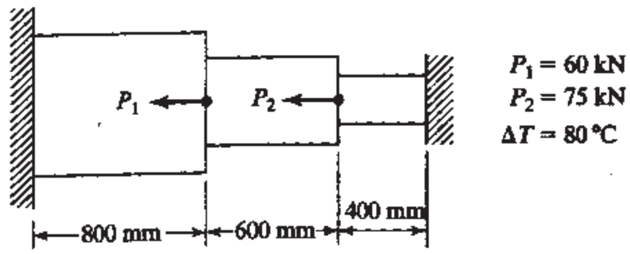


$E = 200 \times 10^9\ \text{N/m}^2$

3.14. The rigid beam in Fig. P3.14 was level before the load was applied. Find the stress in each vertical member. (*Hint:* The boundary condition is of the multipoint constraint type.)



3.23. The structure in Fig. P3.23 is subjected to an increase in temperature, $\Delta T = 80°\text{C}$. Determine the displacements, stresses, and support reactions. Solve this problem by hand calculation, using the elimination method for handling boundary conditions.



	Bronze	Aluminum	Steel
$A =$	2400 mm²	1200 mm²	600 mm²
$E =$	83 GPa	70 GPa	200 GPa
$\alpha =$	$18.9 \times 10^{-6}/°\text{C}$	$23 \times 10^{-6}/°\text{C}$	$11.7 \times 10^{-6}/°\text{C}$

$(1\ \text{GPa} = 10^9\ \text{N/m}^2)$