1. (20 points) In the steel structure shown, a 6-mm-diameter pin is used at C and 10-mm-diameter pins are used at B and D. The ultimate shearing stress is 150 MPa at all connections, and the ultimate normal stress is 400 MPa in link BD. Knowing that a factor of safety of 3 is desired, determine the largest load \( P \) which may be applied at A. Note that link BD is not reinforced around the pin holes.

2. (25 points) A wooden pile is being driven into a hole in the ground as shown in Figure 2 by a force \( F = 100,000 \) lb. A friction force of \( f \) lb/unit length opposes this force. The force intensity \( f \) varies as the square of the distance \( z \) from the top surface, being zero at the top. If the modulus \( E \) of the pile is \( 2 \times 10^6 \) psi, \( L = 30 \) ft, and \( D = 12 \) in., how much has the pile shortened at the given loading conditions?

3. (35 points) The rigid bar CDE is attached to a pin support at E and rests on the 30-mm-diameter brass cylinder BD. A 22-mm-diameter steel rod AC passes through a hole in the bar and is secured by a nut which is snugly fitted when the temperature of the entire assembly is 20°C. The temperature of the brass cylinder is then raised to 50°C while the steel rod remains at 20°C. Assuming that no stresses were present before the temperature change, determine the stress in the cylinder. Steel rod AC, \( \alpha_{st} = 12 \times 10^{-6} / ^\circ C \), \( E_{st} = 200 \) GPa; Brass cylinder BD, \( \alpha_{br} = 18.8 \times 10^{-6} / ^\circ C \) and \( E_{br} = 105 \) GPa.

4. (40 points) An aluminum shaft (3) and a steel sleeve (2) are fixed at the immovable wall A at one end and are welded to a stiff plate B. Another aluminum shaft (1) is welded to both stiff plates B and C. The external loads of 100 kN and 200 kN are applied to the assembly as shown in Figure 4. In addition, the temperature of this assembly is increased uniformly by 20°C. Determine a) the normal stresses in the sleeve and shafts, b) changes in the length of the shafts and sleeve. Steel C, \( \alpha_{st} = 12 \times 10^{-6} / ^\circ C \), \( E_{st} = 200 \) GPa, \( \alpha_{al} = 22 \times 10^{-6} / ^\circ C \) and \( E_{al} = 100 \) GPa.

5. (40 points) In Figure 5 is shown a steel bolt and nut and an aluminum sleeve initially touching with no stress. The bolt has 12 threads/in, and when the material is at 20°F, the nut is tightened one-fourth turn. The temperature is then raised from 20°F to 60°F. Determine the stresses in both bolt and sleeve. Neglect body forces. Steel, \( \alpha_{st} = 6.5 \times 10^{-6} / ^\circ F \), \( E_{st} = 30 \times 10^6 \) psi, \( \alpha_{al} = 12 \times 10^{-6} / ^\circ F \) and \( E_{al} = 10 \times 10^6 \) psi.

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