

6.48 This problem calls for us to specify expressions similar to Equations 6.20a and 6.20b for nodular cast iron and brass. These equations, for a straight line, are of the form

$$TS = C + (E)(HB)$$

where TS is the tensile strength, HB is the Brinell hardness, and C and E are constants, which need to be determined.

One way to solve for C and E is analytically--establishing two equations using TS and HB data points on the plot, as

$$\begin{aligned}(TS)_1 &= C + (E)(BH)_1 \\ (TS)_2 &= C + (E)(BH)_2\end{aligned}$$

Solving for E from these two expressions yields

$$E = \frac{(TS)_1 - (TS)_2}{(HB)_2 - (HB)_1}$$

For nodular cast iron, if we make the arbitrary choice of $(HB)_1$ and $(HB)_2$ as 200 and 300, respectively, then, from Figure 6.19, $(TS)_1$ and $(TS)_2$ take on values of 600 MPa (87,000 psi) and 1100 MPa (160,000 psi), respectively. Substituting these values into the above expression and solving for E gives

$$E = \frac{600 \text{ MPa} - 1100 \text{ MPa}}{200 \text{ HB} - 300 \text{ HB}} = 5.0 \text{ MPa/HB} \quad (730 \text{ psi/HB})$$

Now, solving for C yields

$$\begin{aligned}C &= (TS)_1 - (E)(BH)_1 \\ &= 600 \text{ MPa} - (5.0 \text{ MPa/HB})(200 \text{ HB}) = -400 \text{ MPa} \quad (-59,000 \text{ psi})\end{aligned}$$

Thus, for nodular cast iron, these two equations take the form

$$\begin{aligned}TS(\text{MPa}) &= -400 + 5.0 \times \text{HB} \\ TS(\text{psi}) &= -59,000 + 730 \times \text{HB}\end{aligned}$$

Now for brass, we take $(HB)_1$ and $(HB)_2$ as 100 and 200, respectively, then, from Figure 7.31, $(TS)_1$ and $(TS)_2$ take on values of 370 MPa (54,000 psi) and 660 MPa (95,000 psi), respectively. Substituting these values into the above expression and solving for E gives

$$E = \frac{370 \text{ MPa} - 660 \text{ MPa}}{100 \text{ HB} - 200 \text{ HB}} = 2.9 \text{ MPa/HB} \quad (410 \text{ psi/HB})$$

Now, solving for C yields

$$\begin{aligned} C &= (TS)_1 - (E)(BH)_1 \\ &= 370 \text{ MPa} - (2.9 \text{ MPa/HB})(100 \text{ HB}) = 80 \text{ MPa} \quad (13,000 \text{ psi}) \end{aligned}$$

Thus, for brass these two equations take the form

$$\begin{aligned} TS(\text{MPa}) &= 80 + 2.9 \times \text{HB} \\ TS(\text{psi}) &= 13,000 + 410 \times \text{HB} \end{aligned}$$