2-3  Conversion of \( \text{kN/m}^3 \) to \( \text{kg/ m}^3 \) multiply by \( 1(10^3) / 9.81 = 102 \)
AISI 1018 CD steel: Tables A-20 and A-5
\[
\frac{S_y}{\rho} = \frac{370(10^3)}{76.5(102)} = 47.4 \text{ kN·m/kg} \quad \text{Ans.}
\]
\[
\frac{S_y}{\rho} = \frac{169(10^3)}{26.6(102)} = 62.3 \text{ kN·m/kg} \quad \text{Ans.}
\]
Ti-6Al-4V titanium: Tables A-24c and A-5
\[
\frac{S_y}{\rho} = \frac{830(10^3)}{43.4(102)} = 187 \text{ kN·m/kg} \quad \text{Ans.}
\]
ASTM No. 40 cast iron: Tables A-24a and A-5.Does not have a yield strength. Using the ultimate strength in tension
\[
\frac{S_u}{\rho} = \frac{42.5(6.89)(10^3)}{70.6(102)} = 40.7 \text{ kN·m/kg} \quad \text{Ans}
\]

2-8  Tangent modulus at \( \sigma = 0 \) is
\[
E = \frac{\Delta \sigma}{\Delta \epsilon} \approx \frac{5000 - 0}{0.2(10^{-3}) - 0} = 25(10^6) \text{ psi} \quad \text{Ans.}
\]
At \( \sigma = 20 \text{ kpsi} \)

\[
E_{20} = \frac{(26 - 19)(10^3)}{(1.5 - 1)(10^{-3})} = 14.0(10^6) \text{ psi} \quad \text{Ans.}
\]
2-15 For the data given, converting $H_B$ to $S_u$ using Eq. (2-21)

<table>
<thead>
<tr>
<th>$H_B$</th>
<th>$S_u$ (kpsi)</th>
<th>$S_u^2$ (kpsi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>230</td>
<td>115</td>
<td>13225</td>
</tr>
<tr>
<td>232</td>
<td>116</td>
<td>13456</td>
</tr>
<tr>
<td>232</td>
<td>116</td>
<td>13456</td>
</tr>
<tr>
<td>234</td>
<td>117</td>
<td>13689</td>
</tr>
<tr>
<td>235</td>
<td>117.5</td>
<td>13806.25</td>
</tr>
<tr>
<td>235</td>
<td>117.5</td>
<td>13806.25</td>
</tr>
<tr>
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<td>13806.25</td>
</tr>
<tr>
<td>236</td>
<td>118</td>
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<td>236</td>
<td>118</td>
<td>13924</td>
</tr>
<tr>
<td>239</td>
<td>119.5</td>
<td>14280.25</td>
</tr>
</tbody>
</table>

$\Sigma S_u = 1172$  $\Sigma S_u^2 = 137373$

$$\bar{S}_u = \frac{\Sigma S_u}{N} = \frac{1172}{10} = 117.2 \text{ kpsi} \quad \text{Ans.}$$

Eq. (20-8),

$$s_u = \sqrt{\frac{\sum_{i=1}^{10} S_u^2 - N S_u^2}{N-1}} = \sqrt{\frac{137373 - 10(117.2)^2}{9}} = 1.27 \text{ kpsi} \quad \text{Ans.}$$

2-18, 2-19 These problems are for student research. No standard solutions are provided.
For strength, \( \sigma = F/A = S \Rightarrow A = F/S \)

For mass, \( m = A l \rho = (F/S) l \rho \)

Thus, \( f_3(M) = \rho/S \), and maximize \( S/\rho \) \( (\beta = 1) \)

In Fig. (2-19), draw lines parallel to \( S/\rho \)

From the list of materials given, both aluminum alloy and high carbon heat treated steel are good candidates, having greater potential than tungsten carbide or polycarbonate. The higher strength aluminum alloys have a slightly greater potential. Other factors, such as cost or availability, may dictate which to choose. \( \text{Ans.} \)

For strength, \( \sigma = F/A = S \Rightarrow A = F/S \)

For mass, \( m = A l \rho = (F/S) l \rho \)

So, \( f_3(M) = \rho/S \), and maximize \( S/\rho \). Thus, \( \beta = 1 \). \( \text{Ans.} \)