Hydraulic Press tonnage calculation

How to compute tonnage requirement:

1. **General** - When pressure per square inch is known:
   \[ \text{psi} \times \text{area of work}/2000 = 2 \text{ tons of ram force required} \]
   Example: Where it is known that 100 psi is needed to do a job on a 5" x 8" wide piece.
   \[ 100 \times 5'' \times 8''/2000 = 2 \text{ tons} \]

2. **Press Fit** - To determine the force required to press fit two round pieces together such as a shaft pressed into a bushing, use the following formula:
   \[ F = D \times \pi \times L \times I \times P/2 \]
   Where:
   - \( F \) = force required in tons
   - \( D \) = diameter of the part to be pressed in inches
   - \( L \) = length of part to be pressed in inches (Note: the length of the interference fit only.)
   - \( I \) = interference in inches (usually .002" to .006")
   - \( P \) = pressure factor (See table below).

<table>
<thead>
<tr>
<th>Diameter (inches)</th>
<th>Pressure Factor</th>
<th>Diameter (inches)</th>
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<th>Diameter (inches)</th>
<th>Pressure Factor</th>
<th>Diameter (inches)</th>
<th>Pressure Factor</th>
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</thead>
<tbody>
<tr>
<td>1</td>
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<td>3</td>
<td>156</td>
<td>5</td>
<td>91</td>
<td>7</td>
<td>64</td>
</tr>
<tr>
<td>1¼</td>
<td>395</td>
<td>3¼</td>
<td>143</td>
<td>5¼</td>
<td>86</td>
<td>7¼</td>
<td>61</td>
</tr>
<tr>
<td>1½</td>
<td>325</td>
<td>3½</td>
<td>132</td>
<td>5½</td>
<td>82</td>
<td>7½</td>
<td>59</td>
</tr>
<tr>
<td>1¾</td>
<td>276</td>
<td>3¾</td>
<td>123</td>
<td>5¾</td>
<td>78</td>
<td>7¾</td>
<td>57</td>
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<tr>
<td>2</td>
<td>240</td>
<td>4</td>
<td>115</td>
<td>6</td>
<td>75</td>
<td>8</td>
<td>55</td>
</tr>
<tr>
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<td>212</td>
<td>4¼</td>
<td>108</td>
<td>6¼</td>
<td>72</td>
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<tr>
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<td>4½</td>
<td>101</td>
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</tr>
<tr>
<td>2¾</td>
<td>171</td>
<td>4¾</td>
<td>96</td>
<td>6¼</td>
<td>66</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Example: A steel shaft 2" in diameter pressed into a hole 3" long. The interference fit between the two diameters is .006".
\[ 2'' \times 3.14 \times 3'' \times .006'' \times (240/2) = 13.56 \text{ tons} \]
3. **Punching** - A quick guide to determine tonnage requirements for punching steel is:

Diameter x thickness x 80 = tons (where 80 is constant for steel. Use 65 for brass.)

Example: A 3" hole in .250" stock: 3" x .250" x 80 = 60 tons

For noncircular holes, instead of the diameter, use 1/3 of the total length of cut.

Example: A rectangular hole 4" x 6" in .250" stock: (4" + 6" + 4" + 6"/3) x .250" x 80 = 133.3 tons

4. **Deep Drawing** - Deep-drawing calculations can be complex. The press, dies, material, radius, and part shape all have bearing. For drawing round shells, the following formula is a simple guide:

C x T x Ts = tons

Where:

C = circumference of the finished part; T = material thickness in inches; and

Ts = tensile strength of the material.

Example: To draw a 5" diameter cup of .040" stock with a tensile strength of 46,000 psi would require the following tonnage:

\[(5 \times 3.1416) \times .040 \times (46000/2000) = 14.44 \text{ tons}\]

A 20-ton press would be recommended

5. **Straightening** - The pressure required to straighten a piece of metal depends on its shape. Below is an approximate formula with a further definition for different shapes.

\[F = \frac{6UL}{2000Z}\]

Where F is the ram force in tons; 6 is a constant; U is ultimate strength of the material in psi; Z is the section modulus (see below); and L is the distance between the straightening blocks in inches.

\[Z = \frac{\pi a^3}{32} \text{ for round stock solid}\]

\[Z = \frac{a^4}{6} \text{ for solid square stock}\]

\[Z = \frac{(D^4 - d^4)}{32D} \text{ for round hollow}\]

\[Z = \frac{bd^2}{6} \text{ for rectangular stock}\]

Example: A 2" diameter shaft, 18" between the blocks, 100,000 psi ultimate strength.

\[
\frac{6 \times 100,000 \times 3.14 \times 2 \times 2 \times 2}{2000 \times 18 \times 32} = 13.1 \text{ TONS}
\]

**How to determine strokes per minute for a hydraulic press**

The number of strokes per minute for a hydraulic press is determined by calculating a separate time for each phase of the ram stroke. The rapid advance time is calculated, then the pressing time, (the work stroke); then, if there is no dwell time, the rapid return.

The basic formula for determining the length of time in seconds for each phase of the stroke:
\[
\frac{D \times 60}{\text{IPM}} = T
\]

Example: a hydraulic press with a 600 IPM rapid advance, 60 IPM pressing speed, and 600 IPM rapid return. The work requires a 3” advance, 1” work stroke, and 4” rapid return.

\[
\begin{align*}
\text{Rapid close } 3” \times 60 & = 600 \text{ IPM} = .300 \\
\text{Press } 1” \times 60 & = 60 \text{ IPM} = 1.000 \\
\text{Rapid return } 4” \times 60 & = 600 \text{ IPM} = .399 \\
\text{Allowance for valve shift time} & = \frac{.500^*}{2.199} \\
\end{align*}
\]

\[
60 \div 2.199 = 27 \text{ cycles per minute.}
\]

* Electrical actuation and valve shift time varies depending on the type of hydraulic circuit. One half second is a reasonable average figure.
1. These formulae are intended as guidelines only. Please consult a qualified manufacturing engineer for recommendations concerning your specific requirements.
2. Based on steel shaft and cast iron bushing (with OD/ID > 2).

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