### Calculation of cutting forces, boring (simplified)

#### Example calculation:

**Boring tool** ø 80 mm;  
**Z = 5;** pre-drilled ø 72 mm **κ = 90°**  
**Material:** EN-GJL-250  
**k_c1.1* = 1160**  
**m_c = 0.26**  
**v_c 200 m/min**  
**f_z = 0.2 mm**  
**Blunting 30%**

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<th>Basic formula</th>
<th>Calculation</th>
<th>Result</th>
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<tr>
<td>1. Spindle speed</td>
<td>( n = \frac{V_c \cdot 1000}{\pi \cdot D} )</td>
<td>( n = \frac{200 \cdot 1000}{\pi \cdot 80} )</td>
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<tr>
<td>2. Cutting depth</td>
<td>( a_p = \frac{(D - d)}{2} )</td>
<td>( a_p = \frac{(80 - 72)}{2} )</td>
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<tr>
<td>3. Cutting cross section</td>
<td>( A = a_p \cdot f \cdot z )</td>
<td>( A = 4 \text{ mm} \cdot 0.2 \text{ mm} \cdot 5 )</td>
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<tr>
<td>4. Chipping thickness</td>
<td>( h = f_z \cdot \sin \kappa )</td>
<td>( h = 0.2 \text{ mm} \cdot \sin 90° )</td>
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</table>
| 5. Specific cutting force | \( k_c = \frac{k_c1.1}{h \cdot m_c} \) | \( k_c = \frac{1160}{0.2 \cdot 0.26} \) | \( k_c = 1763 \text{ N/mm}^2 \)  

with 30% blunting:  
1763 N/mm² × 1.3 = 2292 N/mm²

| 6. Cutting force | \( F_c = A \cdot k_c = b \cdot h \cdot k_c \) | \( F_c = 4 \text{ mm}^2 \cdot 2292 \text{ N/mm}^2 \) | \( F_c = 9.17 \text{ kN} \) |
| 7. Cutting torque | \( M_c = \frac{F_c \cdot d_m}{2} \) | \( M_c = \frac{9167.3 \text{ N} \cdot 0.076 \text{ m}}{2} \) | \( M_c = 348.3 \text{ Nm} \) |
| 8. Cutting power | \( P_c = \frac{2 \cdot \pi \cdot n \cdot M_c}{60s} \) | \( P_c = \frac{2 \cdot \pi \cdot 800 \text{ min}^{-1} \cdot 348.3 \text{ Nm}}{60s} \) | \( P_c = 29.2 \text{ kW} \) |

* Value for cutting force calculation, WTO GmbH  
Note: The efficiency of the main spindle drive is not taken into account.  
Appropriate power calculations can be made by MAPAL.
Machine tool selection:

Comparison with torque and output power of the machine tool

There follow two spindle speed/power diagrams. The number of teeth and cutting parameters are to be defined as a function of the machine.

In the example calculation the machine with the motor spindle is unsuitable, as here at a spindle speed of 800 1/min a torque of 187 Nm and a power of approx. 20 kW is achieved (Figure 1).

Solution:
Either reduce number of teeth, reduce cutting speed and feed, divide cut between two tools or select more powerful machine (e.g. with geared spindle, (Figure 2).

The example diagrams are shown in a simplified form.