**Technical Data**

**Strength of Bolts, Screw Plugs, and Dowel Pins**

- **Bolt Strength**
  1. When bolts are subjected to tensile load:
     \[ P_t = \sigma b \times A_s \]  
     \[ \sigma = \frac{P_t}{b \times A_s} \]
  2. When bolts are subjected to shear load:
     \[ P_s = \tau \times A_s \]  
     \[ \tau = \frac{P_s}{A_s} \]

Examine: Find a suitable size for a single hexagon socket head cap screw that will be subjected to repeated (pulsating) tensile loads of \( P = 200 \text{ kgf} \). (Hexagon socket head cap screw material: 4137, 38~43 HRC, strength class 12.9)

From formula (1):
\[ A_s = \frac{P}{\sigma b} = \frac{200}{800} \times \frac{3}{4} = 0.75 \text{ mm}^2 \]

- **Dowel Pin Strength**
  - **Unwound safety factor \( \alpha \)** based on tensile strength
  \[ \alpha = \frac{P_t}{b \times A_s} \]

- **Screw Plug Strength**
  Find the maximum allowable load \( P \) when a MSW30 screw plug is subjected to impact load. (MSW30 material: 1045, tensile strength \( \sigma = 34 ~ 43 \text{ HRC 65} \text{ kgf/mm}^2 \))

Examine: When a MSW10 with a M8 thread section. When the bolt is subjected to shear load, also find maximum shear load \( P \). (Bolt material: D2, 43 HRC, strength class 12.9)

- **Volume Calculation**
  - **Cubical Volume**
    \[ V = L^3 \]
  - **Cylindrical Volumes**
    \[ V = \pi r^2 h \]
  - **Spherical Volume**
    \[ V = \frac{4}{3} \pi r^3 \]

- **Physical Properties of Metal Materials**
  - **Density**
    \[ \rho = \frac{m}{V} \]
  - **Coefficient of Thermal Expansion**
    \[ \alpha = \frac{1}{\rho} \cdot \frac{d \rho}{dT} \]

The information provided here is only an example of calculating the strength. For actual selections, it is necessary to consider the hole pitch accuracy, hole roundness, screw plug surface condition, thread material, material hardness, use of hardening, accuracy of the press machine, product product volume, tool wear, and various other conditions. Therefore the strength calculation value should be used only as a guide. (It is not a guaranteed value.)