THE BEARING CAPACITIES OF WOODEN ROOF BOLTS

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In Kuzbass collieries, wooden roof bolts are used to support mine workings driven in hard or average-strength coal, to give an ultimate resistance of 80 kg/cm² or more, or in rock roads where they provide an ultimate resistance of more than 300 kg/cm². When the bolt is inserted, its fins do not dig into the walls of the hole, but it is locked in the hole by friction between the bolt and the hole walls. The normal pressure N on the walls of the hole results from forces which are set up as the wood is compressed in the locking part of the bolt.

Diagrams to calculate the installed strength of a wooden roof bolt lock in a hole are shown in Figs. 1, a-g. The installation strength of the roof bolt and the hole is found by the equation

\[ P = (F_1 + F_2) = F = 2fN = f_N S, \]

where \( P \) is the installation strength of the wooden roof bolt in the hole in kg, \( F_1 = F_2 = F/2 \), where \( F \) is the friction at the bolt and hole interface in kg, \( S \) is the area of contact between the bolt and the hole walls in \( \text{mm}^2 \), \( N \) is the normal bolt pressure on the hole walls in kg, and \( a_h \) is the stress in the wood when compressed across the grain in kg/mm².

It follows from Eq. (1) that to find the installation strength of a wooden roof bolt in a hole we must know \( f \), the friction of the wooden bolt against the hole walls, and the normal pressure exerted by the bolt on the hole walls as a function of the wedge dimensions and diameters of the bolt and the hole for various types of timber used to make wooden roof bolting, taking the moisture content of the timber into account.

The friction of wood against various types of rock was found in the laboratory, with wood moisture contents of 4.1-42.9%. Figure 2 gives average data on the friction between various types of wood and rock, taking account of the moisture of the timber in the bolt, for conditions typical of the Kuzbass. It will be seen that as the timber moisture increases, the friction between the surface rises sharply at first and then remains virtually constant.

To find the normal pressure of the bolt on the hole walls, taking timber moisture content into account, we plotted compressive stress for various types of wood versus their relative compression. In the plastic deformation range, the stress in compression is virtually a linear function of relative compression. It is under such conditions that the bolt functions.

The laboratory results were processed by statistical methods to derive the following equations between \( \sigma_h \) and relative compression \( \epsilon \), taking account of wood moisture content for the various types of wood:

\[
\begin{align*}
\text{Birch} & : \sigma_h = \frac{1}{18W + 0.82} + \frac{W_s}{1.12W - 0.39}; \\
\text{Larch} & : \sigma_h = \frac{1}{22.3W + 0.5} + \frac{W_s}{2.35W - 0.1}; \\
\text{Pine} & : \sigma_h = \frac{1}{13W + 1.13} + \frac{W_s}{2.2W - 0.08}; \\
\text{Cedar} & : \sigma_h = \frac{1}{11.7W + 2.45} + \frac{W_s}{3.5W - 0.13}; \\
\text{Spruce} & : \sigma_h = \frac{1}{10W + 2.5} + \frac{W_s}{2.3W - 0.06}; \\
\text{Fir} & : \sigma_h = \frac{1}{12.6W + 2.2} + \frac{W_s}{3.38W - 0.12};
\end{align*}
\]

where \( W \) is the timber moisture in dimensionless units.

Fig. 1. Schemes for calculating installation strength of a wooden bolt lock: a) principle of operation of bolt lock; b) scheme for calculating the initial volume of bolt lock; c) determination of the generatrix of the contact between bolt lock and hole; d) determination of contact surface between lock and hole; e, f, and g) schemes for determining the compressed volume of the bolt lock from the wedge dimensions.