Schmidt hammer

The Schmidt or Swiss hammer was primarily developed for the rapid determination of concrete strength. Soon its application began for defining rock parameters. The device is very inexpensive, its use is extremely simple both in the field and in the laboratory. By releasing a tensioned spring, a piston strikes the surface of the rock being tested. As a consequence of the impact, the piston rebounds from the rock and that rebound value is the Schmidt number. In stronger rocks the rebound is greater. Thanks to that fact, correlations between the Schmidt number and uniaxial compressive strength, but also some other parameters, were experimentally established. A large number of researchers dealt with this, which resulted in a large number of formulas for different types of rocks.

And what actually happens during the process of testing rock with the Schmidt hammer will be explained using a simple model with three rock particles. The model is two-dimensional, the particles are not deformable and have a circular shape, Figure 1. When the piston (K) strikes the particle (A) it communicates to it a corresponding quantity of energy (Eu), that is, a corresponding deformation work is performed. The particle (A) moves in the direction of the impact force and in doing so separates the particles (B) and (C). The particle (A) slides by its contact surfaces over the particles (B) and (C). A part of the deformation work is converted into potential energy, that is, tensile stress between the particles (B) and (C), while a part is consumed in overcoming the friction resistance between the particles in contact. Therefore the tensile stress or the potential energy of elastic deformation (Ep) will be:

$$E_p = E_u \cdot I_e$$

Where:

Ie – index of elasticity or index of recoverability of the introduced energy.

After the completion of the energy transfer the piston (K) remains at the attained position. Thanks to the tensile stress between them, the particles (B) and (C) move toward the initial position and in doing so also push the particle (A) toward the initial position. The potential energy of elastic deformation is converted into the kinetic energy of particle (A), which communicates it to the piston (K), which is thrown back to the corresponding position. In doing so

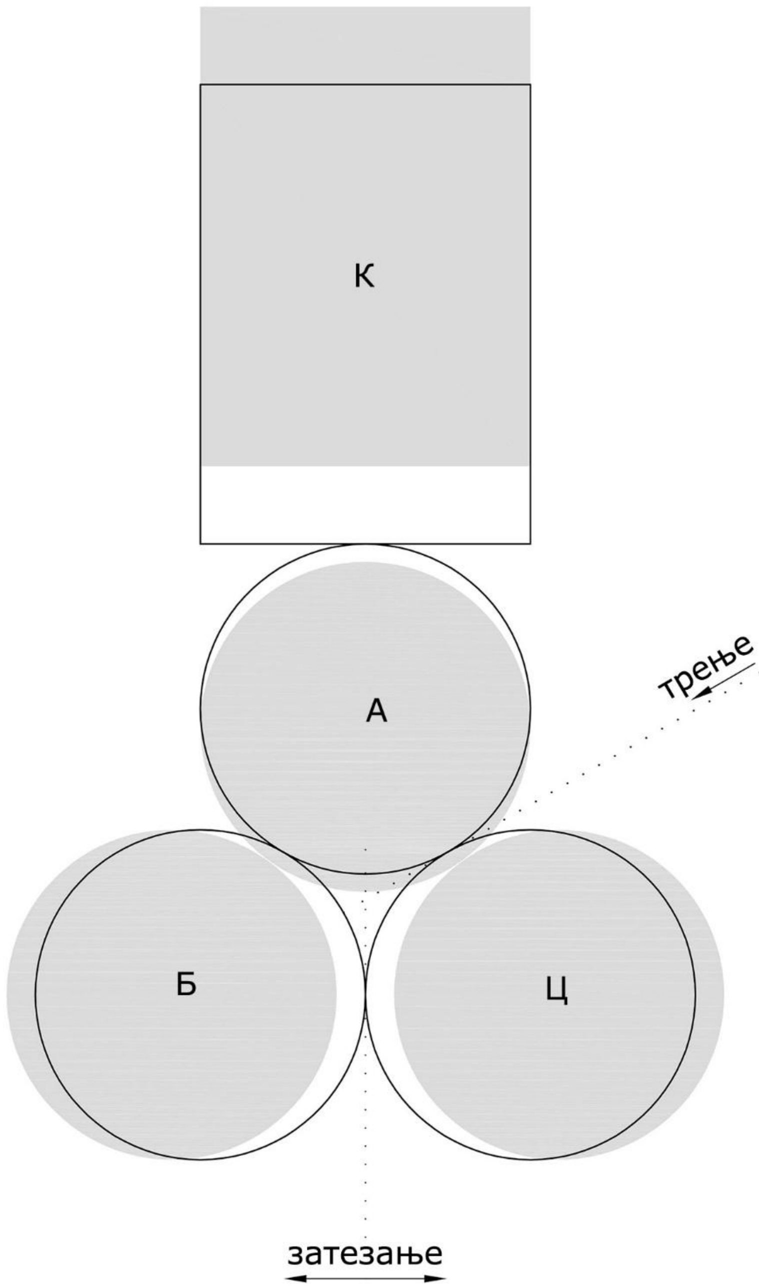

Figure 1 Determination of the elasticity index.

only part of the energy is returned to the piston while part is consumed in overcoming the friction between the particles in contact. Therefore the energy communicated to the piston will be:

$$E_k = E_p \cdot I_e$$

$$E_k = E_u \cdot I_e \cdot I_e$$

$$E_k = E_u \cdot I_e^2$$

The hammer is calibrated so that if there were no friction the return of energy would be 100%, that is, the Schmidt number would be 100. For steel it is around 80, and that means that for one stress change the index of elasticity or the index of recoverability of deformation for steel is:

$$I_e = \sqrt{\frac{80}{100}} = 0.89$$

That is:

$$I_e = \sqrt{\frac{SHRN}{100}}$$

Where:

SHRN – rebound of the hammer piston, Schmidt number.