noticed that they could do such a search independently, without the need for a teacher. However, in the process, such comments disappeared, as students received answers to questions that could not be found on the Internet sources. Also, sometimes there were situations when students found obsolete, distorted or false information.

Conducted at the end of the semester, test has shown that students who took an active part in finding information, formed their own notes on the results of the search during interactive lectures, gave more correct answers to the questions and accordingly received a higher score. Hence, the quality of their knowledge turned out to be higher than that of students for whom traditional lectures were read. In addition, such students have better fulfilled the tasks of practical and laboratory work.

The best results of their work, according to our observations, are due to the fact that students used already prepared theoretical materials, without having to spend time searching for them, or more likely to find relevant information. This allows us to conclude that, in modern terms, interactive lectures, in the described sense, are effective pedagogical methods.

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EVALUATION OF THE DURABILITY OF HARD-FACED LAYERS WELDED ON THE CONICAL PICKS ON THE BASIS OF LABORATORY TESTS

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The measurement of the wear rate of tangential-rotary picks (also known as conical picks) is aimed at determining their durability. The measurements have to be made under identical conditions to make sure that the results are reliable, reproducible, and probabilistic. This will allow for the evaluation of the durability of the pick as well as the comparison of different picks. In industrial conditions, the durability of cutting picks is usually defined as a ratio of the number of replaced picks to the volume of extracted material. Most frequently, it is the number of worn picks necessary to obtain 1000 Mg or m^3 of extracted material. However, under

laboratory conditions, the wear rate (durability) of the pick (or picks) is most-effectively determined on the basis of the loss in its (their) weight in relation to the volume of rock specimen extracted with this pick (these picks).

The tests were conducted for four types of conical picks with the same structural parameters and made of different grades of alloy steels and with the different surfaces of the operational part protected with hard materials. The tests were carried out for two sets of standard picks and two sets of picks which had been hardfaced with different electrodes to improve their durability. The length of the operational part of all picks was 90 mm, the edge angle was $2\beta u = 90°$ and they were equipped with sintered carbide insert $\phi 22$.

The tests were performed on the following picks:

- standard picks, commercially available made of S235 steel and heat treated with hardness of the operational part 45 HRC - 4 picks - marked as Commercial S235 (Fig. 1a),
- picks hardfaced using EP-TB-1-6 electrode with hardness ± 50 HRC - 4 picks (the Commercial S235 picks were used for hardfacing) - marked as Hardfaced S235 (Fig. 1b),
- standard picks, commercially available made of 35HGS steel and heat treated with hardness of the operational part 48 HRC - 4 picks - marked as Commercial 35HGS (Fig. 1c),
- picks hardfaced using EP-TB-2-46 electrode with hardness ± 60 HRC - 4 picks (the Commercial 35HGS picks were used for hardfacing) - marked as Hardfaced 35HGS (Fig. 1b),

It is easy to see that the commercial and hardfaced picks were used for the tests, were made of steel grades S235 and 35HGS. In either case the electrodes, which were used to hardfacing, were supplied by the Ivano-Frankivsk National Technical University of Oil and Gas from Ukraine.

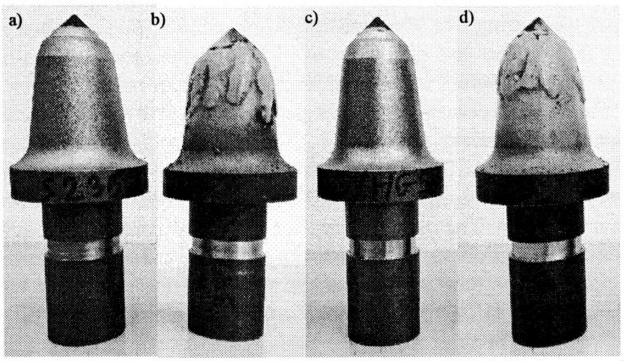

Fig. 1. Selected picks intended for testing: a - Commercial S235, b - Hardfaced S235, c – Commercial 35HGS, d – Hardfaced 35HGS

Tests were performed on a laboratory test stand to research the cutting process or rotation drilling with the use of a single cutting tool or cutting drum, the property of the Department of Mining, Dressing, and Transport Machines of the AGH UST in Krakow (Fig. 2). This is used to perform comprehensive laboratory tests related to the widely-understood rock-cutting process. This particular test stand allows us to perform the cutting process with a particular cutting head on an artificial or natural rock sample under laboratory conditions.

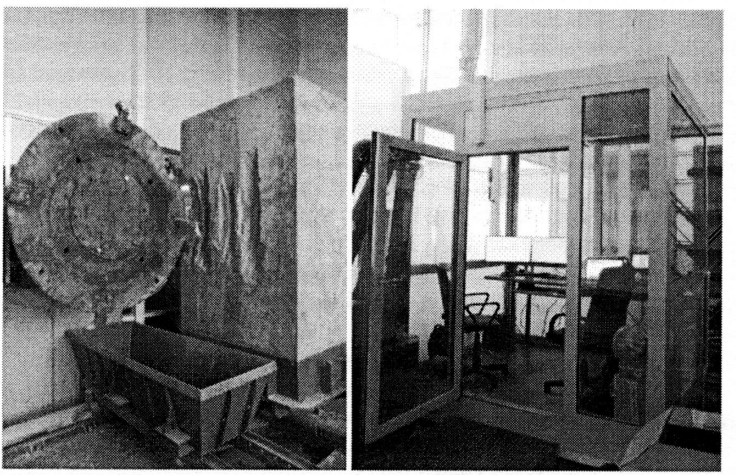

Fig. 2. Laboratory test stand to research cutting process or rotation drilling with use of single cutting tool or cutting head

To assess the durability of the picks provided for the tests, the wear rate defined as the total loss in weight of the picks in relation to the volume of the extracted material during the cutting test of an artificial rock sample. The assumed definition of the parameter that defines the durability of picks and the requirements pertaining to testing their wear rate resulted in the approval of the proper research plan.

During the tests, a cement-sand sample consisting of cement, sand and basalt aggregate, with an invariant mass γ_w = 2.3 Mg/m^3 and a uniaxial compression strength USC = 30 - 35 MPa. Due to the high strength and abrasiveness of the sample, the advance speed v_p was set at 0.05 m/min and the number of revolutions of the test drum n = 42 rpm. The outside diameter of the test drum ϕ1863 mm.

After the milling process, the picks were photographed and their weight was measured. Following the measurement of the weight of the picks, the volume of the cut material extracted with these picks V_u was calculated. The volume V_u is a calculated value and is determined on the basis of the measured web cut, diameter of the cutting head and length of the cut. After this, it was possible to determine the factor characterizing the wear rate of the tested picks C2. The tests of all types of picks were performed in accordance with the approved methodology and research

plan. The following should be noted: the lower the value of the C2 parameter, the lower the wear rate of the pick.

The conducted tests of the wear rate of conical picks showed that the type of protective layer on the operational part of the pick, the steel grade applied to the picks' bodies and the pick position on the test drum, have a significant influence on their durability. A further search for the protective layers of the operational part of the pick is required to determine the best and the cheapest protective layers to increase their durability, especially in hard and/or abrasive rocks.

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NUMERICAL CRASH TESTS OF MODERNIZED HEAD STRUCTURE OF THE ED72 ELECTRICAL TRAIN UNIT ACCORDING TO THE EN 15227 STANDARD

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The aim of the project was the modernization of the head structure of the ED72 train unit including static (EN 12663 standard), crash (EN 15227 standard) and fatigue strength (DVS 1612 standard) requirements. The ED72 is an electrical train unit consisting of four wagons (two steering and two motor) [1, 2].

The work presents numerical crash calculations of the modernized head structure of the ED72based on EN 15227 standard. The focus was on collision