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Hard Rock Cutting with Roadheaders the Icutroc Approach

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Abstract:

The introduction of Roadheaders with low cutting speed opened a whole new range of applications. First, this low cutting speed was achieved with a specially designed switch gear and later, by a newly designed low speed cutter gear. This new low speed cutter gear resulted in a 1.4 m/s cutting speed, instead of the former common speed of around 3 m/s while still maintaining use of the fully installed cutter head power. Therefore, different to the previous solutions of using pole changing motors, no drop of performance had to be accepted if hard and abrasive rock formations demanded pick-saving measures. The available torque was even increased, which also increased the forces available on the picks. First applications in comparably soft, but highly abrasive rock showed encouraging results with increased performance and highly reduced pick consumption. However, theoretically expected results in actual hard rock could not be achieved without essential alterations of the entire machine system, which would allow full utilization of these higher forces. For this task the EU-funded research and development project called ICUTROC was initiated.

The aim of this project was, to analyze the individual components of a Roadheader with regard to their contribution to the machine capability of hard rock cutting. Integrating a machine and pick manufacturer, universities, research institutions as well as end users from the mining and construction industry not only gave the ICUTROC-team a solid theoretically based, but also a practical oriented back ground for setting the demands to be covered by a "hard rock"-Roadheader. The individual steps covered the development of new pick qualities, new pick cooling systems and cutter heads with improved tool lacing. Furthermore, to withstand the higher reactive forces, both the stiffness and the structural strength of the machines most stressed components had to be increased. All these individual steps have been backed up by theoretical design investigations, cutting tests on a test rig and most important by field tests under actual field environment.

First tests with the new picks and the new cooling system showed a reduction of pick wear by more than 60 %. Following field trials in a test mine confirmed these early results. Cutting porphyroide with a compressive strength ranging between 90 and 200 MPa, the pick consumption could be lowered by 75 % and the cutting rate increased by 25 to 75 %. Since that time, Roadheaders of the ICUTROC-generation have excavated motorway tunnels in Italy and Greece (both in limestone), worked on the extension of an underground powerhouse in Italy (in gneiss), drove roadways in a number of German coal mines (there predominantly in sandstone formations), excavated the Kimberlite ore in a Russian Diamond mine and are used for mine development in the Skaliistiy mine of the Norilsk Nickel group in northern Russia. All these applications were previously beyond the limits for standard Roadheader technology.

Keywords: ICUTROC; Erzberg trial; Roadheader for application in hard rock; rock-tool interaction; low speed cutting; targets of the project; pick development; pick cooling; new cutter heads; the “stiff” roadheader; tuning of the entire machine system; field tests; American College Tunnel, Athens, Greece; Premadio Power Station, Italy; Luisenthal Colliery, Germany; Skaliistiy Mine, CIS; qualification of rock mass influence; ICUTROC principles in soft rock.