EAN '97

35th International Conference on
Experimental Stress Analysis
June 4 - 6, 1997, Olomouc, Czech Republic

EFFECT OF TECHNOLOGY OF ROCK SAMPLES CUTTING ON SAMPLES STRENGTH PROPERTIES

Konečný P., Sitek L.

The rock samples of the sandstone was prepared by the two technologies. By the new technology of high velocity abrasive water jet and by the classical cutting with diamond disc cutter. The strength of both samples was measured, and the results were compared.

INTRODUCTION

At present intense development as well as modernization of laboratory methods of rock testing always occur. Higher demands are connected with this trend both upon instrumentation of laboratories, computer quality and software outfit as well as upon precise preparing of rock samples tested.

New technology in the rock samples cutting area - cutting of materials by high velocity abrasive water jet - enables equally as cutting by diamond or hard metal disc cutters, shaping of rock samples for needs of laboratory tests.

CUTTING OF THE SAMPLES USING HIGH VELOCITY ABRASIVE WATER JET

The principle of disintegration by high velocity water jet is based on high energy (stored in the jet) transmission to extremely small area. The material destruction is caused afterwards by complicated physical processes during jet impact (Hood et al. 1990).

The problems connected to liquid jet involve wide range of up to now realized applications, probably there is an area for new unknown solution as well. It is caused by wide variety of the jets: various liquid pressure upstream from the nozzle exit, various liquid flow, the use of pure liquid, colloid or non-colloid lotion, the ingredient of abrasive particles; the jet can be generated as continuous, pulsed or cavitating jet etc. In addition the liquid jet technology is "cold technology". It means that the cut surface of material to be cut has no thermal interference.

The use of continuous water jet with add-on abrasive particles (so-called abrasive jet) seems to be the best configuration for rock samples cutting. Abrasive particles are sucked by means of underpressure to mixing chamber. The particles are mixed with the jet here and abrasive jet come into existence after the mixture passing through so-called abrasive tube. Abrasive jet is suitable for cutting not only conventional engineering and construction materials (metals, glass, rocks and concrete) but new developed materials (ceramics, ceramic babbitt, babbitt with metal matrix, fiberglass etc.) as well.

High pressure pump based on multiplicator FLOW with operating pressure up to 380 MPa was used as the source of high pressure water during cutting. The movement of abrasive jet above rock sample supported six degree of freedom industrial robot VUKOV APR 20.

The cutting of sandstone samples was performed using following parameters of the abrasive jet: water nozzle dia 0.25 mm, water pressure upstream from the nozzle exit 300 MPa, abrasive tube dia 1.2 mm, stand-off distance 3 mm and cutting velocity 0.6 $mm.s^{-1}$. Czech garnet type GBK (MASH 80) was used as abrasive material, abrasive flow rate was 300 $g.min^{-1}$.

RESULTS

For comparing measurements cubic samples of 8 cm cube edge were applied which were shaped from homogenous Godula sandstone. Density as well as velocity of ultrasonic wave propagation values are mentioned in Tab. 1. The first four test pieces were shaped by the above-mentioned method of application of high velocity abrasive water jet and the subsequent four specimens were cut out of 8 cm high sandstone slabs so that the method of cutting of bottom bearing surfaces (i.e. surfaces perpendicular to force action) was identical in both test series.

Tab. 1 Basic physical characteristic of the samples

No.	Density $[kg \cdot m^{-3}]$	Ultrasonic waves velocity $[km \cdot s^{-1}]$
5107/1 (water jet)	2464	3,3
5107/2 (water jet)	2453	3,3
5107/3 (water jet)	2479	3,4
5107/4 (water jet)	2426	3,3
5107/A (dia.-disc)	2474	3,3
5107/B (dia.-disc)	2470	3,2
5107/C (dia.-disc)	2465	3,2
5107/D (dia.-disc)	2458	3,2

After the measurement of density and ultrasonic wave velocity simple compression strength of samples as well as Young modul by mechanical press

ZWICK (max. force of 600 kN) were measured on samples. The results mentioned in Tab. 2 show that no distinct affecting of results has occurred during preparing of samples by the one or other methods. Due to the fact that only natural and no synthetic material is concerned, the results are affected more likely by properties of samples than by method of cutting.

Tab. 2 Strength & strain properties

No.	Strength [MPa]	Young modul [MPa]
5107/1 (water jet)	102	35 000
5107/2 (water jet)	118	37 000
5107/3 (water jet)	129	41 000
5107/4 (water jet)	103	26 000
5107/A (dia.-disc)	117	44 000
5107/B (dia.-disc)	121	43 000
5107/C (dia.-disc)	76	8 245
5107/D (dia.-disc)	115	40 000

CONCLUDING REMARKS

The above mentioned results have shown that the rock samples for laboratory experiments prepared by abrasive jet cutting are similar like the rock samples prepared by conventional method of diamond disc cutting. The presented results are the first one, and further experiments shall follow, at which both cutting mode and material tested shall be varied.

The importance of preparing rock samples by means of high velocity abrasive water jet lies especially in ability to shape materials which are very difficult to cut by a diamond or hard-metal disccutter. As examples geo-composites can be mentioned - i.e. mixtures of synthetic materials with rock (epoxide resins + sand, polyurethane + gravel etc.), or various kinds of concrete or reinforced concrete, and very hard and abrasive rocks, too.

Just in this area the application of cutting by means of high velocity abrasive water jet appears as the only applicable method which allows how to prepare quickly and in high-quality way samples for laboratory testing.

ACKNOWLEDGMENT

The authors are thankful to the Grant Agency of Czech Republic for supporting the work presented in this paper by the projects No. RA K1042603 and GAČR 105/96/1531 and prof. Kožušníková for valuable remainders during the paper preparation.

REFERENCES

Hood, M., Nordlund, R., Thimons, E. 1990. A Study of Rock Erosion using High-Pressure Water Jets.Int.J.Rock Mech. Min. Sci. & Geomech. Abstr. Vol. 27, No. 2.

Konečný Pavel, Ing.
Sitek Libor, Ing.

Ústav geoniky AVČR, Studentská 1768, 708 00 Ostrava - Poruba
Tel.: (069) 6918651, Fax: (069) 6919452,
E-mail: konecpa@ugn.cas.cz, sitek@ugn.cas.cz