Rock Mechanics Laboratory Report

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Over 2012, we focused on a number of projects furthering the understanding of rock brittleness, led by Professor Boris Tarasov. Our work on paradoxical features of hard rocks at highly confined compression established that, in contrast to relatively soft rocks, intact hard rocks increase their brittleness up to hundreds of times with rising confining stress. In this case the brittleness variation follows a typical pattern of initially increasing, reaching a maximum and then ultimately decreasing. The harder the rock, the greater the effect of embrittlement.

A new shear rupture mechanism was identified which causes embrittlement. The mechanism decreases friction within the fracture zone providing transient "negative friction" within a certain range of confining stress. It was shown that the failure mechanism exhibits maximum efficiency on hard rocks similar to granite at confining stresses about 300 MPa, which corresponds to depths of about 10 km. The mechanism creates another paradoxical effect, providing the formation of new faults in intact rock masses at stress levels significantly below the frictional strength. Today frictional strength of pre-existing faults is considered as the lower limit on rock shear strength in the lithosphere. These hitherto unknown rock properties exhibited at stress conditions of the seismogenic layer suggest an alternative concept of lithospheric strength and earthquake mechanisms which can explain a number of unresolved earthquake problems.

Experiments conducted on hard rocks at highly confined conditions showed that existing rock brittleness criteria are not good enough for proper characterisation of rock brittleness. Brittleness is one of the most important mechanical properties of rocks because it has a strong influence on the failure process and on the rock mass response to mining or tunnelling activities. A new brittleness criterion based upon the post-peak energy balance was proposed and a universal scale of brittleness was developed which allow unambiguously characterising rock brittleness within the whole range from absolute brittleness till ductility.

The new concept of brittleness was used for practical estimations of the proneness of rock to strainburst for a Golden Grove mine in Western Australia. An extensive testing program identified anisotropic rock brittleness and established the most dangerous areas of the mine. This estimation was confirmed by the mining experience where strainburst was witnessed as predicted.

COFS Rock mechanics laboratory contains two universal testing apparatus providing a very wide range of testing regimes including:

- Uniaxial and triaxial compression
- Post-peak control of very hard and brittle rocks
- Static and dynamic regimes
- Cyclic loading
- Permeability measurement
- Borehole simulation
- Hydraulic fracturing
- Thick wall cylinder collapse tests

Main parameters of the machines:

- Load capacity up to 2000 kN
- Confining pressure range 0 – 200 MPa
- Strain rate from 10^{-5} till 10^{3} strain/s
- High loading stiffness 50 MN/mm
- Specimen size: diameter up to 38 mm, length up to 80 mm

Figure 13: Boris Tarasov with the stiff triaxial static-dynamic machine

Figure 14: Blast simulator machine