GEOMECHANICS GROUP @ UofT

Post-peak fracture behavior during direct shear tests of rock joints

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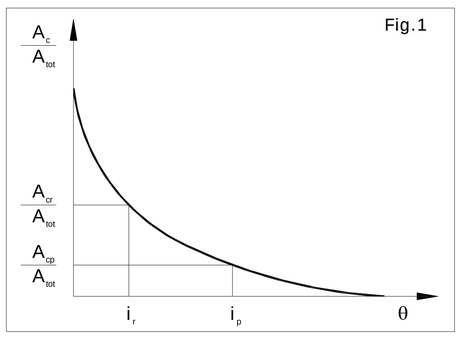
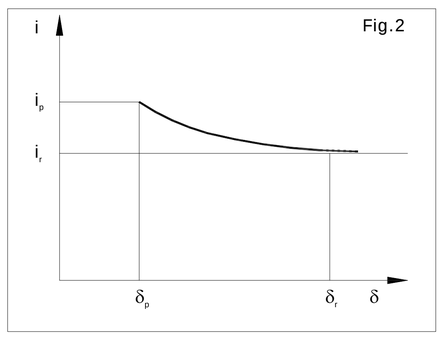
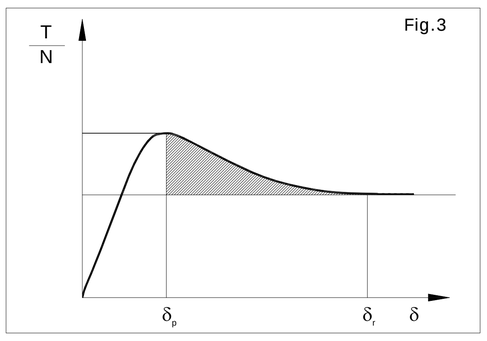
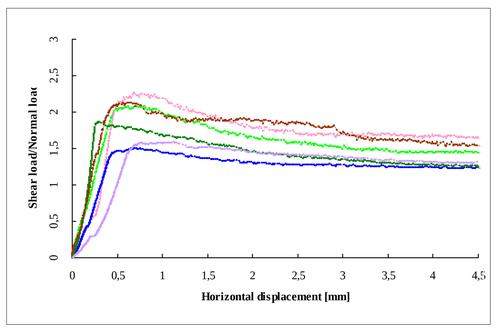
In this work we have studied the post-peak behaviour of rock joints during shear tests, with the aim of understanding how fracture dilation relates to the initial surface morphology and loading conditions. Systematic analysis of data from joint surface topographies and direct shear tests of granitic and sedimentary rocks has been carried out at the University of Toronto. Rock fractured surfaces have been digitized using a 3D stereo-topometric measurement system. The joint surfaces were reconstructed from the three-dimensional point clouds with a specially developed triangulation algorithm (Wirth, 2002). For each direct shear test normal load (*N*), shear load (*T*), shear displacement (*d*), joint dilation angle (*i*), and the initial surface topography have been monitored.

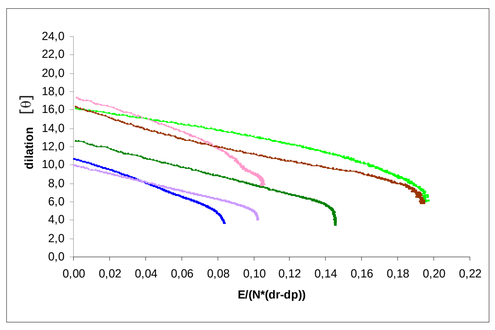


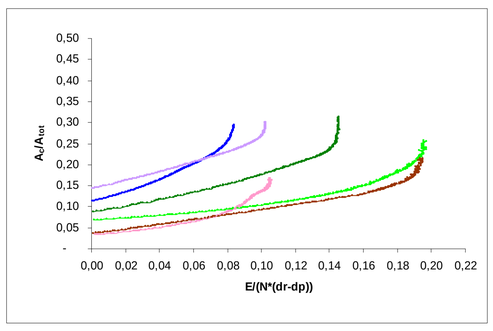


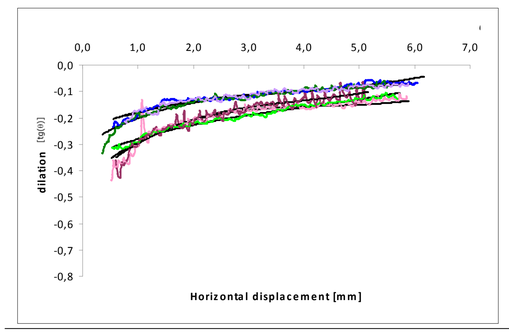


Limestone

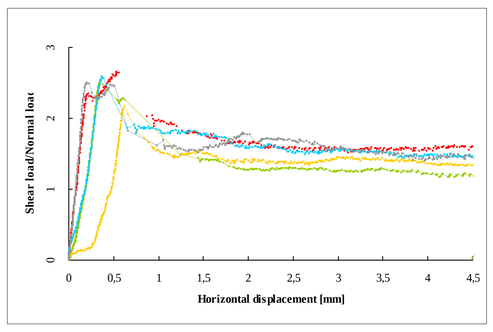


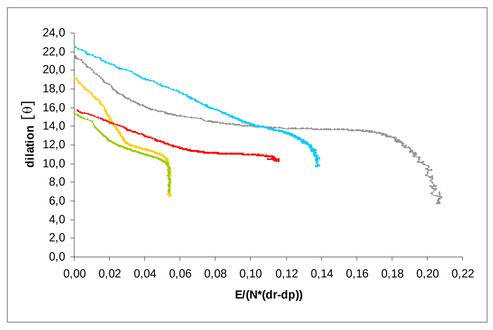


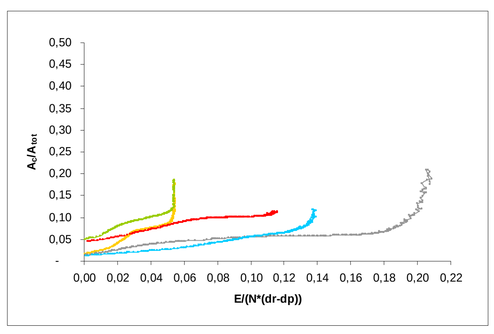


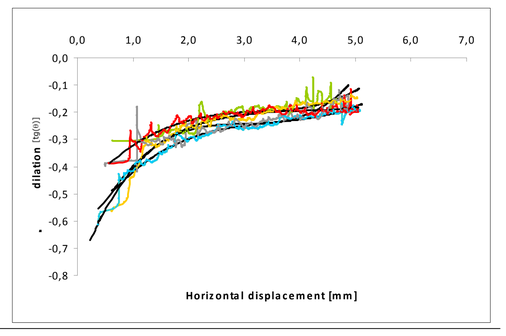


Granite









During direct shear test of rock joints the dilation angle measured in the post-peak phase tends to decrease from a maximum (i_p) towards a residual constant value (i_r). We found that the evolution of the dilation angle can be empirically described by a polynomial equation that fits very well all experimental results. Using the dilation angle and the digitized fracture surface we have been able to calculate the increase in contact/damaged area with the progression of the shear test.

As described in detailed by Grasselli (2006) the percentage of surface that is potentially damaged during shear tests (A_c/A_{tot}) can be calculated as function of surface roughness (*C*) and maximum apparent dip angle in the shear direction (θ^*_{max}). [θ] [tg(θ)]

The energy (*E*) consumed after the peak to reach the residual shear strength is calculated by integrating the applied shear force, normalized by the normal force, over the shear displacements. The energy dissipated in the post-peak can be divided in frictional energy and post-peak damage energy that is the energy necessary to damage the surface asperities (shaded in the fig.3).

Our preliminary results suggest that during shear tests most of the damage on the rock surface occurs after the peak. In the post-peak phase the joint surface progressively degrades and the asperities are gradually sheared and crushed until the system reaches its residual state equilibrium. Our preliminary results suggest that post-peak strength, dilation percentage of damaged area, and shear energy depend on the rock type.

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