FRICITION PROPERTIES AND FRICTIONAL BEHAVIOR OF ROCK SEPARATION PLANES

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* All figures quoted in the text are at the end of the lecture.
1. Introduction

Since the birth of rock mechanics as a separate branch of science a few decades ago, it has been clear that the laws of continuum mechanics could not be applied to the mechanical behaviour of rock masses near the earth's surface. The concept of discontinuum mechanics was developed, in which the deformational behaviour of rock masses takes place by relative movements along discontinuities like faults, joints, bedding-planes, etc. The separation planes may be present before deformation starts or may be caused by fracturing of the rock mass due to local concentration of stresses during the loading process.

The resistance against relative movement along the planes of separation in a rock mass is referred to as friction or shear resistance. Although large amounts of the resistance against relative movement along pre-existing planes can be attributed to shearing resistance of asperities on both sides of the separation planes, we will here use the terminology of friction for all processes of relative movement along pre-existing planes and we will use shear for relative movement by creation of new discontinuities. The simplest friction criterion is the Coulomb criterion:

\[ T \geq \mu N \]

\[ \sigma \geq \mu \tau \]

in which \( T \) is the tangential force necessary for relative movement, \( N \) is the normal force and \( \mu \) is the coefficient of friction which can also be expressed as \( \tan \varphi \) (\( \varphi \) being called angle of friction). \( \sigma \) and \( \tau \) are the stresses in normal and tangential direction, obtained by division of \( N \) and \( T \) by the area of apparent contact between the two bodies.

2. History of Friction Investigations

LEONARDO DA VINCI (1452–1519) was already puzzled about the nature of frictional resistance and found the proportionality between normal force and friction, as well as the independency of frictional resistance from the area of contact between the sliding bodies. AMONTONS, almost two centuries later, came ignorant of da Vinci's work on friction - to these same conclusions and explained the nature of friction by assuming a submicroscopic roughness on the surface of both sliding bodies which causes the bodies to slide up and down to interlock again in the next asperities.

EWING (1892) is the first scientist to attribute friction to molecular cohesion across the contact plane.