SHEAR STRENGTH AND DEFORMATION RESPONSE OF JOINTED ROCKS

By

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TO MY PARENTS

CERTIFICATE

This is to certify that the thesis entitled "Strength and Deformation Response of Jointed Rocks" being submitted by Shri R.K. Yaji to the Indian Institute of Technology, Delhi, for the award of the degree of DOCTOR OF PHILOSOPHY is a record of bonafide research work carried out by him. Shri Yaji has worked under our supervision for the submission of this thesis, which to our knowledge has reached the requisite standard.

The thesis, or any part thereof, has not been submitted to any other University or Institution for the award of any Degree or Diploma.

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ABSTRACT

Many important engineering structures on rock are being planned, designed and constructed all over the world. For the realistic analysis and design of these structures, it is essential to understand the behaviour of rockmass. The strength and deformation characteristics of the rockmass are dependent on a number of factors such as type of rock, stress conditions, presence of discontinuities and nature of joint surfaces. One of the major factors affecting the strength and deformation response is the joint characteristics. Very limited work has been reported on this aspect and most of it is based on the study carried out in direct shear. Keeping in view the existing knowledge about the behaviour of the joints, a systematic laboratory investigation was planned to study the effect of joint plane which includes its shape, roughness and inclination..

In the present investigation specimens of plaster of paris, sandstone and granite were tested. Plaster of paris has been chosen to represent weak rock whereas sandstone and granite to represent medium hard and hard rocks respectively. In the case of plaster of paris planar and rough joint surfaces of 34 types and of 8 orientations were tested under 5 confining pressures. The asperities along the joint plane were simulated to have obtuse and right angle apexes. In the case of sandstone and granite, the study has been restricted only to planar joints. Planar joints having 5 orientations have been tested in 5 confining pressure ranges. On all the three materials, tests were also carried out on intact specimen for the

purpose of comparison with the response of the jointed specimens.

The specimens were tested in standard triaxial stress conditions. Plaster of paris specimens were tested in conventional triaxial cell, whereas sandstone and granite specimens in a high pressure triaxial cell. The study was restricted to confining pressures resulting failure within the brittle range. Accordingly the maximum confining pressure has been 1.0 MPa in the case of plaster of paris and 10.0 MPa for sandstone and granite.

The results of this investigation have been analysed for stress-strain response, shear strength parameters (c and ϕ), modulus of elasticity (E_t) and modulus parameters (K and n).

Some of the important findings of this investigation are that (i) the friction angle remains almost constant irrespective of the conditions (i.e. jointed or unjointed) of the rock; (ii) the cohesion intercept (c) is very sensitive to the conditions of the rock; also it varies with the joint orientation and is minimum around an orientation of 45 degrees with respect to major principal stress direction. As the roughness of the joint surface increases, the cohesion intercept also increases due to the increase in interlocking; (iii) the variation of the uniaxial compressive strength (σ_c) is very similar to that of cohesion intercept and for a material the value of the ratio σ_c/c is almost constant; (iv) the modulus parameters K and n vary with orientation and roughness of the joint plane. The variation pattern of K is similar to that of cohesion intercept whereas that of n is opposite in nature.

Using the above findings procedures were evolved to predict uniaxial compressive strength (σ_{cj}), shear strength and modulus parameters of the jointed rock using uniaxial compressive strength (σ_{ci}) of the intact material alone. The significance of these solutions in solving the field problems have also been highlighted.

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