S Y N O P S I S

The cardinal need to understand the mechanical behaviour of a material and its implications on stability analysis lie in evolving a valid failure criterion and associated flow rule for stress-strain relationship for the material. The rational approach is to deliberate from the fundamental considerations rather than to conform with idealized models. The primary requirement, however, for the mechanistic model is its proof against reliable observations. Necessarily the shearing behaviour of jointed rocks is complex one and therefore merit meticulous focus so as to accomplish a clarity to guard against probable confusion in delineation of the basic process of deformation and failure.

The theoretical models concerning the jointed rocks stem from the classical concepts of friction between the bodies from Leonardo-de-Vinci to Coulomb. On the clues of the expositions emanated from arduous efforts of various workers over a period of time a rational path has been paved to tread over to investigate various aspects that affect the shearing behaviour of jointed rocks. The pertinent points identified fall in a compass of joint configuration, gouge characteristics and stress combinations.

To investigate into the mechanistic behaviour the need is to devise and develop appliances which can reliably produce data to confirm the theoretical postulations put forward to understand the basic mechanism. Numerous experimental studies employing various testing setups have been reported which recommend cylindrical triaxial test from the point of view of integrity testing. However, the conventional triaxial setup provide gross responses and are incapable to sense and record the fine responses calling for a sophisticated system to surmount the drawbacks.

The essense of shearing mechanism for jointed rock material lies in the separation of frictional and geometrical parameters and evolving interrelationships with respect to operating conditions. The current state of knowledge is rather arbitrary as regards the definition of the phenomenological parameters concerning friction and dilatancy. The central point therefore of the present research is to invest efforts towards the meaningful definition of these parameters by testing against the actual observations. To accomplish the objective it is essential to postulate a mechanistic model from fundamental considerations and to identify a testing system capable to furnish unambiguous data.

The principal strategy is to invoke the classical friction model and subject to rigour of static equilibrium to derive an expression for critical combinations of stresses at the point of failure on the hypothesis that the minimum energy in friction is dissipated only in sliding at a critical angle $45+\phi_{\mu}/2$ with major principal plane and excess energy due to deformation associated with volume change is in sliding at an orientation deviating from the critical orientation. Based on the postulated energy considerations a phenominological parameter for dilatancy gets defined which is in macroscopic terms the ratio of tangents of joint orientation to critical orientation and in microscopic terms it represents the instantaneous change of poisson's ratio.

The scheme to verify the proposed mechanistic model is to conduct test series so as to prove the efficacy against the physical factors namely joint orientation, gouge material characteristics and stress fields governing the shearing behaviour of jointed rocks. Fifty eight experiments grouped in three catagories, one, in which three orientations viz. 54.8°, 45° and 30° to the horizontal, gouge material as cement : sand of proportions viz. 1:2, 1:3 and 1:4, second, in which N_x (5.4 cm) and A_x (2.86 cm) sizes of specimens jointed at 54.8° to the horizontal filled with gouge material as cement : bentonite with proportions viz. 50:50, 40:60 and 30:70 and third, in which three stress fields viz. monotonic, triangular and sinusoidal have been conducted. To ensure the integrity of testing meticulous care has been exercised in the preparation of the jointed rock specimens which involved the development of special grips, standardization of the method for joint preparation and invigilance during the operation which employed both conventional strain controlled triaxial test setup as well as modern sophisticated closed loop servo controlled MTS setup of high precision. The significant achievement has been in observing the responses which provided insight into the phenomena of dilatancy hither to not clearly pin pointed which is unequivocally a governing phenomena for jointed rocks.

The paramount task is to know whether there exists a failure criterion, and whether it can be casted into a form for mathematical exploitation to accomplish a tool for the solution of engineering problems concerning jointed rocks. As a result of the present research work it has been possible to achieve few steps in understanding the shearing behaviour of jointed rocks and further it helps pointing towards the steps for full realisation of the goal. In nutshell, the significant conclusions are mentioned below in a condensed form:

* The classical model of friction after Coulomb is potential enough to produce a failure criterion for jointed rocks as accomplished during the present investigation.

* The separation of the failure stress into two distinct parameters is achievable on the basis of unambiguous definition of friction and dilatancy as accomplished in the present investigations.

* The yielding mechanism is comprehendable in terms of a process in which the elastic energy stored at the instant of deformation of the contacts acts as triggering energy to produce plastic deformation at every subsequent loading leading to a catastrophic failure by way of bursting of energy at a specific combination of critical stresses beyond which the failure conforms to classical sliding. The corroboration to the conceptulized mechanism is found in the responses recorded from tests on a closed loop servo controlled MTS setup.

* The implication of the exposition from the present investigation on the methods of analysis by limit equilibrium is to modify for dilatancy since the conventional methods

based on Coulomb's expression assume no volume change corresponding to the dilatancy value of unity.

The most significant point bears out from the present investigation is that it is possible to exploit the theoretical model under the umbrella of theory of plasticity if rigorous treatment is invested in the discovery of a flow rule. The starting point may be Drucker-Prager associative and non - associative flow rules applied in conjunction with Drucker-Prager approximated Mohr-Coulomb criterion to derive an incremental stress strain relationships. It has been amply demonstrated during the present investigation that the servo controlled closed loop MTS setup has a promise in obtaining the insight into the phenomena governing the mechanical behaviour of the materials. It is possible to test the validity of various concepts by subjecting the carefully prepared specimens to any specific static or dynamic stress fields. It would be interesting to investigate the concave downward nature as depicted in the initial part of the loading and phenomenal volume change near the peak and the residual shear stress in a post peak region. In order to investigate the appropriatness of theoretical model it is essential to verify against the results of model and prototype structures.