C H A P T E R - VII

SUMMARY OF FINDINGS

The search to understand the mechanical behaviour of rock material among engineers has a motive to evolve a mathematical tool to analyse rock-structure interaction. The present investigation attempted to 'bridge the gap' of knowledge essential to produce a realistic and rational criterion of failure by introducing quantitatively the influence of 'stresses locked' in the rocks formed as a result of cooling of hot lava. The brittle fracture in the rock is triggered as a consequence of release of stored elastic energy to a level of pre-stress locked in to inherent structure comprised of micro-cracks. The critical instant for the occurance of fracture is whence the ratio of maximum stress difference and maximum tensile stress reaches a critical value characteristic of the material. A constitutive law for rock materials bear out from the experimental observations. The approach followed for the present investigation is the validification of the physical concepts against the experimental observations and formulation in to mathematical relations. Followings are the summary of major findings:

I Physical model for the mechanics of failure:

Igneous rocks are the consequence of pressure temperature cycles which leaves residual stress locked in the inherent structure comprised of submicroscopic flaws. When an external stress

is applied to a rock material there occurs a storage of elastic energy until the nullification of locked stresses the release of which triggers the failure at the submicroscopic flaws whence the critical stress conditions initiates the crack propagating throughout the material.

II Failure criterion:

Whence the ratio of stress difference (between excess compressive stress and pre-stress) to maximum tensile stress reaches a critical value at any critically oriented flaw the failure occurs which if expressed on Mohr diagram generates a mathematical equation for failure in rock materials. The failure equation is a general parabola which degenerates in to Griffith parabolic failure criterion for no pre-stress in the material.

III Constitutive relationship:

The constitutive relationship between stress ratio and strain it any point has been established from the mechanism of failure in a hyperbolic form for a mathematical scheme to solve the boundary value problems in rock mechanics.

IV Pre-stress in rocks:

Pre-stress is defined as the stress locked in to the structure of rock during the process of cooling of hot lava which gets manifested as concave portion in a load displacement curve. The geometrical linearlization of load displacement curve determines the value of pre-stress. A one to one correspondence exist with the value of pre-stress obtained from the derived general failure criterion.

V Tensile strength in rocks:

Tensile strength in the rock is the value of maximum tensile stress at the point of failure represented as a vertex of the failure parabola on a Mohr plot. This value corresponds to the maximum tensile stress value calculated from elastic analysis of disc subjected to diametral line loading.

VI Critical stress ratio:

Failure in rock material occurs when the ratio of stress difference between the excess compressive stress and pre-stress to tensile stress approaches a critical value. The critical value at no pre-stress is 8 corresponding to Griffith critical ratio. When there is a pre-stress the critical value exceeds 8 depending on the magnitude of the pre-stress.

VII Validity of Brazil test:

Brazil test on Nx size discs and rings has been found to be valid if load is distributed along the arc of a cicle substending at 10°. The primary fracture initiates near the centre of the disc or near the centre hole of the ring and tend to coincide with the plane of the loaded diameter.

VIII Behaviour of the disc and annuli:

Disc exhibit mild pulsating pattern approximating to a straight line signifying no appreciable change in the ultimate value of the failure load with loading rate ranging between 0.48 μ to 6100 μ. Annuli with radii ratios .055, .074 and .0925 show no appreciable effect on the failure load ofcourse there is a slight decreasing trend as the radii ratio increases.

IX Initiation and propagation of cracks:

The primary crack is initiated along the loaded diameter as could be expected in a disc or a ring of an elastic isotropic material with instantaneous transfer of the maximum failure stress conditions to the pre-existing flaws whether it is situated along, across or at any orientation manifested as secondary or tertiary cracks.

X Grip performance:

The steel loading jaws designed and developed for disc shaped rock samples consisting of diametrically opposed surface over an arc of a contact of approximately 10° performed as per theoretical requirements of stress distribution initating the primary fracture along the loaded diameter for the majority of 44 specimens tested during the present investigation.

XI Specimen preparation:

Specimens to exact diamensions conforming to theoretical requirements could be prepared through a sequence of controlled slicing, finishing and polishing by means of specially developed appliances whose tolerances stood against the profilometer observations.

XII Method of testing:

A 30 speed conventional strain controlled 5 Tonne loading frame with proving ring dial gauge systems performed satisfactorily to produce data and observations for analysing the behaviour under the theoretical frame work developed during the present investigation.

The expositions from the present investigation should contribute towards the basic understanding of

failure phenomenon in a typical igneous basaltic rock. It is suggested that postulations and formulations may by subjected to rigourous investigations on other varieties of igneous rocks and further extended to sedimentary and metamorphic classes of rocks. To accomplish the vividity in to the entire process of failure a sophisticated stiff load frame with micrographic attachments is essential so as to acquisise the record of all the significant instances from crack initiation to ultimate fracture through the sequence of crack propagation.