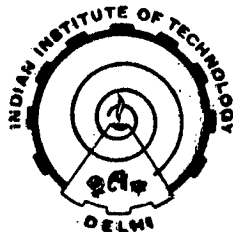


SOIL-CEMENT CHARACTERIZATION UNDER CYCLIC LOADING IN GENERAL STRESS SYSTEM

By

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A thesis submitted to the
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**DEPARTMENT OF CIVIL ENGINEERING
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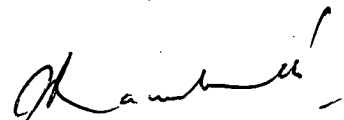
CERTIFICATE

This is to certify that the thesis entitled "Soil-Cement Characterization Under Cyclic Loading in General Stress System", submitted by Mr. Chandra Prakash Narain Nag to the Indian Institute of Technology, Delhi, for the award of degree of Doctor of Philosophy, is a record of the bona fide research work carried by him. Mr. Chandra Prakash Narain Nag has worked under our guidance 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

Under a moving wheel load an element in a pavement is subjected to generalised conditions of stresses comprising of both normal and shear stresses which undergo cyclic variations both in magnitude and direction. For a realistic evaluation of the pavement material, it is imperative that its characteristics be determined under the generalised stress field. None of the existing laboratory tests is known to simulate the in-situ conditions in toto.

Under the effect of fatigue loading, the pavement materials undergo gradual change in their characteristics which is known as divagation. In order to evaluate the pavement at any given time, it is necessary to define the pavement materials in their divagated form. Many of the field methods of pavement evaluation take cognisance of this approach. In the laboratory long term fatigue tests are employed usually to determine the number of cycles to failure. In such a testing although the various material characteristics obtained viz. stress, strain, modulus of resilient deformation, etc. have been related to number of load cycles to failure, a physical explanation to these inter-relationships on the basis of fatigue phenomenon is not yet available. Lately, some researchers (Goetz and Harr 1967, Irwin 1977) have opined that the energy dissipated during a fatigue cycle may provide a suitable answer to it.

Keeping the above facts in view the present investigations aims at firstly to study the behaviour of a silty soil (local subgrade) and cement stabilized soil in generalised stress-field

(ii)

both under static and cyclic conditions, and to compare the same with that under unconfined and axisymmetric conditions; and secondly to explore fracture energy as a material characteristic to represent the divagated material.

To achieve the objectives delineated above, an apparatus is developed to generate general stress-field. With the help of this apparatus identical specimens of soil and soil-cement were tested under static condition to failure before and after N cycles of load application. The effect of various test and material variables e.g. cement content, curing period, confining pressure, lateral stress ratio, cyclic deviatoric stress and number of load cycles on various material characteristics viz. stress, strain, modulus of elastic deformation and fracture energy was studied. Similar tests were also conducted under unconfined and axisymmetric triaxial compression.

The major conclusions arrived at under the present study are

- (i) the apparatus developed for application of general stress system, UTA-II functions satisfactorily, yielding consistent results.
- (ii) Material characteristics are significantly affected by lateral stress ratio. For both soil and soil-cements with increasing lateral stress ratio (σ_2/σ_3) there is an increase in axial stress at failure, modulus of elastic deformation and fracture energy. Whereas for soil

(iii)

specimens the axial strain at failure decreased with increase in σ_2/σ_3 , those for soil cements increased marginally.

- (iii) Cyclic stress level and number of load applications are the two major variables responsible for material divagation. At higher cyclic stress level the material divagation takes place at much faster rate. A mechanism explaining the behaviour of soil and soil-cement under cyclic loading is presented.
- (iv) Fracture energy defines the material state under repeated load conditions more distinctly as compared to parameters such as stress, strain or modulus of elastic deformation.
- (v) A multiple linear regression equation relating fracture energy and other test and material variables for soil-cement specimens is developed.
- (vi) Based on the concepts of energy transfer, a relationship between fracture energy of the paving material and the remaining life has been developed. This relationship can be further extended for its use in estimating the remaining life of a pavement structure based on simple laboratory tests.

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