AN ENERGY BASED CONSTITUTIVE FRAMEWORK FOR SIMULATION OF HEALING IN ASPHALT CONCRETE: - THEORETICAL, EXPERIMENTAL AND NUMERICAL ASPECTS

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Laboratory experimental evidence clearly indicates the beneficial effects of rest periods in restoring the stiffness and strength characteristics of asphaltic samples subjected to fatigue loading. There is consensus among researchers that currently available cracking failure prediction models grossly underestimate asphalt concrete pavements field life by as much as 100 times. It is commonly accepted that the reason for this discrepancy is the exclusion of healing effects from design calculations.

An extensive experimental and analytical investigation is currently being carried out at TU Delft on the mechanisms leading to the initiation, propagation and healing of damage in asphalt concrete pavements. One of the major goals of the investigation is the development and finite elements implementation of a triaxial, strain rate sensitive, history and temperature dependent constitutive model.

By postulating a multiplicative decomposition of the deformation gradient and an additive decomposition of the Helmholtz free energy function, an elegant formulation is obtained for the three dimensional elasto-visco-plastic response of asphaltic concrete materials by systematic exploitation of the Clausius-Planck local dissipation inequality.

An operator splitting methodology has been utilized for formulation of efficient computational algorithms for integration of the local evolution equations in the principal logarithmic strains space. Explicit procedures have been also formulated for the experimental determination of the model parameters.

The model has been implemented in the finite element code CAPA-3D. Results of the utilization of CAPA-3D for the simulation of cracking of asphaltic concrete mixes and the associated self-healing capability under the appropriate environmental and mechanical conditions will be presented in the last part of this contribution.

Keywords: bituminous materials, cracking, selfhealing, constitutive modeling, energy formulations