CONSTITUTIVE FORMULATION, LOCALIZATION AND FAILURE ANALYSIS OF POROUS MATERIALS LIKE CONCRETE SUBJECTED TO HIGH TEMPERATURE

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In this work, a thermodynamically consistent non-local poroplastic constitutive theory for quasi-brittle materials like concrete subjected to high temperature is presented [1]. Thereby, gradient poroplasticity and fracture energy-based homogenization are combined to describe the post peak behavior of porous media when subjected to long term exposure of temperature. The proposed couple thermo-mechanical material formulation is able to predict the strong variation of stiffness, strength and ductility of a porous material like concrete in terms of the acting temperature and confining pressure. To this end, a temperature dependent maximum strength criterion, and hardening and softening laws are defined. The last includes two characteristic lengths describing the non-local gradient and fracture energy-based dissipations, respectively, in the post-peak regime.

For the numerical implementation of the model, the consistent tangent operator is developed and the dual mixed FE formulation for thermodynamically consistent gradient plasticity by Vrech and Etse [2] is considered, which was extended to porous media by Mroginski and Etse [3].

Localization analysis of the non-local poroplastic model is performed to evaluate the potentials of discontinuous bifurcation of concrete under different temperature and stress state scenarios. Both numerical and geometrical procedures for localization analysis are followed. The results provide relevant information regarding the variation of the transition point of brittle-ductile failure mode with the acting temperature and confining pressure.

Finally, the attention focuses on numerical analysis of failure behavior of concrete components subjected to different temperature and loading conditions. The results demonstrate the predictive capabilities of the model and numerical tools to reproduce the degradation

of concrete with increasing temperature, as well as the influence of the acting stress state in the temperature dependent degradation. The results also show the regularization of post-peak failure behavior of concrete components provided by the gradient based model.

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