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STRAIN INJECTION TECHNIQUES FOR MODELLING TENSILE CRACK PROPAGATION IN CONCRETE GRAVITY DAMS

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Cracks propagating deep inside gravity dams can seriously affect their structural safety. Due to the potential catastrophic scenarios associated to the collapse of large concrete dams, it is a fundamental issue to predict realistically the eventual crack profiles and the loss of structural resistance associated to the failure mechanisms.

This work investigates tensile crack propagation in concrete gravity dams by using some recently developed numerical techniques (crack-path field and strain injection techniques) applied to a Rankine-type plasticity model. The work carefully addresses aspects related to mesh independence of the results (mesh bias and stress locking), robustness, and computational cost, which are the main issues in material failure modeling.

The proposed strain injection technique is implemented in a finite element framework using continuum constitutive models equipped with strain softening. It consists of a procedure to insert, in proper parts of the domain, specific strain fields (constant strain and discontinuous strain modes) that will enhance the performance of the underlying standard finite elements for capturing and propagating strain localization. The necessary data to inject the discontinuous displacement modes into the appropriated position inside the finite element is obtained by an auxiliary technique conceived to identify the crack path: the crack-path field technique.

The methodology enjoys the benefits of the intra-elemental methods, E-FEM or X-FEM, for capturing complex propagating displacement discontinuities in coarse meshes, without resorting to global, code invasive, crack-path-tracking algorithms.

Representative numerical simulations show the accuracy and robustness of the used methodology in predicting tensile crack propagation in concrete gravity dams.