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A STABILIZED, LOW-ORDER EDGE-BASED SMOOTHED FINITE ELEMENT METHOD FOR NUMERICAL ANALYSES IN GEOMECHANICS

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A stabilised smoothed finite element method for both linear and nonlinear numerical analysis in geomechanics is proposed. The presented method retrieves the use of equal-order linear interpolations as a natural, practical choice in the context of consistently stabilised Galerkin methods in computational Geomechanics. The formulation presented avoids numerical instabilities and sub-optimal convergence rates often observed when (nearly) incompressible conditions are studied. In this study, the smoothing gradient technique is adopted to preserve the consistency of the proposed method for equal-order linear interpolations by eliminating all derivatives that appear in consistently stabilised formulations. This is achieved by employing the smoothing gradient operator, in which integrations of the interested quantities over the smoothing domains are transformed into those over the boundaries of the smoothing domains using the divergence theorem. This is the first time that such an unconditionally stabilised method is implemented to coupled flow-deformation problems in geomechanics. The robustness and accuracy of the proposed method are examined by comparing the numerical results with reference solutions of several benchmark coupled problems that encompass both linear and nonlinear material behaviour. The numerical results are also compared with those obtained by the stabilised polynomial pressure projection FEM, which has been applied previously in Geomechanics.