A meshless IRBFN-based numerical simulation of dynamic strain localization in quasi-brittle materials

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Abstract

This paper describes an integrated radial basis function network (IRBFN) method for the numerical modelling of the dynamics of strain localization due to strain softening in quasi-brittle materials. The IRBFN method is a truly meshless method that is based on an unstructured point collocation procedure. The integration approach is the key to achieving accurate function derivatives necessary for numerical stability and solution accuracy. A new coordinate mapping technique for the IRBFN method is introduced in this paper to resolve the steep velocity, strain and strain-rate gradients associated with the strain localisation process. The behaviour of a one dimensional bar is investigated using a nonlocal damage model governed by a Telegraph-type constitutive relation. The bar is dynamically loaded in tension with a constant end velocity. The strain waves propagating from the two ends meet at the centre of the bar and causes a large strain increase at this location. This strain increase, under suitable conditions, will initiate the strain localisation process due to the strain-softening constitutive behaviour of the material. Numerical results obtained compare favourably with those obtained by the FEM and demonstrate the efficiency of the present IRBFN approach in solving steep (singularity-like behaviour) nonlinear PDEs encountered.