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A meshless formulation for the strain gradient elastic materials in fine-scale

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Summary

Selected elastic and plastic behaviors of materials have been shown to exhibit size-dependence when they are in the micro-nanoscale. Experiments have shown that the scale-dependent behavior can be modeled by adding strain gradient terms into the finite element models, but modifications need to satisfy C1 displacement continuity in the models. In this investigation, meshless finite element formulation, where C1 continuity can be satisfied without new additions nodal degrees of freedom, was developed. In the formulation, the strain gradients were decomposed into dilatation, stretch and rotation parts; and the governing equations were discretized on local domains using the meshless local Petrov-Galekin (MLPG) method. Using this approach, the strain gradient field and higher-order stresses can be derived directly from the solved displacement field. The meshless method was used to model strain gradient elastic beams in bending and the results were benchmarked with higher order analytical solution and experimental data from the literature. The comparisons showed that the novel numerical method for strain gradient computation was in good agreement with the analytical solution and experimental data in both size-dependent and size-independent regimes.