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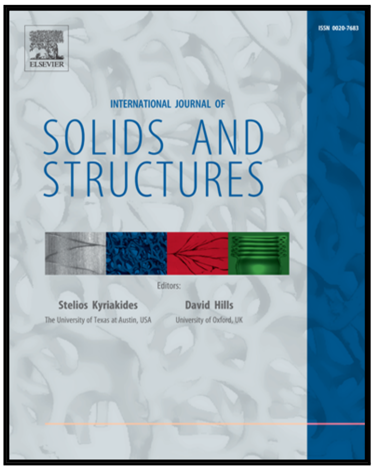

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J. Luo, V. Sundararaghavan

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Stress-point method for stabilizing zero–energy modes in non–ordinary state–based peridynamics

J. Luo[a,*], V. Sundararaghavan[b,**]

[a]*Department of Mechanical Engineering, University of Michigan, Ann Arbor*
[b]*Department of Aerospace Engineering, University of Michigan, 1320 Beal Avenue, Ann Arbor, MI 48109, USA*

Abstract

Non–ordinary state–based peridynamics is a promising continuum mechanics theory that combines non–local dynamics with conventional material models. Within this theory, the correspondence principle can be invoked to compute deformation gradients from the computed displacement fields. However, correspondence based models are prone to a zero–energy mode. This paper proposes the use of stress points to resolve this issue in the peridynamic family with nearest–neighbor discretizations. Each particle horizon is assigned with stress points at which derivatives of field variables are computed. The method is first demonstrated in a simple 1D problem and is compared with analytical solution and other control methods. 2D and 3D examples are compared with the finite-element method. Zero-energy modes are shown to be completely damped in all cases. The computation efficiency of the explicit stress–point based peridynamic model is then analyzed.

Keywords: zero-energy mode; peridynamics; state based; stress points; particle methods

1. Introduction

In classical elasticity, stress at a point is locally dependent on the strain at that point which leads to stress singularities at crack tips and dislocation cores. To resolve this issue, generalized continuum theories have been developed that introduce a length–scale via the assumption of non-locality [1–5]. In these theories, length scale dependent constitutive laws that involve higher-order strain or stress gradients and higher order stiffness tensors are introduced. Peridynamics, introduced as an alternative integral formulation for continuum mechanics [6], is a relatively new theory that naturally lends itself to the use of meshfree and particle-based discretizations. In the particle-based peridynamic approach,

*Corresponding author. Email: jiangyi@umich.edu
**Tel: +1 734-615-7242, Email: veeras@umich.edu