LOCKING-FREE STABILIZED CONFORMING NODAL INTEGRATION FOR MESHFREE MINDLIN-REISSNER PLATE FORMULATION

J. S. Chen and **D. Wang**

Department of Civil and Environmental Engineering
5731G Boelter Hall
University of California, Los Angeles
Los Angeles, CA 90095-1593
jschen@seas.ucla.edu

The cause of numerical shear locking in Mindlin-Reissner plate formulation is due to the inability of the numerical formulation in representing pure bending mode without producing parasitic shear deformation. To resolve shear locking in meshfree formulation of Mindlin-Reissner plates, the following two issues are addressed: (1) the construction of meshfree approximation functions that are capable of representing pure bending modes without parasitic shear deformation, and (2) the formulation of domain integration of Galerkin weak form, that, in conjunction with the meshfree approximation functions, can produce exact solution under pure bending situation.

In this study, we first identify the necessary conditions in the construction of meshfree approximation functions that can represent the pure bending modes. We show that for reproducing kernel or moving least-square approximation to produce pure bending deformation in the Mindlin-Reissner plate kinematics, a second order monomial basis must be used in the approximation of translational and rotational degrees of freedom. Next, the integration constraints that can yield an exact solution in the Galerkin meshfree discretization of Mindlin-Reissner plate formulation under pure bending condition are derived. A nodal integration with strain smoothing stabilization that meets the pure bending integration constraints is then formulated for Mindlin-Reissner plate. This is an extension of the stabilized conforming nodal integration originally developed for meshfree discretization of 2^{nd} order differential equations [1, 2]. The strain smoothing stabilization is introduced in the Galerkin weak form via an assumed strain formulation, and this allows the use of simple nodal integration to construct the meshfree discrete equation. The resulting meshfree formulation is stable and free of shear locking in the limit of thin plate. Both computational efficiency and accuracy are achieved in the proposed meshfree Mindlin-Reissner plate formulation.

References

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