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On the Reflection and Transmission of Waves in a 1D Coupled FE-Peridynamic Model

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Handling the high computational cost associated with the implementation of Peridynamics [1] is essential for advanced applications with many degrees of freedom. One way to reduce the size of the resulting matrix systems, when the peridynamic theory is applied, is through coupling it with the Finite Element Method (FEM). Given the robustness of Peridynamics for crack propagation modelling, a good strategy is to apply FEs (based on standard continuum models) in areas where failure is not expected to occur and employ Peridynamics at the vicinity of failure sites. Using this approach, the computational efficiency of FEs is combined with the ability of Peridynamics to accommodate discontinuous fields and incorporate microstructural characteristics within the simulation.

A simple and efficient approach to the aforementioned strategy was presented recently in [2] and [3]. One of these studies [2] reported spurious reflections at the FE-Peridynamic mesh interface. The aim of this work is to study in more depth the intensity of these spurious reflections and the underlying parameters that affect them (e.g. material parameters, discretization length, peridynamic horizon).

Numerical studies are performed on the 1D propagation of pulses in a simple bar. The problem domain is modelled assuming a peridynamic lattice surrounded by a FE mesh. To achieve the coupling of the models various methodologies are considered and their effectiveness in reducing the spurious reflections is assessed. Initial results indicate that spurious reflections can originate due to dissimilarities in the material properties, disparities between the characteristic mesh size in the FE and peridynamic region and the extent of the peridynamic horizon. Coupling the models by introducing an overlapping region can improve the transmission characteristics at the grid interface. The outputs of this study provide insights regarding wave propagation phenomena using coupled FE-Peridynamic models.

REFERENCES

[1] S. A. Silling, "Reformulation of elasticity theory for discontinuities and long-range forces," *J. Mech. Phys. Solids*, vol. 48, no. 1, pp. 175–209, 2000.
[2] M. Zaccariotto, T. Mudric, D. Tomasi, A. Shojaei, and U. Galvanetto, "Coupling of FEM meshes with Peridynamic grids," *Comput. Methods Appl. Mech. Eng.*, vol. 330, pp. 471–497, 2018.
[3] M. Zaccariotto, D. Tomasi, and U. Galvanetto, "An enhanced coupling of PD grids to FE meshes," *Mech. Res. Commun.*, vol. 84, pp. 125–135, 2017.