FORMULATION OF THE PERIDYNAMIC HEAT EQUATION CONFIRMING CONSERVATION OF HEAT ENERGY FROM HEAT FLUX

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ABSTRACT

The conservation of energy from the heat flux by conduction has not been introduced directly into the peridynamics from the classical heat equations for the last decades. In this study, we present a new formulation to describe the peridynamic heat conduction in isotropic materials by applying the peridynamic differential operator (PDDO) to the classical governing equations of one-dimensional heat conduction, replacing the derivative terms in the governing equations with integral expressions of different orders of PDDO's Taylor series expansions (TSE), and introducing the weighting functions to the peridynamic horizons. The replacement using PDDO leads to the conservation of the energy from the heat flux. The peridynamic heat flux is equivalent to the classical heat flux of the static thermal analysis, and the relationship among the weight functions of PDDO for heat conduction is established. Several quasi-static peridynamic heat transfer equations with different TSE orders and weight functions are solved, and the proposed peridynamic heat conduction formulations yield accurate results in good agreement with the analytical results. This proposed formulation can be extended to the peridynamic analyses for various physical problems of various kinds of differential equations.