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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
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# CRACK PROPAGATION MODELLING IN PRESENCE OF VOIDS AND INCLUSIONS USING A PERIDYNAMIC APPROACH

**Abstract**

The capability to predict damage and crack evolution by adequate numerical techniques is becoming increasingly important, both for safety and economy reasons in many industrial applications. The presence of voids and inclusions, due to manufacturing process, increases the difficulty of the analysis. Classical mechanics methods, based on partial differential equations, cannot be directly applied to discontinuities and requires auxiliary equations that govern damage initiation and progression. These auxiliary equations get more complicated to solve discontinuities which can occur simultaneously at multiple locations in 3D structures. A new approach, based on the non-local peridynamic theory, will be presented. In this theory each point of the domain of interest interacts with the other points that are within a finite distance (horizon). Each pair of interacting material points can be assumed to be connected through a bond, and they interact through a force defined by a specific function. The force function contains the whole constitutive information about the material and depends on the distance between the material points. The peridynamic equations of motion are formulated using spatial integral equations, as opposed to spatial partial differential equations such as those in classical-continuum theory. The fact that displacement derivatives do not appear in peridynamic equations permits this formulation to be valid whether discontinuities, such as cracks, voids or interfaces, are present or not. The peridynamic approach is more potent than conventional finite element method because the integral equations remain valid even at discontinuities. Damage is introduced into the peridynamic model by permitting the bonds to break irreversibly. After a bond breaks, it sustains no force. Plasticity can also be included by allowing bonds to undergo permanent deformation. A distinguishing feature of this approach is its ability to treat the spontaneous formation of discontinuities at different locations together with their mutual interaction and dynamic growth in a consistent framework. The method does not require a separate crack growth law to be provided that governs cracks and damage initiation, growth, arrest, branching and so on: these features emerge from the equation of motion and constitutive models. The peridynamic method will be applied to model a 2-D structure in presence of voids and inclusions: a first time considering an isotropic material and then with a laminate composite material. Results will be evaluated taking into account different mesh sizes, crack initial lengths and crack orientations.