Matériaux bio-inspirés : Optimisation du comportement mécanique via la méthode des éléments discrets

Kaoutar RADI

Sous la direction de C. Martin et D. Jauffres

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Bâtiment André Rassat – UFR de Chimie et Biologie

Jury :
Mr François BARTHELAT, Professeur, Mcgill University, Rapporteur
Mr Ivan IORDANOFF, Professeur, Arts et Métiers ParisTech, Rapporteur
Mr Florian BOUVILLE, Maitre de conférences, Imperial College, Examinateur
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Résumé : Natural materials such as bone and the nacre of some seashells are made of relatively weak building blocks and yet often exhibit remarkable combinations of stiffness, strength, and toughness. Such performances are due in large part to their brick and mortar architectures.
Many efforts are devoted to translate these design principles into synthetic materials. However, much of the progress is based on trial-and-error approaches, which are time consuming and do not guarantee that an optimum is achieved. Modeling is an appealing alternative to guide the design and processing routes of such materials. In this work, we develop a numerical model based on Discrete Element Method (DEM) to understand the reinforcement mechanisms and optimize the mechanical properties of nacre-like materials. The model accounts for different reinforcement mechanisms, and quantitatively assess stiffness, strength, and toughness. Results are then combined to provide design guidelines for synthetic brick-and-mortar composites comprising with only brittle constituents.