Numerical analysis of regularly arranged brick structures inspiring nacre tissue

Masayuki Arai*[1] and Hayato Fujita[2]

[1]Department of Mechanical Engineering, Faculty of Engineering, Tokyo University of Science – Japan
[2]Graduate School of Mechanical Engineering, Tokyo University of Science – Japan

Abstract

Nacre is a composite material composed of calcium and organic matter, which is known to have excellent fracture strength and toughness. Recently, the development of composite materials that mimic the microscopic structure of such organisms has been actively promoted. In this paper, we developed a finite element model in which the calcium layers of nacre are periodically arranged in a group of bricks, replacing the organic layers with a cohesive model, and exampled about the deformation and crack propagation process. The obtained result shows that as the aspect ratio of each brick (defined as the ratio of width to height) increases, the bricks slip together and deform along the cohesive layer, and cracks propagate with large deflections along the interfaces between the bricks, resulting in high fracture ductility and high fracture energy. On the other hand, it is found that if the aspect is chosen too large, the cracks propagate in a straight line, and the expected properties are not be obtained. Therefore, we will claim that by optimizing the crack orientation plane and the aspect ratio of the brick geometries an extremely excellent biomimetic composite material can be obtained.

*Speaker