Delft University of Technology

Aerospace Structures & Computational Mechanics
Ph.D. Seminar Series

Sathiskumar Anusuya Ponnusami

Crack-particle interactions in particle dispersed systems

Particles are typically embedded in a matrix material to increase its functionality, particularly its effective fracture behavior. A classic example is a particle-reinforced material where crack shielding and deflection lead to toughening of the original material. More recently, however, a distinct mechanism using embedded particles has been proposed to enhance the resistance against cracking. In particular, in the so-called self-healing materials, particles containing a suitable healing agent are dispersed in the matrix. Upon loading the material, existing microcracks interact with the healing particles, thereby activating the self-healing mechanism. In order to successfully trigger the healing mechanism, it needs to be ensured that a propagating crack gets attracted towards the healing particles instead of deflected away from them. In addition, the crack needs to break the healing particles, which requires a sufficiently strong particle-matrix interface. Consequently, the crack-particle interaction is a critical issue that needs to be addressed in order to facilitate the successful development of self-healing materials.

In this work, crack-particle interaction in a two-phase material system has been analyzed. It involves understanding how cracks interact with constituent phases in the heterogeneous system. As a first step, a system with a single particle embedded in a ceramic matrix is considered. Finite element simulations are performed to investigate the effect of properties of particle, matrix and interface on the crack propagation. Cohesive elements based on traction-separation laws are used to simulate fracture in the two-phase system. In order to quantify the effect of particle properties, concept of configurational forces is employed. Accordingly, crack tip driving force is split into two components, one from the far-field applied boundary conditions and the other is from the presence of inhomogeneity (particle). A parametric analysis has been carried out to identify the favorable range of elastic and fracture properties for the healing particles and the ceramic matrix. Geometric parameters such as particle offset and aspect ratio are also considered for the study. A general design guideline is provided for selecting the healing particles in terms of their mechanical properties.

time: **Thursday, April 3rd, 2014, 16:00**
location: **meeting room 7**
organization: **Dr. Martin Ruess ‹m.ruess@tudelft.nl›**