Three dimensional crack orientation measuring technique based on X-ray computed tomography

***Sheng Jiang, †Luming Shen, François Guillard and Itai Einav**

School of Civil Engineering, The University of Sydney, NSW 2006, Australia

*Presenting author: sheng.jiang@sydney.edu.au
†Corresponding author: luming.shen@sydney.edu.au

Abstract

X-ray tomography is an extremely useful tool for non-destructive inspection of the internal damage of granular materials in great detail. However, how to quantitatively portray the orientation of internal cracks is still a challenging task, especially in three dimensions (3D). Here we resolve this technological problem by applying a three-dimensional crack determination technique derived from three-dimensional Fourier transform. In our approach, the reconstructed images are divided into several overlapped voxel patches. Using the Fourier transform, each voxel patch is assigned a 3D structure tensor that describes the distribution of gradient directions within the patch. To be specific, each structure tensor can be replaced by a visual ellipsoid whose semi-axes are equal to the tensor matrix eigenvalues and directed along their corresponding eigenvectors. Thus, each single voxel patch can be converted into an ellipsoid having a true geometric dimensioning and a specific spatial deflection direction, which directly characterizes the geometrical morphology and orientation properties of internal cracks. The innovative technique developed in this paper is used to quantitatively analyse the fracture pattern within a single cemented glass bead under impact. The results shows that most cracks are localized in the centre of the bead and propagate along the impact direction to split the bead.

Keywords: Dynamic fracture, Crack orientation, X-ray micro-computed tomography, Fourier transform, Structure tensor