MECHANICAL CHARACTERISATION OF FOAM-CEMENT INTERFACE UNDER COMPLEX LOADING CONDITIONS

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Introduction

Open-cell foams are often used as a substrate for evaluation of cementing techniques. In the current study the AlSi7Mg (45ppi) foam was selected as an analogous model for its resemblance to trabecular bones [Guillen et al., 2011] in morphology. Foam-cement coupons were produced [Wang et al., 2010] and mechanically tested under tensile, shear, mixed-mode and step-wise compression loading conditions [Wang et al., 2010; Tozzi et al., 2012]. FE simulations of the foam-cement interfacial behaviour were performed under compression, tension and shear loading conditions as well.

Methods

The loading device used in Wang et al. [2010] was adopted to allow tensile (θ=0°), shear (θ=90°) and mixed-mode (θ=22.5°; 45°; 67.5°) loads to be applied on the foam-cement composites (n=10). Other five specimens underwent μCT analysis (60kV, 140μA, 20μm) and were step-wise compressed at two selected displacements (ultimate strength, final failure) [Tozzi et al., 2012]. FE analysis of a typical foam-cement model was used to predict the apparent behaviour and local interfacial damage following the protocol reported elsewhere [Zhang et al., 2012]. The results were then compared with the bone-cement correspondent values.

Results

The foam-cement interfacial strength as a function of the loading angle compares reasonably well with that of the bone-cement interface (Fig.1). Under step-wise compression the deformation was found to initiate in the foam region and virtually no load transfer occurred at the interface, as opposed to the bone-cement case [Tozzi et al., 2012]. The compressive strength for the foam-cement (0.90±0.05MPa) differed considerably from the 4.93±1.10MPa reported for the bone-cement [Tozzi et al., 2012]. The FE analysis showed that the foam region sustained most of the load under tension and compression. Under shear loading condition both foam-cement and bone-cement models showed similar stress distribution patterns.

Discussion

When shear is the predominant component an increase in the interfacial strength for both foam and bone cement interfaces was observed, suggesting that shear action may not be very sensitive to foam/bone material properties. Under compression the interfacial strength of the foam-cement interface was found much lower than that of bone-cement interface (<1MPa for foam-cement vs 3.5–6MPa for bone-cement). This may be attributed to the higher contribution of the foam material on the overall response of the interface. The foam region sustained almost the deformation compared to the bone-cement [Tozzi et al., 2012], where a more effective load transfer at the interface was observed.

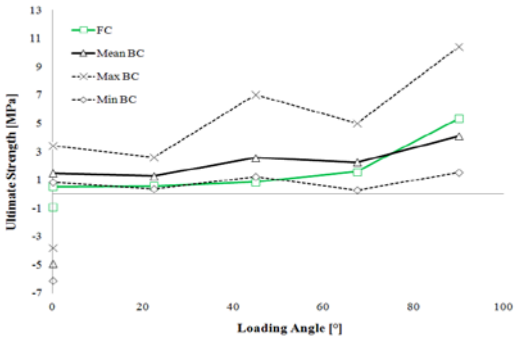

Figure 1: The foam-cement interfacial strength (green) as a function of the loading angle. The results are compared with those obtained for bone-cement samples (black) [Wang et al., 2010; Tozzi et al., 2012].

References

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