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Meshless Analysis of 2D trabecular patches using a Constitutive Tensor Obtained Directly from Micro-CT Images

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ABSTRACT

A fabric tensor is a symmetric second rank tensor that characterizes the arrangement of a multiphase material. A relationship between the fourth rank elasticity tensor $\mathbf{C}_{ijkl}$ and the fabric tensor **A** was developed by Cowin, 1985 [1]. Later, the Mean Intercept Length tensor (MIL), was developed by Whitehouse 1974 [2] and used to estimate the fabric tensors. It is usually computed by defining a family of parallel lines to a specified direction v. The number of intersections, $C(v)$, between lines and the interface between both phases is counted. MIL is a function of v, $MIL(v)$, and computed as a reason between the summation of the length of traced lines, h, with the number of intersections, $C(v)$: $MIL(v) = \mathrm{h}/C(v)$. Researchers found that for many types of materials, particularly bone trabeculae, an ellipse could be fitted to a rose diagram of the MIL [3]. With this, in 2D MIL, tensor, **A**, can be computed as the 2×2 matrix that represents the estimated ellipse.
In this work, the MIL technique is applied to obtain directly from the Micro-CT images the constitutive tensor of a trabecular patch. Then, the patch is analysed using a linear elasto-static meshless analysis. The results are discussed and compared with other numerical approaches.

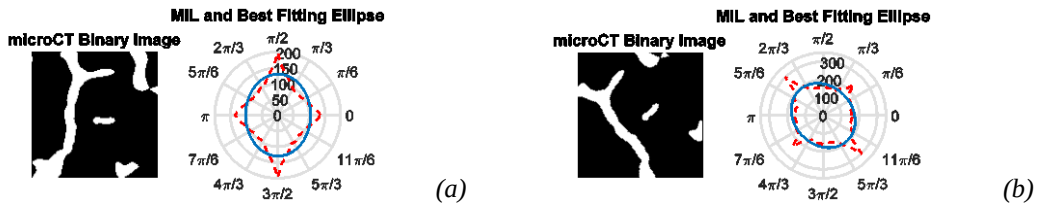

Figure 1 – MIL results from two Micro-CT images. a) Trabecula image, leading to an ellipse with the principal axis alight at 90°. B) Original image rotated 45°, leading to an ellipse with the principal axis alight at 135° (90°+45°).

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