

## Analysis of Trabecular Bone as a Hierarchical Material

**Iwona M. Jasiuk**

*Georgia Institute of Technology, Atlanta, U.S.A.*

We study trabecular bone as a hierarchical material with a highly complex and random structure. First, we characterize the trabecular bone's structure at several structural levels: nanoscale (apatite crystal and collagen fibril level), sub-microscale (single lamella level), microscale (single trabecula level), and mesoscale (porous trabecular network level) using atomic, scanning and transmission electron microscopy and x-ray microtomography. Then, we model the trabecular bone at each structural level as a linear elastic solid employing either classical elasticity or higher order elastic theory (Cosserat theory). Modeling techniques include analytical micromechanics theories and numerical simulations involving finite element, spring network, and beam network approaches. We compare our theoretical results at each scale of observation with our experimental measurements. This study sets a framework for the analysis of other biological materials with hierarchical structures.

[View the extended summary](#)