BLUE WATERS
SUSTAINED PETASCALE COMPUTING

Allocation: Exploratory/50 knh
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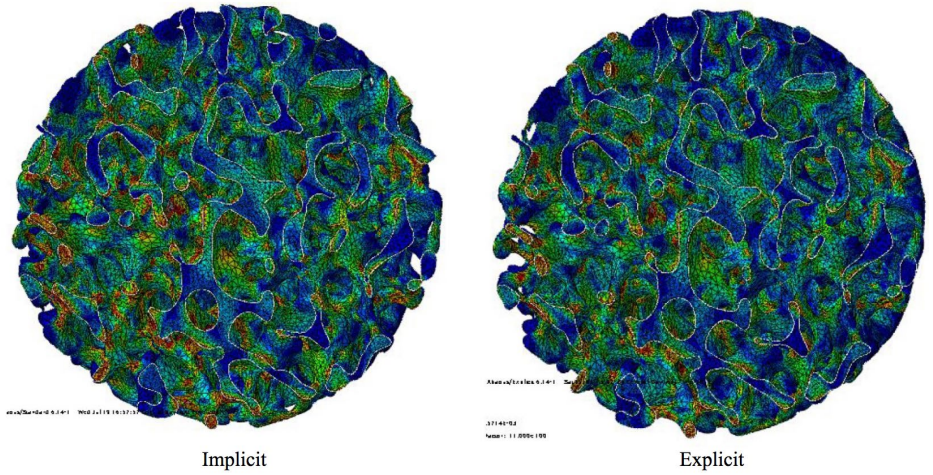
ADVANCED DIGITAL TECHNOLOGY FOR MATERIALS AND MANUFACTURING



Comparison of apparent response resulting from implicit and explicit solvers.

Research Challenge

Bone has a hierarchical architecture spanning from atomistic to macroscopic scales. Osteoporosis is a bone disease characterized by low bone density, which often leads to an increased risk of fractures that mainly occur in trabecular (inner) bone. Trabecular bone is also the primary site for insertion of orthopedic implant systems. Thus, the mechanical properties of trabecular bone are of great clinical and research interest for prediction of age- and disease-related fractures as well as the design of improved implant systems.

Methods & Codes

Modeling of trabecular bone entails a highly nonlinear mechanical behavior along with contacts. As a result, it is of considerable interest to assess the effectiveness and efficiency of an explicit solution method. In this project, researchers used the implicit and explicit solvers of Abaqus to analyze nonlinear micro-Computed Tomography (micro-CT) finite element (FE) models of trabecular bone and compared the performance of the two solvers.

Results & Impact

Results show that by using a similar setup for the model (e.g., element type, loading type, etc.) when using implicit and explicit solvers, there is a perfect match between micro-CT FE model results using implicit and explicit solvers. In addition, the researchers observed that implicit and explicit solvers scale similarly, while the explicit solver performs five times faster.

Why Blue Waters

The team was able to successfully scale their simulations on eight to 12 nodes on Blue Waters with the explicit solver, which significantly reduced computational time. Each of their models have many millions degrees of freedom and nonlinearities, making them impossible to solve without the use of the Blue Waters supercomputer.