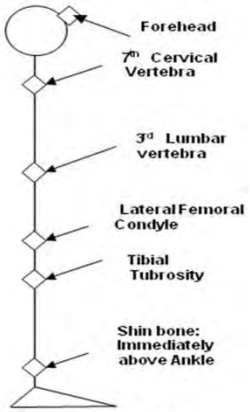
Mechanical Damping of Mouse Bone and Surrounding Tissues

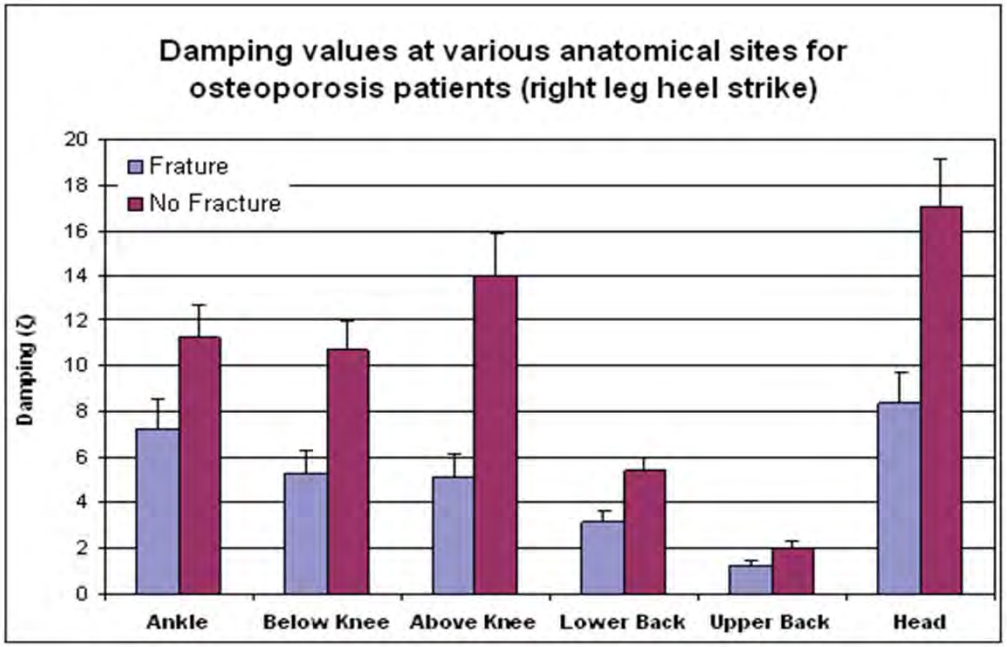
BY:

Ramez Ayoub
Mina Wanis
Nelson Watts
Amit Bhattacharya
Ozan Akkus
Alexander Robling
Hiroki Yokota

Cincinnati, OH
October 14, 2011

Question

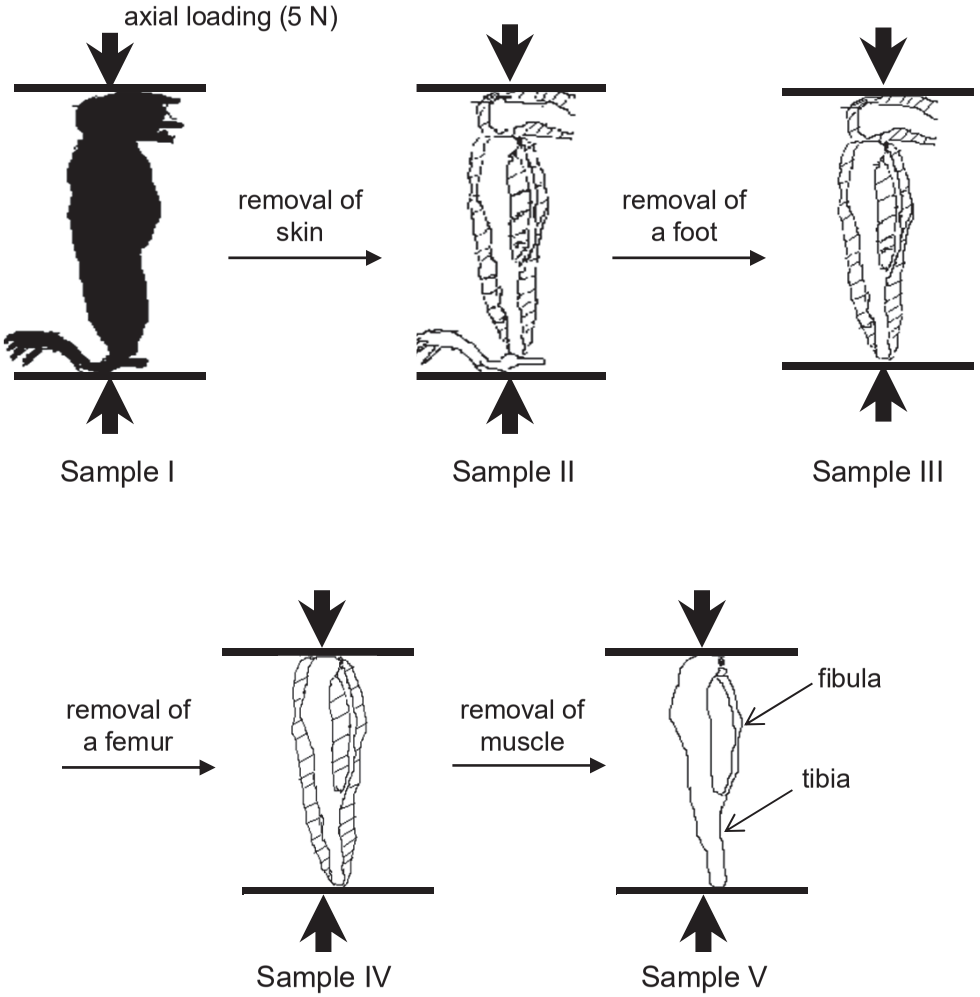




Damping is lowered in osteoporotic patients, particularly in patients with bone fracture. **Mechanism?**

Approach (experiment)

Mouse loading experiment with/without connective tissues



Phase shift angle

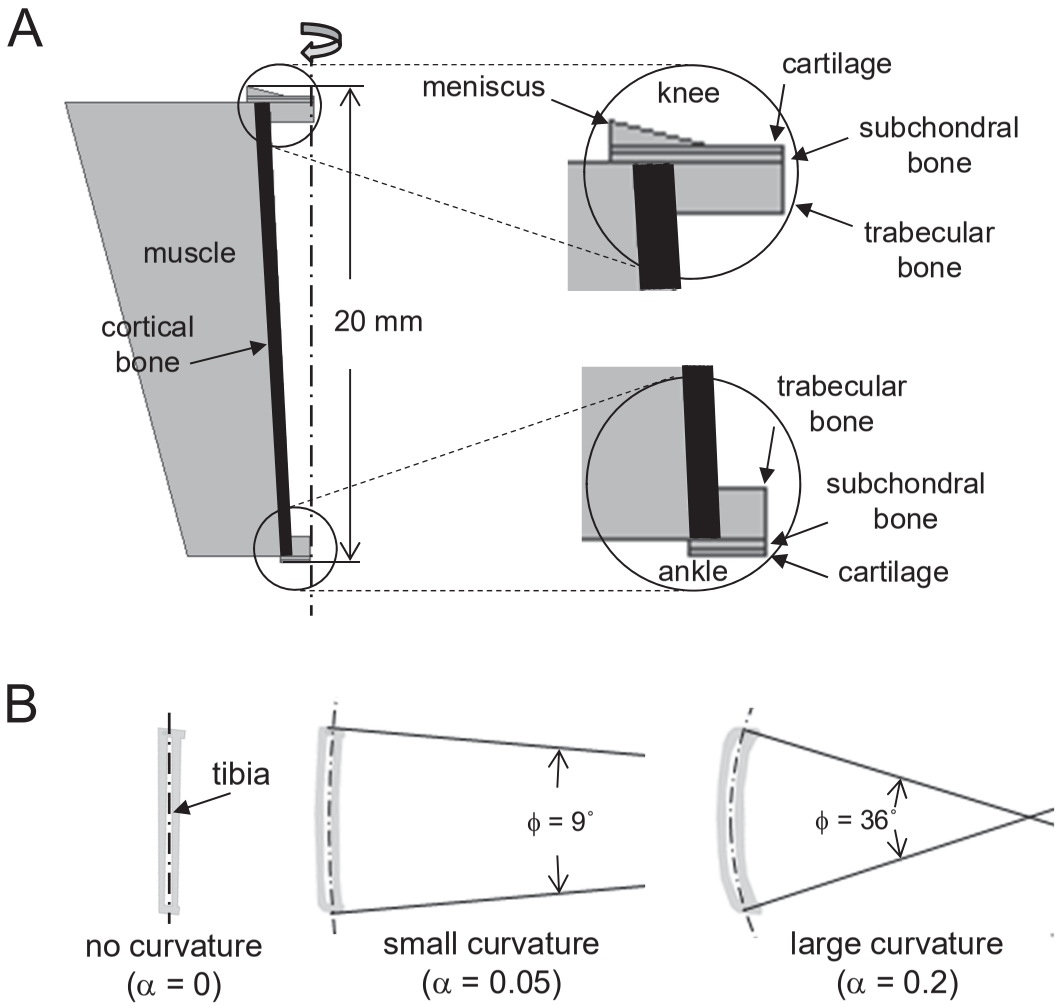
Determination of a phase shift angle

- $f = A_f sin(\omega t + \theta_f) + B_f$
- $L = A_L sin(\omega t + \theta_L) + B_L$

- $\Delta\theta = \theta_f - \theta_L$

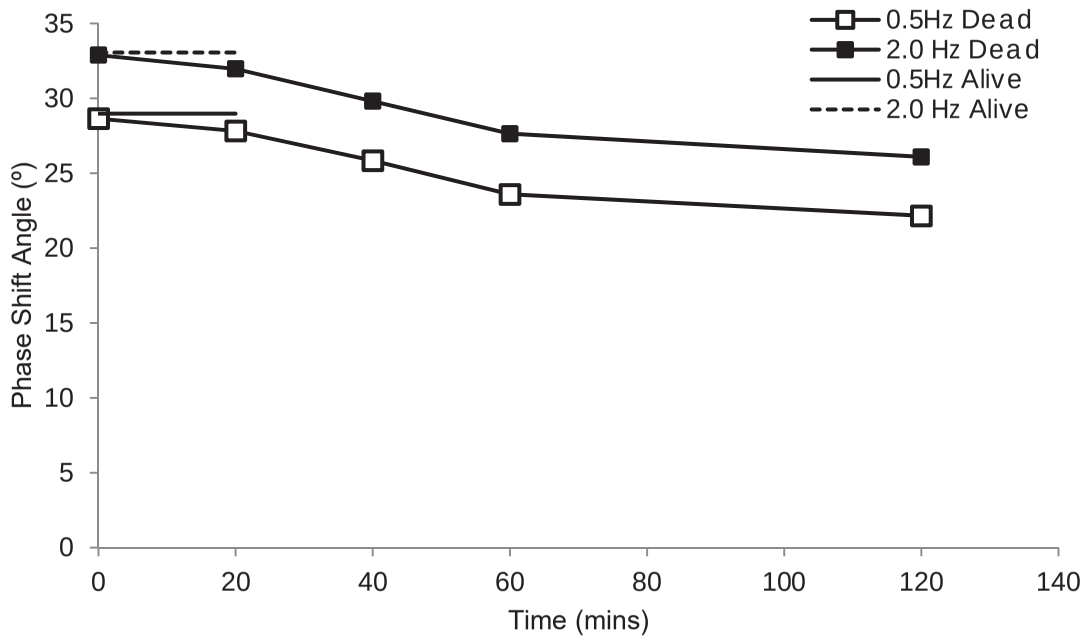
Approach (FE model)

Finite element analysis



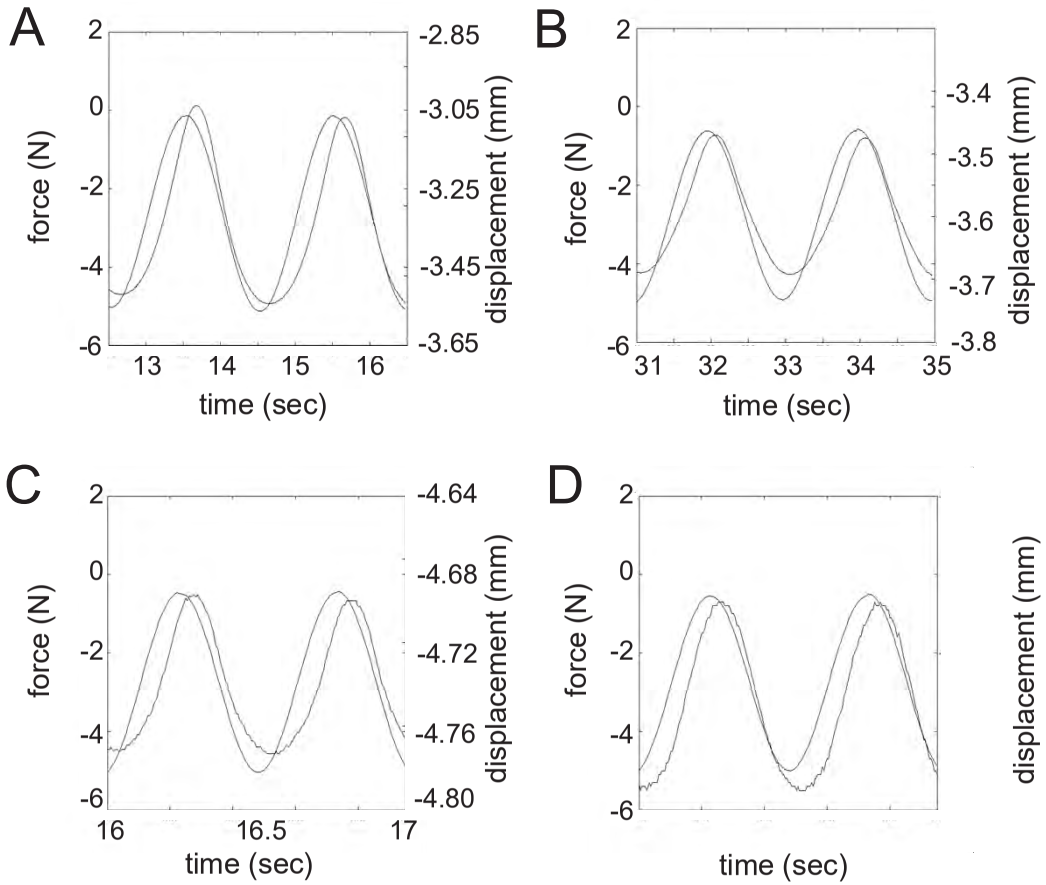
Model system

Anesthesia vs. euthanasia



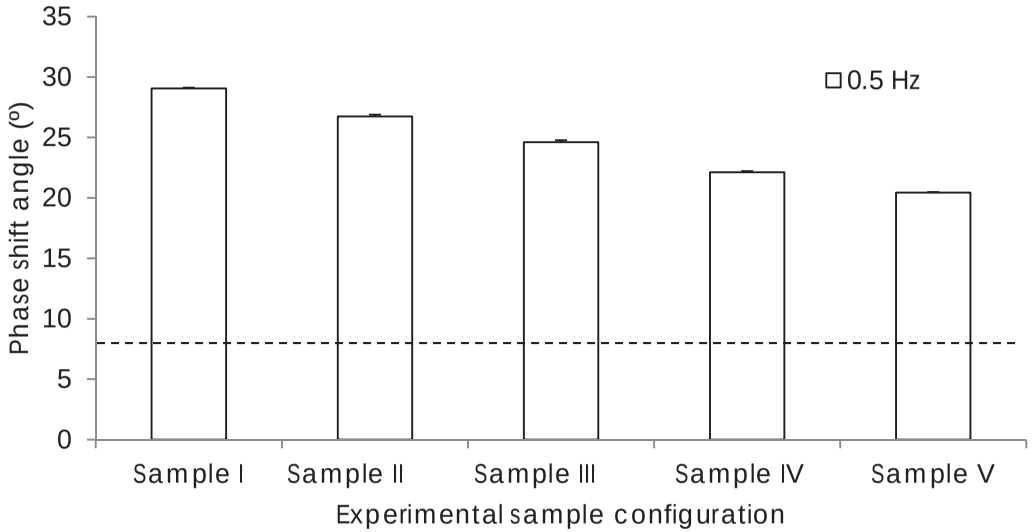
Result (experiment)

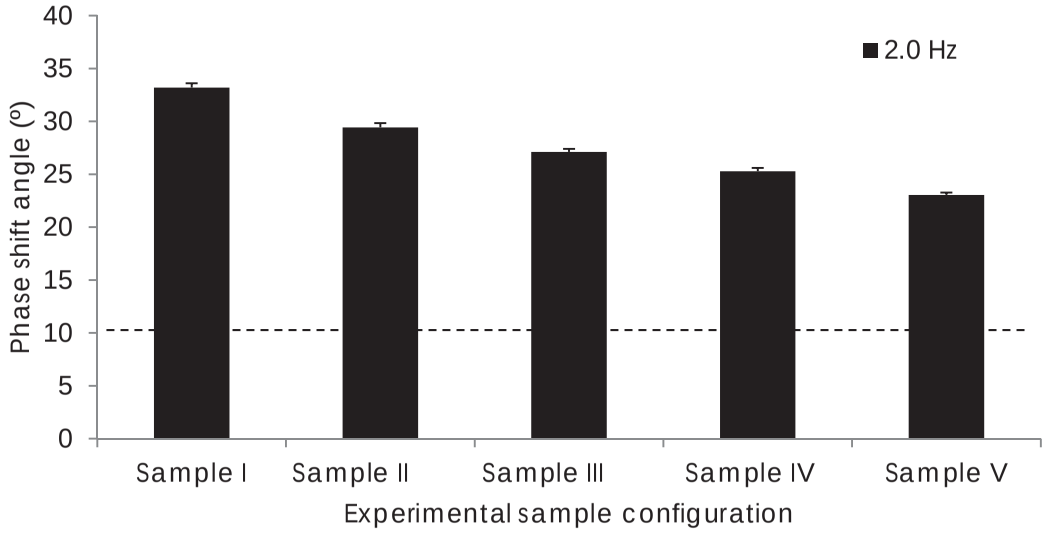
Force/displacement diagram



Result (experiment)

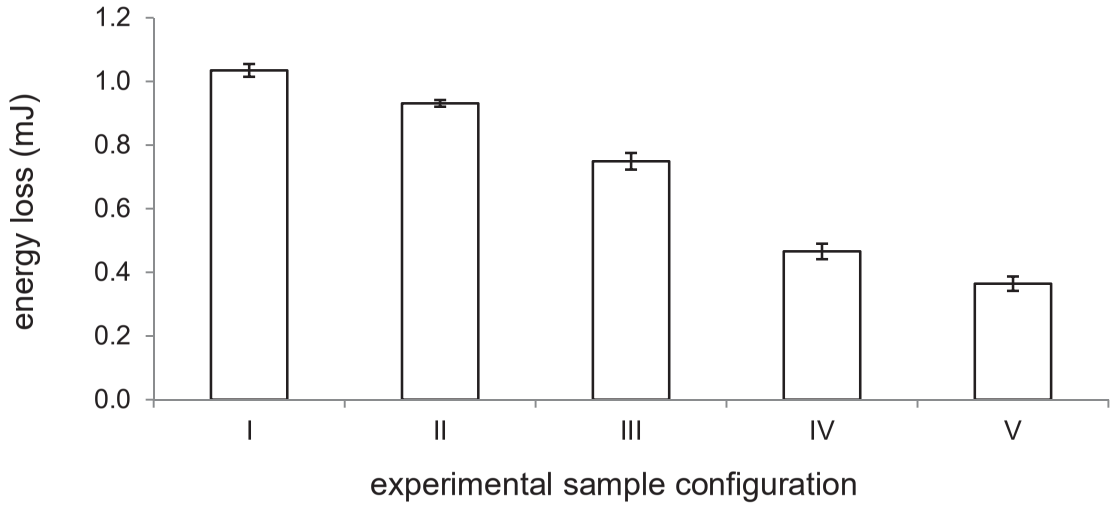
Phase shift angles





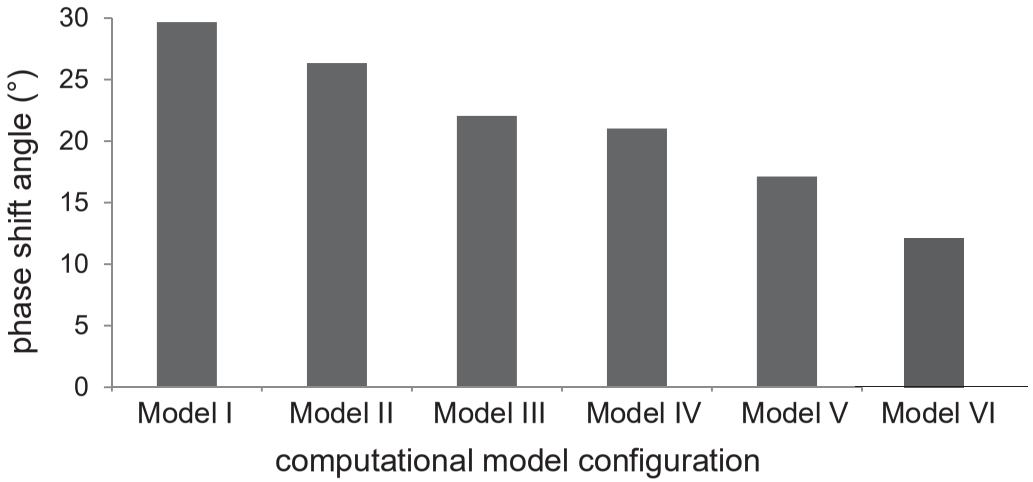
Result (experiment)

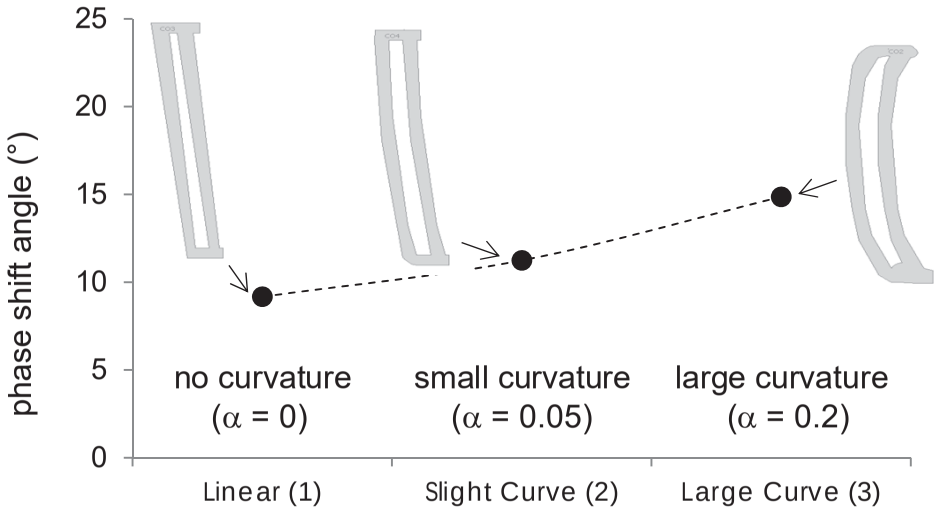
Energy loss for the sample configurations I-V



Result (FE model)

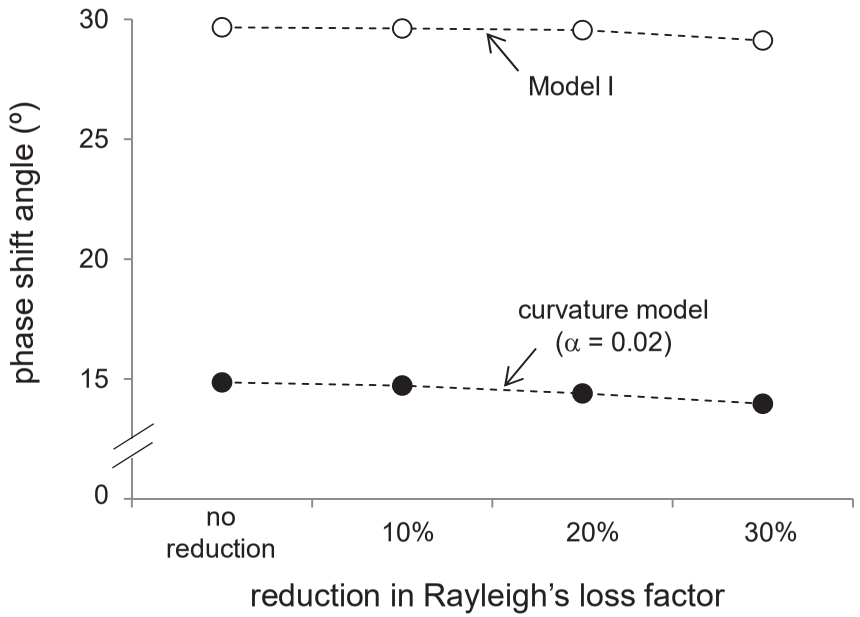
Prediction of phase shift angles





Result (FE model)

Predicted sensitivity



Summary

- The experimental and computational results revealed that both surrounding tissues and bone contributed to load damping.
- Approximately 60% of phase shift was induced by bone itself and this shift was increased with bone curvature.
- Although structural curvature reduces critical loads for buckling in a beam theory, evolution apparently favors maintaining curvature in the tibia.
- In addition to bone's compressive damping capacity, surrounding tissues as well as naturally occurring bone curvature are contributors to mechanical damping, which may ultimately affect bone remodeling and bone quality.

Acknowledgements

- Shana Ellis for mechanical loading
- Muller Soliman for data analysis

- Project Training Program of the University of Cincinnati Education and Research Center Grant T42/OH008432-06

- NIH R01AR052144

University of Cincinnati
12th Annual
Pilot Research Project Symposium
October 13-14, 2011

Main Menu

Hosted by: The University of Cincinnati Education and Research Center Supported by: The National Institute for Occupational Safety and Health. (NIOSH) Grant #: T42/OH008432-06

Produced by Kurt Roberts Department of Environmental Health