A ROBUST SHELL FINITE ELEMENT AND NONLOCAL APPROACHES TO STUDY ARCHITECTED MATERIALS AND FRACTURE IN SOLIDS

J.N. Reddy[1,2]

[1]J. Mike Walker '66 Department of Mechanical Engineering, Texas A&M University
College Station, Texas 77843-3123 USA
[2]Director, *Center of Innovation in Mechanics for Design and Manufacturing*
jnreddy@tamu.edu; http://mechanics.tamu.edu

ABSTRACT

The lecture will present the speaker's recent research in: (1) the development of higher-order, locking-free shell finite elements for large deformation of laminated and functionally graded plate and shell structures [1], (2) nonlocal approaches for modeling architected materials and structures [2] and a graph-based finite element analysis of fracture [3-5]. The seven-, eight-, and twelve-parameter shell elements developed are based on modified first-order and third-order thickness stretch kinematics, and they require the use of fully three-dimensional constitutive equations. Through the numerical simulation of carefully chosen benchmark problems, it is shown that the developed shell elements are insensitive to all forms of numerical locking and are the best alternative to 3-D finite elements in saving computational resources while predicting accurate stresses. The graph-based finite element approach with nonlocal criterion (called GraFEA) to study fracture in solids is found to be very robust and accurate in predicting fracture. The approach has the ability to model discrete microcracking with random crack orientations. The computational technique also incorporates a probabilistic approach to damage growth by using a measure of "microcrack survival probability" and its evolution. The approach will be demonstrated using several examples.

References

1. G.S. Payette and J.N. Reddy, *Computational Methods in Applied Mechanics and Engineering*, **278**, 664-704, 2014.
2. Praneeth Nampally, Anssi Karttunen, and J.N. Reddy, *European Journal of Mechanics, A/Solids*, **74**, 431-439, 2019.
3. K. Sarah, P. Thamburaja, A. Srinivasa, and J. N. Reddy, *Mechanics of Advanced Materials and Structures,* **27**(13), 1085-1097, 2020.
4. P. Thamburaja, K. Sarah, A. Srinivasa, and J. N. Reddy, *Proceedings of the Royal Society A*, **477**(2252), 2021.
5. H. Y. Shin, P. Thamburaja, A. Srinivasa, and J.N. Reddy, *Extreme Mechanics Letters*, **52**, article 101618, 2022.