Structural Engineering Seminar Series

CEE 595 S

On Robust Shell Finite Elements and Architected Materials and Structures

J.N. Reddy

Advanced Computational Mechanics Laboratory
Center of Innovation in Mechanics for Design and Manufacturing
J. Mike Walker '66 Department of Mechanical Engineering, Texas A&M University.

Abstract:

The lecture will present the speaker's recent research in: [1] the development of locking-free shell finite elements for large deformation of laminated and functionally graded plate and shell structures [1,2] and non-local mechanics [3] ideas to model architected materials [4] and damage and fracture [5,6]. The seven- and twelve-parameter shell elements developed are based on modified first-order and third-order thickness stretch kinematics. Both theories 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 [2]. In the context of explaining certain observed phenomena which cannot be explained by classical continuum mechanics models, new theories are being postulated (in an attempt to improve existing models). The non-local continuum models that account for material and/or structural length scales are discussed to model architected materials and structures (e.g., web-core sandwich panels [4]) and graph-based finite element analysis of fracture in brittle-material structures [5,6].

References
[1] G.S. Payette and J.N. Reddy, Comp. Meth. Appl. Mech. Engng., 278, 664-704, 2014.
[2] Miguel E. Gutierrez Rivera, J.N. Reddy, and Marco Amabili, Composite Structures, 151, 183-196, Sep 2016.
[3] Arun Srinivasa and J.N. Reddy, Applied Mechanics Reviews, 69, 10.1115/1.4036723, May 2017.
[4] Anssi Karttunen, J.N. Reddy, and Jani Romanoff, Int. J. Solids and Structures, 170, 82-94, 2019.
[5] P. Khodabakhshi, J.N. Reddy, and A.R. Srinivasa, Acta Mechanica, 51 (12), 3129-3147, 2019.
[6] Prakash Thamburaja, K. Sarah, A.R. Srinivasa, and J.N. Reddy, Computer Methods in Applied Mechanics and Engineering, 354, 871-903, 2019.

Bio:

Dr. Reddy is a Distinguished Professor, Regents' Professor, and inaugural holder of the Oscar S. Wyatt Endowed Chair in Mechanical Engineering at Texas A&M University, College Station, Texas. Dr. Reddy, an ISI highly-cited researcher, is known for his significant contributions to the field of applied mechanics through the authorship of 21 textbooks and nearly 700 journal papers. His pioneering works on the development of shear deformation theories (that bear his name in the literature as the Reddy third-order plate theory and the Reddy layerwise theory) have had a major impact and have led to new research developments and applications. Some of the ideas on shear deformation theories and penalty finite element models of fluid flows have been implemented into commercial finite element computer programs like ABAQUS, NISA, and HyperXtrude. In recent years, Reddy's research has focused on the development of locking-free shell finite elements and nonlocal and non-classical continuum mechanics problems, involving couple stresses, surface stress effects, micropolar cohesive damage, and continuum plasticity of metals.

Dr. Reddy has received numerous honors and awards. Most recent ones include: 2019 Timoshenko Medal from American Society of Mechanical Engineers, 2018 Theodore von Karman Medal from the from the American Society of Civil Engineers, the 2017 John von Neumann Medal from the U.S. Association of Computational Mechanics, the 2016 Prager Medal from the Society of Engineering Science, and 2016 ASME Medal from American Society of Mechanical Engineers. In a recent world ranking of researchers in engineering by Stanford University survey published, he is #13 in all of engineering and #5 in mechanical engineering. He is a member US National Academy of Engineering and foreign fellow of Indian National Academy of Engineering, the Canadian Academy of Engineering, the Brazilian National Academy of Engineering, the Chinese Academy of Engineering, and the Royal Engineering Academy of Spain.

Monday, September 13th, 2021 4:00 – 5:00 p.m.

1310 Yeh Student Center