

Woh Hup Distinguished Lecture

You are cordially invited to a Lecture organized by
Department of Civil and Environmental Engineering

A Robust Shell Finite Element and A Nonlocal Approach to Model Architected Structures

by

Professor J.N. Reddy

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Date: Thursday, 13 July 2023
Time: 4 pm – 6 pm
Venue: Engineering Auditorium
National University of Singapore
College of Design and Engineering
9 Engineering Drive 1
Singapore 117575



Scan code to register
(Pending PDU)

Seats are limited. Please register early. All are welcome and admission is free

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 [1-3], (2) nonlocal approaches for modeling architected materials and structures [4,5]. The seven-parameter shell element 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. A 2-D micropolar equivalent single-layer (ESL), first-order shear deformation (FSDT) plate model for 3-D web-core sandwich panels are also discussed. First, a 3-D web-core unit cell is modeled by classical shell finite elements. A discrete-to-continuum transformation is applied to the microscale unit cell and its strain and kinetic energy densities are expressed in terms of the macroscale 2-D plate kinematics. The hyperelastic constitutive relations and the equations of motion (via Hamilton's principle) for the plate are derived by assuming energy equivalence between the 3-D unit cell and the 2-D plate. The 2-D

micropolar model gives only small errors of 2.7–3.4% as it can emulate the 3-D deformations better through non-classical antisymmetric shear behavior and local bending and twisting. The approach will be demonstrated using several examples.

References

1. R. A. Arciniega and J.N. Reddy, *Computer Methods in Applied Mechanics and Engineering*, **196**(4-6), 1048-1073, 2007.
2. G.S. Payette and J.N. Reddy, *Computational Methods in Applied Mechanics and Engineering*, **278**, 664-704, 2014.
3. Miguel Gutierrez Rivera and J.N. Reddy, *Mechanics Research Communications*, **78**, Part B, 60-70, Dec 2016.
4. Anssi Karttunen, J.N. Reddy, and Jani Romanoff, *International Journal of Solids and Structures*, **170**, 82-94, 2019.
5. Praneeth Nampally, Anssi Karttunen, and J.N. Reddy, *European Journal of Mechanics, A/Solids*, **74**, 431-439, 2019.

Speaker's Biography



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 24 textbooks and over 800 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 and damage and fracture in solids.

Dr. Reddy has received numerous honors and awards. Most recent ones include: 2022 *IACM Congress (Gauss-Newton) Medal*, 2019 *SP Timoshenko Medal* from American Society of Mechanical Engineers, 2018 *Theodore von Karman Medal* 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. He is a member US National Academy of Engineering and foreign fellow of the Brazilian National Academy of Engineering, Indian National Academy of Engineering, the Canadian Academy of Engineering, the Chinese Academy of Engineering, the Royal Engineering Academy of Spain, the European Academy of Sciences, and the European Academy of Sciences and Arts.

Programme Itinerary

Time	Agenda
3:45 pm - 4:00 pm	Registration
4:00 pm - 4:05 pm	Welcome Address by Professor Quek Ser Tong
4:05 pm - 5:20 pm	Woh Hup Distinguished Lecture by Professor JN Reddy followed by Q & A
5:20 pm - 6:00 pm	Refreshment and Networking Session
6:00 pm	End of Programme

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