

A family of residual stress bases

Dr. Sankalp Tiwari, Okinawa Institute of Science and Technology, Japan

ABSTRACT

Residual stresses are ubiquitous and generally have varied and complex origins. Due to the former, it is crucial to characterize them; due to the latter, it is not easy to characterize them. Unlike existing theoretical works concerning residual stresses, which are often predicated on a given constitutive response, we wish to develop a framework to characterize general residual stresses in arbitrary solid bodies without regard to their physical origins or material properties. Toward that objective, we develop a family of residual stress bases such that the elements of each member of this family can be linearly combined to represent any square-integrable residual stress field. This is done by posing an optimization problem whose objective function is a suitable quadratic functional of the stress-gradient, leading us to a second-order elliptic partial-differential equation whose solutions are the sought bases. We demonstrate three applications of these bases: (a) interpolation, (b) fitting, and (c) representation of arbitrary residual stresses. The fact that we have a family of bases provides us with great leeway in their choice, depending on the problem at hand.

ABOUT THE SPEAKER

I have been a postdoc since September 2023 at the Materials and Mechanics Unit, Okinawa Institute of Science and Technology, Japan. This unit is headed by Prof. Eliot Fried. The problems I have worked on as a postdoc include characterization of residual stresses, characterization of a second-order kinematic descriptor in shell theory, and determination of critical height of trees, among others. I received my Bachelor's, Master's, and PhD degrees from Mechanical Engineering, IIT Kanpur. After submitting my PhD thesis, I worked for 15 months at the Nimbkar Agricultural Research Institute, a rural technology NGO in Phaltan, Maharashtra, on developing a jaggery plant. After this remarkable learning experience, I worked for eight months at IIT Hyderabad as a research associate on the stability of delay-differential equations. Apart from the above-mentioned research themes, I have also worked on the physics of Tabla, presented bounds on the efficiency of a base-excited energy harvester, and developed a delayed low-dimensional COVID-19 model. Upon becoming an independent researcher, I plan to develop theoretical techniques to aid residual stress measurement, and to utilize the framework developed in my PhD and postdoc to design initially-stressed materials toward desired functionality.



December 06, 2024, 4:00 pm, AR Auditorium, Mechanical Engineering, IISc