ME Seminar

A family of residual stress bases

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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 an eigenvalue problem 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. Toward the end of the talk, I discuss two applications of these bases that I intend to pursue as future work: improving experimental estimations of residual stresses and designing residually-stressed materials with desired constitutive response.

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 residual stresses, second-gradient shell theory, local stability of material surfaces and soap films, and 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 spent eight months at IIT Hyderabad as a research associate working on 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.

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