הטכניון מכון טכנולוגי לישראל
TECHNION Israel Institute of Technology

Faculty of Mechanical Engineering
הפקולטה להנדסת מכונות

MECHANICAL ENGINEERING STUDENT SEMINAR

Wednesday, July 3, 2024, at 13:30, D. Dan and Betty Kahn Building, Room 217.
Online: http://technion.zoom.us/my/yossiabramov

Near Equilibria Static Analysis of a Helical Folded Tube

Yossi Abramov

Adviser: Assoc. Prof. Amir D. Gat

Permanent creases on thin-walled objects are imprinted lines on which there is local plastic deformation. Geometrically constrained creases are often leveraged as multi-stable elements with applications in various fields, including robotic actuators, energy storage and release, and meta-materials. Using curved creases, instead of straight ones, increases the design space and thus can lead to better engineering solutions. A single helical crease, located around a long tube (hereafter HFT), can replace a highly complex triangulated crease pattern composed of multiple straight crease lines. This drastically simplifies both fabrication and actuation, while maintaining the functionality of such structures. The aim of my analysis is to model the near-equilibrium mechanical behavior of such helical folded tubes.

The helicoidal crease geometry makes the HFT a natural generalization of the conical frustum, which is an extensively studied element. Therefore, I will begin with a description of the existing static solution of an axially loaded conical frustum. Based on the understanding of this previously derived model and its underlying assumptions, I will construct a near-equilibrium static solution of a pressurized HFT fixed at one end and the other subjected to an axial force coupled with torque.

The static analysis of the elastic HFT structure begins with a position vector ansatz, where I assume a small rigid rotation of the sections, a constant neutral radius, and ideal boundary conditions. Then, I perform a kinematic analysis near the stable equilibrium points, considering that the deformed HFT geometry maintains screw symmetry. This analysis reveals a parabolic relation between rotation and elongation along with a uniaxial strain tensor in the helical direction. Following that, I utilize force equilibrium, assuming a linear elastic material and the absence of gravity and friction, to determine the neutral radius up to a first-order term, as well as a leading-order functional dependence of the force coupled with torque on axial translation. Thus, I am able to provide a novel analytical approximation for helical creases around a tube.

Note: the seminar will be given in **English**

Seminars Coordinator: Assoc. Prof. Gal Shmuel