COLLEGE OF ENGINEERING AND COMPUTER SCIENCE
FLORIDA ATLANTIC UNIVERSITY

Announces the Ph.D. Dissertation Defense of

MUSTAFA O. AYANOGLU

for the degree of Doctor of Philosophy (Ph.D.)

"Influence of Deformation Constraints of Honeycomb Core Cells on the Bending Stiffness of Single-Face Sandwich "

April 21, 2024, 10 a.m.
EW, Room 187
777 Glades Road
Boca Raton, FL

DEPARTMENT:
Ocean and Mechanical Engineering

ADVISOR:
Leif A. Carlsson, Ph.D.
Sarah Du, Ph.D.

PH.D. SUPERVISORY COMMITTEE:
Leif A Carlsson, Ph.D., Chair
Sarah Du, Ph.D.
Vivian Merk, Ph.D.
Francisco Presuel-Moreno, Ph.D.

ABSTRACT OF DISSERTATION
Influence of Deformation Constraints of Honeycomb Core Cells on the Bending Stiffness of Single-Face Sandwich

This research focuses on deformation constraints of honeycomb core cells in a sandwich imposed by bonds to the face sheets. Specifically, the influence of one-sided core constraints on the bending stiffness of a single-face honeycomb core sandwich is examined. To characterize the unconstrained in-plane compressive response of honeycomb core, a range of honeycomb cores was experimentally examined. Cores with a thin cell wall displayed extensive bending deformation of inclined cell walls while cores with thicker walls failed by a shear-type instability of the cells indicated by tilting of vertical cell wall segments. The modulus and compressive strength of the core were compared to predictions from unit cell models. It was shown that geometrical imperfections such as cell wall angle being different from the targeted value results in deviation from in-plane isotropy and have strong influence on modulus and strength of the core**.** Modulus and strength were in reasonable agreement with predictions from unit cell models for cell wall modulus and strength between 5-12 GPa and 72-171 MPa for the set of cores examined.

A honeycomb core in a sandwich panel is constrained by bonding to the two face sheets. The constraint prevents bending of flexible cell walls in the core and the associated large transverse deformation of the core during in-plane extensional loading. The constraint elevates the effective in-plane modulus of the core to a large extent. Analysis of the influence of one-sided constraint on bending stiffness of single-face sandwich beams with Nomex honeycomb core is presented by developing a gradient core modulus model in laminate beam theory. The model includes two parameters, i.e. the factor of core modulus increase and the length of the influenced region. The one-sided constraint is shown to greatly influence the bending stiffness by a factor of about 3-4. Single-face sandwich specimens with a honeycomb core were prepared and tested in flexure. Experimentally test results verify that the core constraint significantly increase the bending stiffness by a factor of about 3-4. The experimental results support the gradient model predictions. The core constraints have a large influence on the compliance and energy release rate calculations for ENF and MMB debond fracture specimens and must be considered in the evaluation of fracture toughness.

BIOGRAPHICAL SKETCH
Born in Hatay, Turkey
B.S., Eastern Mediterranean University, Famagusta, Northern Cyprus, 2009

M.S., University of Hartford, Hartford, Connecticut, USA, 2017
Ph.D., Florida Atlantic University, Boca Raton, Florida, 2024

CONCERNING PERIOD OF PREPARATION
& QUALIFYING EXAMINATION

Time in Preparation: 2018 - 2024

Qualifying Examination Passed: Spring 2019

Published Papers:

- **Ayanoglu, M. O.,** Saseendran, V., & Carlsson, L. A. (2023). Geometrical imperfection sensitivity on in-plane compressive modulus and strength of honeycomb core and deviations from isotropy. *Journal of Composite Materials*, *57*(24), 3853-3864.
- **Ayanoglu, M. O.,** Tauhiduzzaman, M., & Carlsson, L. A. (2022). In-plane compression modulus and strength of Nomex honeycomb cores. *Journal of Sandwich Structures & Materials*, *24*(1), 627-642.
- Tauhiduzzaman, M., Carlsson, L. A., **& Ayanoglu, M. O. (2021).** Design analysis of end notch flexure sandwich specimen with honeycomb core. *Journal of Composite Materials*, *55*(10), 1295-1308.