Performance Evaluation of 3D Printed Architectured Sandwich Panels for Lightweight Structures

Sandwich panels are generally constructed with two facesheets separated by a low-density core cellular structure. The facesheets and the core can be made of different or the same material. The mechanical properties of a sandwich panel depend on the materials of the core and facesheets, the geometry of the panel, and mostly the topology of the core cellular structures. Material of the facesheets and the topology of the cellular structure can be chosen according to the application of the panel such as structural rigidity, energy absorption capacity, vibration and acoustic attenuation, thermal insulation property, etc. Sandwich panels are extensively utilized in airplane wings and bodies, lightweight sportswear, marine and military applications, thermal insulative walls/roofs, vibration absorbing materials, and automotive parts. Most often foams are used as the core where there is no control of core topology and lattice architecture. The bottleneck being the conventional manufacturing process. Advances in additive manufacturing process can allow the incorporation of desired complex core architecture in sandwich structures for myriads of engineering applications.

In this project, we will concentrate to additively manufacture sandwich panels with desired core lattice architectures for specific engineering applications. Additive manufacturing, commonly known as 3D printing, is one of the fastest emerging research areas in the world. In contrast to conventional manufacturing, additive manufacturing allows one to fabricate objects or custom tailor complex geometry parts directly from the 3D models to meet specific applications. However, the introduction of such complex geometry by additive manufacturing for many engineering products remains limited at present. Advances in 3D printing technology can allow the incorporation of preferred intricate core topology such as the honeycomb, re-entrant honeycomb, diamond, and square architectures (Fig. 1).

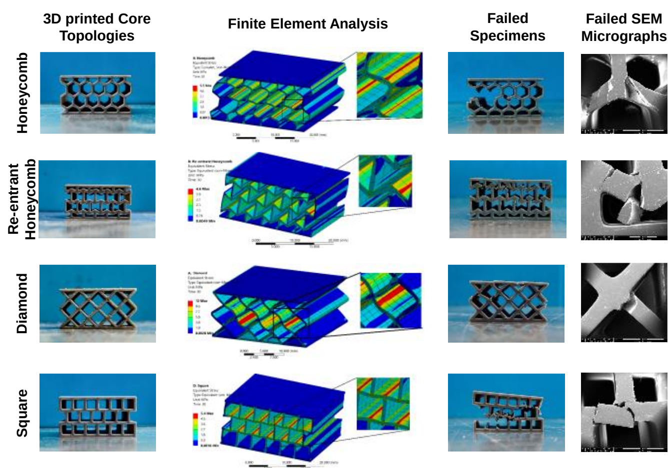

Fig. 1 *3D printed sandwich structures with different core topologies [Honeycomb (1st row), re-entrant honeycomb (2nd row), diamond (3rd row), and square (4th row)] along with corresponding von Mises stress distribution under compressive loading by FEA. FEA predicts stress concentration zones and possible failure locations (insets). Corresponding failed specimen under compressive loading with SEM micrographs are also shown which agree with FEA results.*

The REU student will participate in the manufacturing, characterizing, and learning to execute finite element analysis (FEA) for superior sandwich performance. With the integration of optimized cores and additive manufacturing techniques, the high-performing sandwich products can be custom-tailored to meet specific engineering needs.

References

1. D'Alessandro, V., et al., A review of the vibroacoustics of sandwich panels: Models and experiments. Journal of Sandwich Structures & Materials, 2013. 15(5): p. 541-582.
2. Afshin, M., M. Sadighi, and M. Shakeri, Vibration and damping analysis of cylindrical sandwich panels containing a viscoelastic flexible core. Journal of Sandwich Structures & Materials, 2010. 13(3): p. 331-356.
3. Nath, S.D. and S. Nilufar, An Overview of Additive Manufacturing of Polymers and Associated Composites. Polymers, 2020. 12(11).
4. Henin, E., G. Morcous, and M.K. Tadros, Precast/Prestressed Concrete Sandwich Panels for Thermally Efficient Floor/Roof Applications. Practice Periodical on Structural Design and Construction, 2014. 19(3).