INDIAN INSTITUTE OF TECHNOLOGY MADRAS

DEPARTMENT OF MECHANICAL ENGINEERING |

Ph.D. Seminar Talk 1

Title of the Seminar: Topology-Stacked Hybrid Honeycomb–Re-entrant Diamond Cellular Structures for Tailored Crashworthiness.

Speaker: Mr. Amit Prakash (ME21D068)

Ph.D. Research Scholar, Department of Mechanical Engineering, IIT Madras.

DATE & TIME	VENUE	ONLINE
10 November 2026, Tuesday, 03:00 PM - 04:00 PM	**Room No. 363, Conference Hall, New Academic Complex 2 (NAC-2), IIT Madras.**	**Join via Google Meet** https://meet.google.com/eno-oahq-uvr

Guide: Dr. Shankar Krishnapillai, ME

Co-guide: Dr. R Gnanamoorthy, ME

SCAN TO JOIN

ABSTRACT

Architected cellular structures offer lightweight crashworthiness through high specific energy absorption and controllable deformation. This study investigates how stacking conventional hexagonal honeycomb (UH) and re-entrant diamond (RDA) architectures influences the crushing behaviour of hybrid cellular structures. Six configurations are examined: UH, RDA, UHRDA, RDAUH, UHRDASAND, and RDAUHSAND, designed with approximately comparable relative densities. The mechanical properties of fused-filament-fabricated ABS are characterized using ASTM D638 Type IV tensile specimens. Abaqus/Explicit finite element models are validated against quasi-static compression experiments and subsequently used to simulate crushing at 1, 10, 20, and 30 m/s. Crashworthiness is assessed through specific energy absorption (SEA), peak stress, crushing force efficiency (CFE), stress–strain response, and deformation modes.

Results show that loading velocity and topology arrangement strongly affect structural response. RDAUH performs favorably at lower velocity, whereas UHRDA exhibits more consistent performance at higher velocities. At 30 m/s, UHRDA achieves a SEA of 4090 J/kg and CFE of 75.12%, outperforming UH in these metrics but producing higher peak stress. A TOPSIS-based multi-criteria analysis assesses trade-offs among competing crashworthiness objectives. In particular, the relative positioning of honeycomb and auxetic layers alters progressive collapse and the distribution of crushing loads. The findings demonstrate that hybridization alone does not guarantee improved performance: stacking sequence controls deformation localization, load transfer, and crushing efficiency. These insights provide design guidance for lightweight impact-protection structures.