New experimental platform for investigating soliton and wave dynamics in 1D and 2D polycatenated architected materials (PAMs)

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Polycatenated Architected Materials (PAMs) are a new class of metamaterials composed of interlocked ring-like elements, which offer unique, tunable nonlinear dynamics and energy-dissipative behavior under mechanical loading. Compared to conventional architected or granular materials, PAMs exhibit highly customizable resistance to specific deformation modes, due to the high internal degrees of freedom in their interlocked and per-unit topology. This enables their potential use in advanced shock absorption applications, such as impact-resistant helmets or vehicle protection systems, where tailored mechanical responses are desirable. Because most existing experiments only investigate static properties of PAMs, investigations into the dynamics of PAMs are necessary to fill the knowledge gap for such applications. To this end, we developed an experimental platform to investigate force and soliton propagation in 1D and 2D PAM systems. Using this platform, we obtained high-quality, analyzable data from experiments investigating 1D chains, junctions of chains, and 2D chainmail meshes. These experiments allowed us to compare experimental signatures of nonlinear wave propagation with theory. The setup's modular design allows for various different configurations of PAMs and actuation modes, such as transverse or rotational actuation and the integration of various sensors into the PAM units, yielding great potential for future experimentation.