Contribution ID: **375** Type: **Presentazione orale**

Experimental and Numerical Evaluation of Magnetorheological Fluid-Actuated Metamaterials

Friday 4 September 2026 12:15 (15 minutes)

Smart metamaterials, featuring dynamically tunable mechanical properties, represent a promising frontier in structural engineering and advanced robotics. Tunable properties can be introduced through several approaches, e.g., by designing geometric instability mechanisms, by embedding actuators within metamaterials, or by pre-tensioning lattice metamaterial struts.
In this context, this study presents the design and characterization of a class of smart lattice metamaterials where traditional struts are replaced by hollow beams filled with a magnetorheological (MR) fluid. The MR fluid is leveraged to achieve dynamically tunable and fully reversible mechanical response by applying an external magnetic field, which is used to modify the fluid's yield stress.
Multiphysics finite element simulations were carried out in COMSOL 6.4 to characterize the magneto-mechanical behavior of the lattice metamaterial subjected to large deformation. The numerical results were validated through experiments conducted on real prototypes, allowing for a direct comparison between empirical evidence and computational predictions.
The results bring evidence that filling lattice metamaterial beams with MR fluids enables dynamically tunable and fully reversible mechanical response. This class of metamaterials paves the way for intelligent structures with custom mechanical properties and design, and will be further studied to research any self-sensing capabilities to design autonomous metamaterials.

Primary author: MAZZA, Alex (Politecnico di MIlano)

Co-authors: CADINI, Francesco (Politecnico di Milano; Department of Mechanical engineering); LOMAZZI, Luca (Politecnico di Milano; Department of Mechanical Engineering)

Presenter: MAZZA, Alex (Politecnico di MIlano)

Session Classification: Modellazione

Track Classification: Modellazione