ME – MTech(Res) Thesis Defence

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3D-Printing of Lunar Soil Simulant by Direct-Extrusion method

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ABSTRACT

The extrusion-based additive manufacturing (EAM) technique is recently being widely employed for the 3D printing of complex-shaped components made of ceramic powder (containing irregular-shaped particles) when it is cast in the form of a slurry/ink. In this work, we utilize a direct extrusion method for printing structures from extra-terrestrial soil simulants using a piston-based extruder. Printing is demonstrated using a slurry composed of lunar soil simulant (LSS) variant ISAC-1 (avg. particle size ~ 90μm) mixed with biopolymer guar gum as a sustainable binding agent and DI water as a solvent. Parts were printed using a 2 mm diameter nozzle by optimizing print speed, nozzle height, inter-layer drying time, and build temperature, to ensure shape retention post-printing. The final green parts were dried in a hot air oven (50°C) for 48hrs, followed by sandpaper polishing. The strengths of the printed specimens were evaluated using compression and flexure tests and were found to be comparable to that of bio-consolidated structures. Unlike solid geometries, the well-known shell-infill type area-filling strategy generated several travels and re-tracings in the toolpath for cellular geometries. Owing to the yield stress of slurry, the travels and re-tracings resulted in discontinuous print and poor dimensional accuracy respectively. This necessitated a toolpath with increased continuity in the extrusion path. The customized toolpath is generated by defining a continuous nodal path over a lattice structure corresponding to the cellular frame. The extrusion flow rate is tuned according to the nodal path and the requirement of material deposition. Qualitatively the increased extrusion continuity in the customized toolpath resulted in continuous print with improved dimensional accuracy, whereas quantitatively a significant (~ 60%) reduction in print time is observed. These results show the potential for using the direct extrusion 3D printing method in remote extra-terrestrial environments to obtain lightweight load-bearing structures like cellular frames.

ABOUT THE SPEAKER

Dhanashri Desai is an MTech (Research) student joined in 2020 in the Department of Mechanical engineering at Indian Institute of Science, Bengaluru. She is working with Prof. Aloke Kumar. She graduated with bachelor's degree in Mechanical engineering from College of Engineering Pune in 2017. Her research interests are broadly in the field of Structural Optimization, Mechanical Behaviour Materials, and Additive Manufacturing.