ME – MTech(Res) Thesis Colloquium

3D-Printing of Lunar Soil Simulant via Direct Extrusion method.

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ABSTRACT

We describe here 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 naturally occurring polymeric adhesive (guar gum) and DI water as 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 the 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 samples were evaluated using compression and flexure tests and were found to be comparable to that of bio-consolidated structures. The well-known skin-infill type area filling strategy generated continuous toolpaths for solid geometries like beam, cylinder and cube. On the other hand, the same strategy generated several travels and re-tracings over printed region, when used for cellular frame structures, which are used as light weight load-bearing structures. Owing to the yield stress of slurry, the travel moves resulted in no material deposition at the starting of subsequent extrusion move, whereas re-tracing over the printed region resulted in poor dimensional accuracy. This necessitated a customized toolpath for cellular frame with increased continuity in print path (i.e., containing minimal number of travels and re-tracings). The customized toolpath is generated by defining a continuous extrusion nodal path over a lattice structure of nodes and elements, corresponding to the cellular frame. The extrusion flow rate is tuned locally according to the requirement of material deposition, by dynamically incrementing the extrusion co-ordinate. Qualitatively the increased 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 direct extrusion 3D printing method in remote extra-terrestrial environments to obtain lightweight load-bearing structures.

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, Additive Manufacturing and Mechanical Behaviour Materials.