Debris Impact Resistance of High-Performance 3D-Printed Concrete Wall Systems

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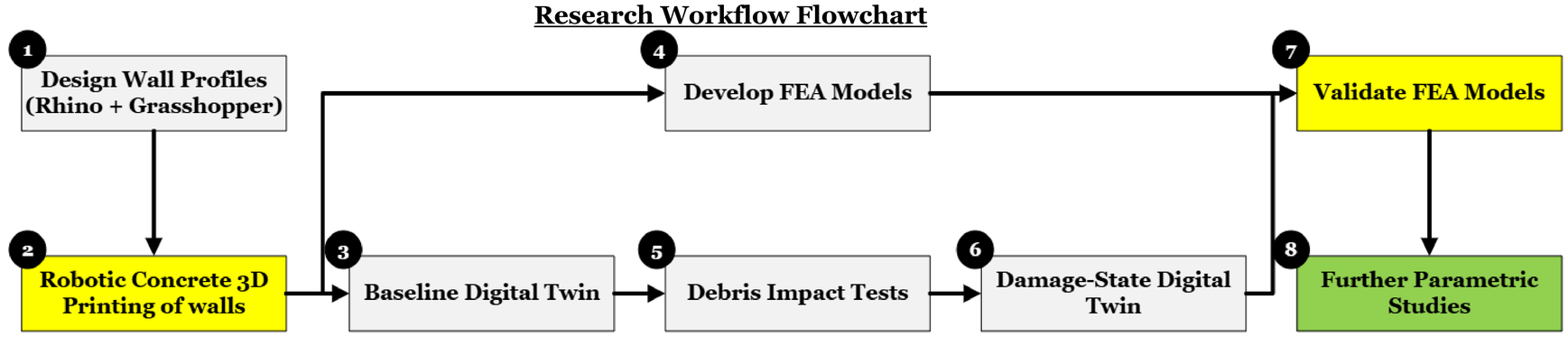
Introduction

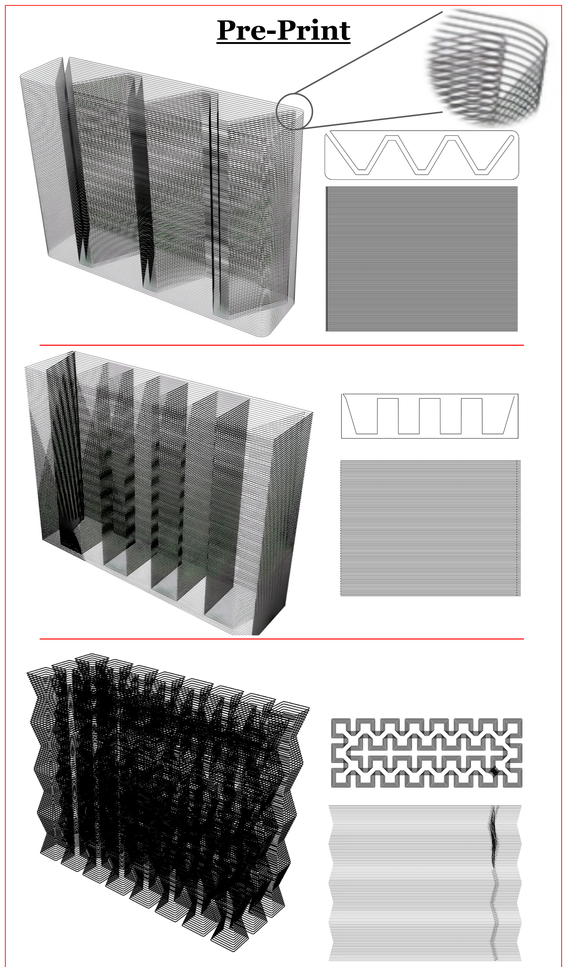
- Windborne debris can strike walls at different speeds and locations, producing distinct damage patterns that remain insufficiently understood in layered 3D-printed concrete.
- This study evaluates three 3DCP wall profiles under debris impacts at varying velocities and impact locations.
- Crack initiation, propagation, interlayer separation, deformation, and material loss are documented after each impact using three-dimensional digital twin models.

Research Workflow Flowchart



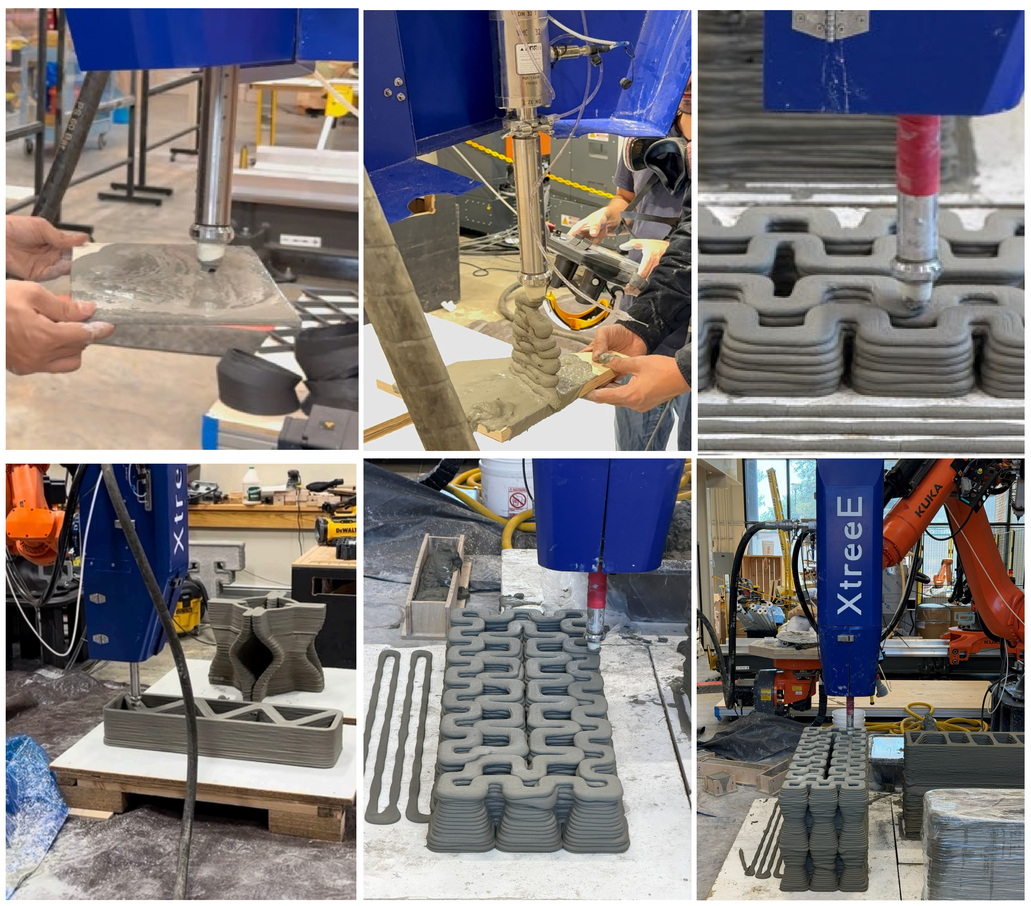
Phase - 1

Pre-Print



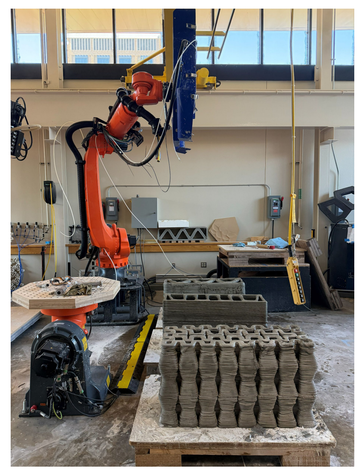
Tool Paths were designed and generated with Rhino-Grasshopper

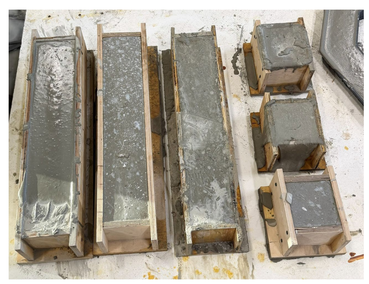
Print



Accelerator flow and material consistency were verified, and samples were then printed using the robotic 3D concrete printing system.

Post-Print

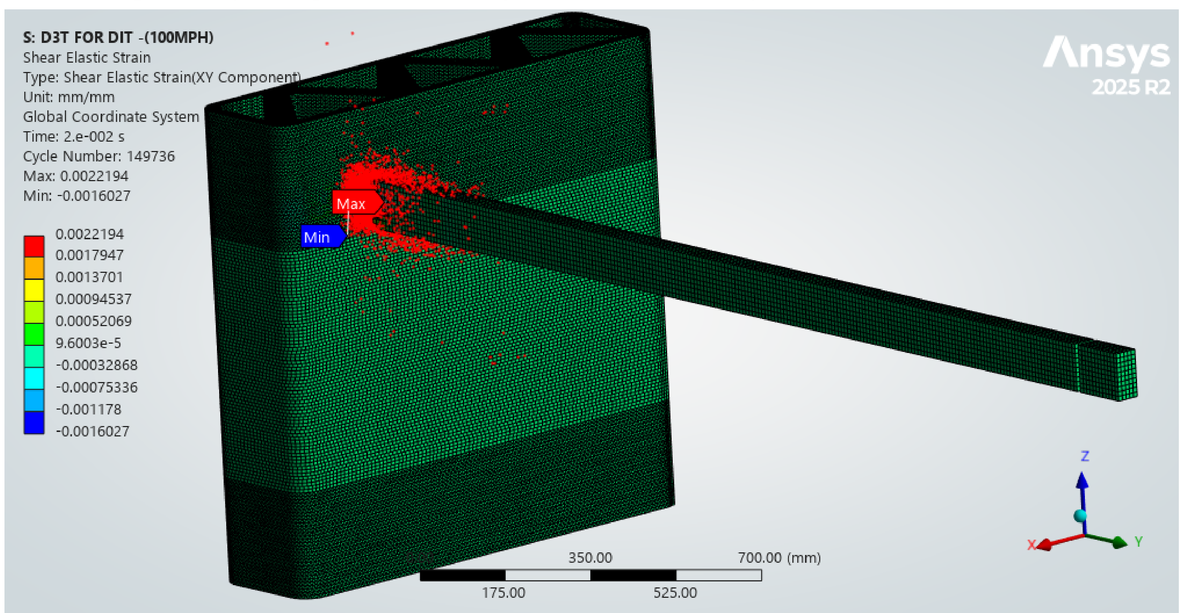


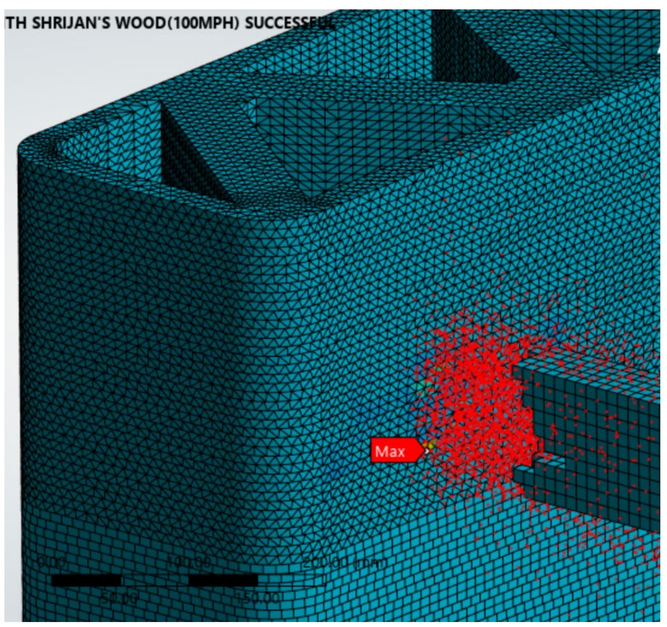


Printed walls were sprayed with water and wrapped in plastic film for **3 days** curing. Cubes and prisms were also prepared and cured separately for **28 days** to determine the material properties required for the FEA models

Phase - 2

Debris Impact Analysis, Experimental Testing & Finite Element Analysis (National Wind Institute, Texas Tech University)





Next Steps

- Transport the printed walls to the National Wind Institute at Texas Tech University.
- Conduct debris impact tests at multiple velocities and wall locations at the National Wind Institute, Texas Tech University, Lubbock TX.
- Document crack patterns and impact-induced damage after each test.
- Develop finite element models to simulate the experimental impacts.
- Use the validated models to investigate additional impact conditions and damage scenarios.

Application

Establish experimental damage data and validated digital models that can support future impact simulations and the development of disaster-resilient 3D-printed concrete walls

Acknowledgement

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