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3D-PRINTED LIGHT STRAW CLAY: OPTIMIZING PRINTING PATHS

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ABSTRACT

The use of 3D printing for earth materials is still limited to earth mixtures with minimal to no fiber reinforcement, resembling a cob-like traditional technique. Yet, recent studies show that fiber-rich earth materials such as light straw clay outperform other earth techniques in terms of their thermal performance and environmental impacts from a life cycle perspective. It is therefore critically required to expand 3D printed earth to a range of fiber-additive mixtures that increase thermal resistivity while enabling biogenic carbon storage and, potentially, enhanced ductility. This study presents an experimental assessment, developing 3D printable earth materials with maximum fiber content and linking their structural behavior to geometrical printing configuration. Part of an ongoing line of research, this work investigates the influences of printing procedures on the structural behavior, specifically the compressive strength and stress-strain curves, for four different printing paths: control cylinder (CC), rigid weaved (RW), wisted weaved (TW) and double twisted weaving (DTW) patterns. The results demonstrate that not only the addition of fiber increases overall strength as opposed to non-fiber reinforced 3D printed earth, but also that the geometrical variation plays a critical factor in the evolution of “specific” strength. The rigid weaved pattern is shown to outperform all other geometries, presumably due to the enhanced moment of inertia along the cross section, which acts as a vertical column assemblage. The compressive strength results for the fiber reinforced 3D prints range between 2.2 and 4.3 MPa, being 2-4 times higher than shown in previous literature on 3D printed earth. The significance of this research lies in the design and development of radically low-carbon natural materials for additive manufacturing, improving material performance and applicability.

KEYWORDS

3D printing; Earth materials; Natural materials; Cob; Light straw clay; Compressive strength; Printing path.