Characterizing Rheological Effects of Corn Oil on Fresh State Concrete Mixtures for 3D Printing Applications

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I. Introduction

In recent years, 3-dimensional concrete printing (3DCP) has proven to be a promising improvement to the construction industry due to its greater cost efficiency, as well as the greater geometrical freedom achieved from the lack of framework needed.

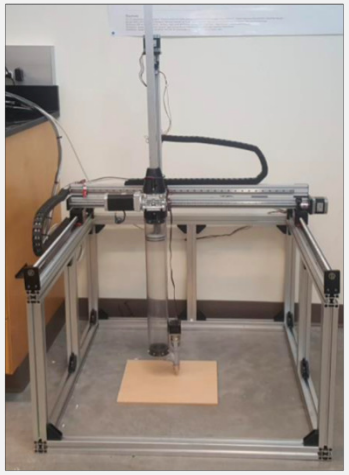

Figure 1: 3D printer at Boise State University

Contradicting rheological properties are required for 3DCP: the concrete must have a low yield stress before it is extruded but must have a high yield stress after it is extruded for buildability. To address these rheological requirements, engineers have introduced chemical admixtures, one type being viscosity modifying agents (VMAs).

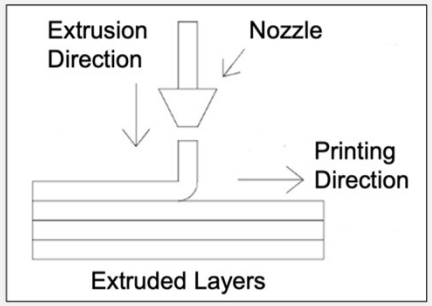

Figure 2: General scheme of 3D printing concrete[1]

Herein, we present efforts towards utilizing industrial waste materials as VMAs that could enhance fresh state rheological properties for 3DCP.

II. Materials and Methods

After screening various biofuel waste materials, we identified 3 candidates for rheological modifiers: Magnesium Silicate (Magnesol), Bentonite Clay, and Crude Glycerol. Because of similar chemical composition, initial rheological profiling has been done using corn oil.

Shear stress and viscosity measurements were made using a rotational viscometer (ViscoQC 300) and were analyzed using Excel to find the yield point stress.

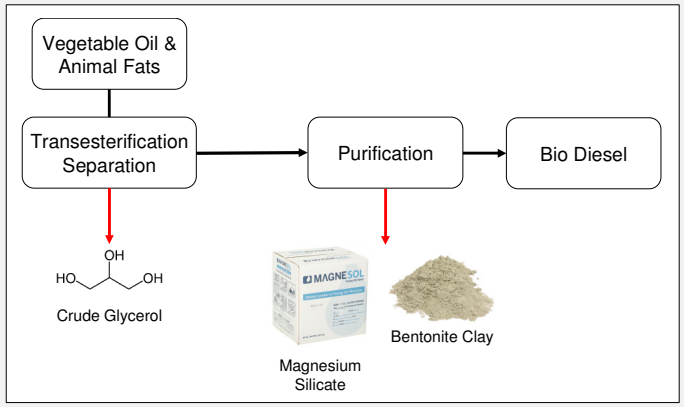

Figure 3: Biodiesel production scheme and desired waste materials[2]

III. Results and Discussion

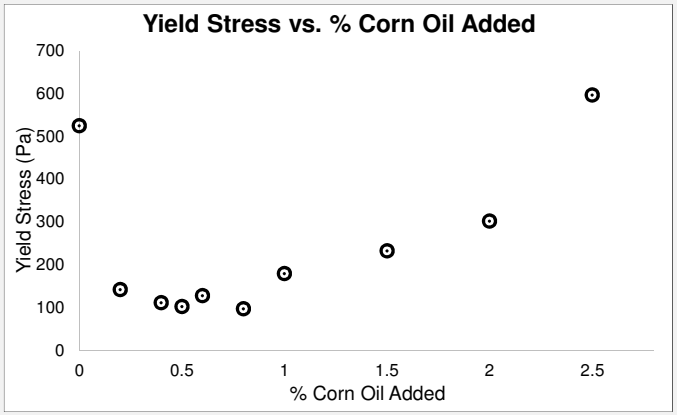

Figure 4: Effect of corn oil on yield stress of fresh state concrete

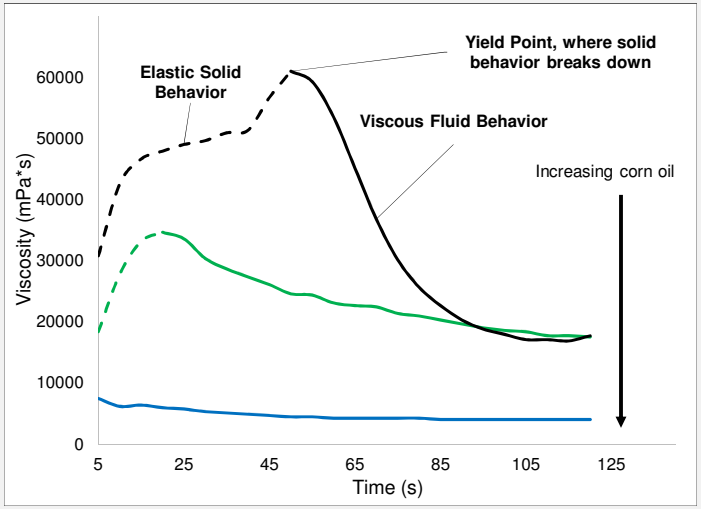

Figure 5: Effect of corn oil on viscosity of fresh state concrete

While the trend is nonlinear, corn oil can be seen in Figure 4 to affect the yield stress of fresh cement pastes. Figure 5 shows how increasing corn oil enhances the viscous fluid behavior and suppresses the elastic solid behavior of fresh cement pastes. Although further work is needed to better understand these trends, it can be concluded that corn oil indeed modifies key rheological features of fresh cement paste.

V. Acknowledgements and References

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[1] Rahul, A. V., Manu Santhanam, Hitesh Meena, and Zimam Ghani. "3D Printable Concrete: Mixture Design and Test Methods." *Cement and Concrete Composites* 97, (2019): 13-23.
[2] Sivasankaran, Chozhavendhan, Dr B. Bharathiraja, Praveen Kumar Ramanujam, Sunita Varjani, Jayakumar Mani, and S. Elavazhagan. "Utilization of Crude Glycerol from Biodiesel Industry for the Production of Value-Added Bioproducts." In , 2018.