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COMBINATORIAL INVESTIGATION OF MECHANICAL PROPERTIES OF BIOMIMICKED COMPOSITES

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ABSTRACT

This study presents the preliminary results of in-situ tests conducted on structural biomimicked composites built by 3D printing. Construction industry is looking seriously into 3D printed structures that can be incorporated into the conventional buildings. Further refinement of materials and processing will lead to the 3D printing of buildings in future. The advantages afforded by 3D printing are unrivaled, creating unprecedented opportunities to express art, economics, environmentally friendly designs, lightweight schemes, among many others. To determine the reliability and suitability of structural composites for use in construction, it is important to test these in shapes, and geometries that are appropriate to 3D printing. Combinatorial materials research allows the fabrication and in-situ testing of composites made by mix and match of various materials. This study focuses on the characterization of mechanical behavior of biomimicked composites fabricated by a 3D printer. To accomplish this, a meter-sized 3D printer was equipped with material dispensers as well as load sensors. Composites were made of various construction materials, adhesive, and reinforcement and subsequently tested by the same printer. The results are presented, and the implications of findings are discussed on their impact on the construction industry.

INTRODUCTION

Mechanical properties of structural materials are influenced not only by their chemical composition but also by their micro and macroscale structure. Concrete as one of the most popular structural materials for the fabrication of strong structures is greatly affected by the pouring process, molding, temperature, environment, among many others. While conventional process of construction has been greatly optimized, the newly explored practice of 3D printing of structures requires fine tuning. The mold-less method of layering deposition material to build houses places stringent constraints on the selection of the construction material. It requires fluidity, fast curing, high final strength, and good resistance against dynamic shear. Toughening mechanisms for concrete and some other materials include the introduction of fibers, rebars, second phase particles, and more recently, biomimicking. Combined with the processing factors such as type of pouring, the geometry and shape of the component, level of porosity and type and thickness of layering, these constitute a complex system with numerous variables. When optimized, they can improve the mechanical properties of the material, lower the cost of the fabrication, shorten the time, and even enhance the esthetics of the final product.

Research on complex systems such as structural materials requires resources that enables the investigation of multiple variables in a cost effective and timely manner. When it comes to small scale, combinatorial materials research allows the processing and testing of thousands of materials in a short period of time. For concrete, and materials with macroscopic ingredients' size, such CMR has not been possible until now.

Recent development in 3D printing allows the fabrication of structures from building homes to printing hearts. Utilizing a 3D printer to do the fabrication has been successfully practiced for decades now. Combining the fabrication and testing by a 3D printer enables CMR on macroscale. The main aim is to mix materials, tailor the