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MECHANICAL PROPERTIES OF 3D PRINTED BIOMIMICKED COMPOSITES

Seyed M. Allameh
Northern Kentucky University
Highland Heights, KY
allamehs1@nku.edu

Roger Miller
Northern Kentucky University
Highland Heights, KY
millerr@nku.edu

Hadi Allameh
Northern Kentucky University
Highland Heights, KY
Allamehh1@nku.edu

Draft

ABSTRACT

Additive manufacturing technology has significantly matured over the last two decades. Recent progress in 3D printing has made it an attractive choice for fabricating complex shapes out of select materials possessing desirable properties at small and large scales. The application of biomimetics to the fabrication of structural composites has been shown to enhance their toughness and dynamic shear resistance. Building homes from bioinspired composites is possible if the process is automated. This can be achieved through additive manufacturing where layers of hard and soft materials can be deposited by 3D printing. This study examines Mechanical properties of reinforced concrete fabricated by 3D printing. Preliminary results of 4-point bend tests will be presented and the implications of 3D-printed home building on current conventional construction practices will be discussed.

INTRODUCTION

The new wave of 3D printing technology is sweeping across multiple fields of industry and academia. No longer being hobbyists' pastime activity toys, 3D printers have fully fledged into additive manufacturing production machines. A 3D printer can replace multiple machines and machining operations that require labor, thereby eliminating the cumulative errors attributable to man and machine. This and many other reasons have compelled manufacturers such as General Electric to produce industrial-scale additive manufacturing machines. The demand appears to be so high that a shortage of qualified engineers is greatly felt and colleges such as the University of Cincinnati have responded by establishing additive manufacturing degree-earning postgraduate programs.

Fig. 1: Nacre based commercial products and a 3D printed structure made of caulk. The insert (left hand side) shows schematic of structure of nacre: layers of Aragonite separated by natural polymer

In the field of construction, there have been efforts to extrude concrete and write structures in a layer-by-layer printing method [Khoshnevis]. This makes it possible to mix and match materials in order to create composites with desired properties. One such type of desirable composites is inspired by nacre (Fig. 1), which has a layered structure. This naturally tough material combines hard ceramic ($CaCO_3$) with natural polymer to create a hard material which features up to 8% elongation in the direction of the layers. It is reasonable, then, to expect any composite that