Proceedings of the ASME 2019 International Engineering Congress & Exposition
IMECE2019
November 8-14, 2019, Salt Lake City, Utah, USA

IMECE2019-10392

MECHANICAL PROPERTIES OF STEEL PRINTED ON CERAMICS

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

Miguel Ortiz Rejon[1]
Universidad de Leon
Leon, Spain
mortir02@unileon.es

ABSTRACT

Construction industry is about to embrace 3D printing as a viable technology for fabricating structures that are not physically or commercially impractical. These include curved components that could be embedded in buildings. On the other hand, whole house building by 3D printing has been attempted around the world using giant concrete printers. The main question is how to integrate steel rebars in concrete by 3D welding and still maintain the structural integrity and reliability of the conventional rebars. To accomplish the incorporation of rebars in concrete, steel must be welded within concrete. Heat dissipation rates may be different in different directions when the 3D molten weld pool solidifies, especially when the substrate is concrete. This may affect the strength of the material along and across the weld bead. To investigate this effect, it is important to study the mechanical properties of 3D welded steel in the directions of length, thickness and width. Experiments conducted in this study include the 3D welding of steel on concrete tiles by attaching the torch of a MIG welder to a meter-scale 3D printer carriage. The weld beads were then cross sections in directions along the weld bead, across the bead and perpendicular to the ceramic substrate. Dog-bone shaped micro- scale samples were extracted along those direction by CNC machining and EDM milling. The specimens were then mounted on the grippers of a hybrid micro- tester and tensile tests were carried out. The results of the tests are reported, and the implications of the findings in terms of the feasibility of 3D printing of steel reinforced concrete are discussed.

INTRODUCTION

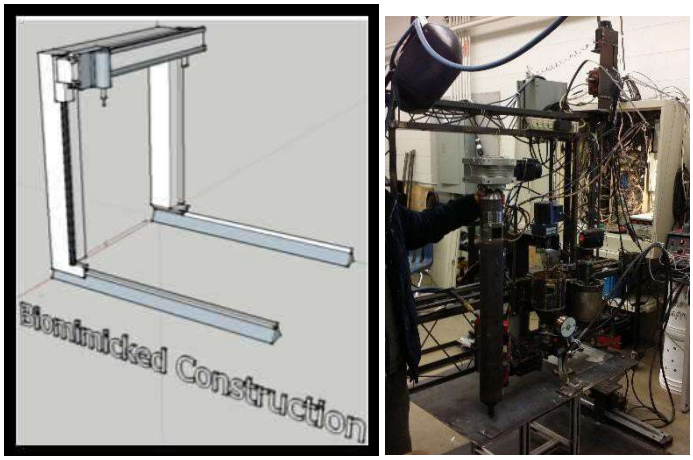

Fig. 1: The schematic of the Gantry-type 3D printer (left) and the image of the actual machine (right) developed at NKU.

Microtesting techniques allow testing small samples [1-19]. These include Microelectromechanical devices and structures deposited by physical and chemical processes as well as small structures extracted from the bulk. For the former, mechanical properties may be different from those of the bulk due to the size effect. Microsamples extracted from walls and thin sections of cast, laser sintered, or 3D welded metals allow validation of the corresponding processes and assures the reliability of the components. With the 3D printing of homes and commercial structures approaching reality, the real question is if the current construction practice can be mimicked by 3D printers [20]. This includes the fabrication of the steel rebars or metallic

[1]Miguel Ortiz was an exchange student at Northern Kentucky University during the course of this study