Tensile Testing of Additively Manufactured Joineries Complementary to Digital Engineering

Zhang, Zhaoxian (School: Episcopal School of Jacksonville)

Additive Manufacturing, or three dimensional printing, is the method of fabricating objects and components layer by layer, compositing material in horizontal lattices. The method prevails in rapid prototyping and has limitless potentials in integrating digital design with engineering. Yet Additive Manufacturing lacks production speed and is suspected of lacking strength in the axis perpendicular to the printing surface, both of which hinder its applicability in many situations. Additive Manufacturing also operates in finite boundaries and cannot fabricate anything larger than those boundaries, which further limits its capabilities. This project seeks to tackle exactly two of the problems, the suspected lack of strength and the finite boundary of machines, by testing the tensile strength of additive manufactured material in varying axises and investigating the behaviors of joinery structures which may serve connecting separately printed parts under stress. This goal was approached by conducting series of tensile strength tests on PLA additive manufactured joineries with a tensile tester for the effect of Additive Manufacturing on material tensile strength and properties of joineries under stress. Two types of joineries were tested with two control groups, all printed in two orientations normal to each other. After comparing tensile tests data of respective samples, the following results were discovered. First, control samples printed with layers parallel to exerted force yielded highest ultimate tensile strength 62.5% higher than accepted value for PLA, 37 MPa, and when printed with layering normal to the force, the strength is 14.9% lower than this value. Joineries show 5% to 10% strength but 2 to 7.5 times the ductility, and was affected by layering the same way.

Awards Won:
Society for Experimental Mechanics, Inc.: Second Award of $1,500