

A Large Sustainable Housing Prototype built with a drone

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Abstract

Terramia is a group of sustainable housing prototypes built in Milan in 2019 using drones fitted with a spraying pump to deposit different layers of natural mortars onto lightweight formworks. This built project is the largest and most challenging to date - in terms of engineering and on-site fabrication of large elements - compared to previous pavilion-size structures using the same drone architecture called “Bioshotcrete”.

The Terramia project consists of three different shells each built with lightweight lost and removable formworks involving clusters of bamboo rods and textiles, subsequently drone-sprayed, thus offering variations in terms of techniques and results that are detailed in this paper. Different non-cementitious mortars composed of clay, lime, sand, fibers and water are carefully formulated to match the capabilities of the drone spray apparatus. The mortars are precisely sprayed in a sequence specific to the mix types, proportions and corresponding drying times. The design and engineering of the shells were tailored to the concept of using actively bent bamboo as falsework to create natural mortar, compression-only structures. The geometries that were parameterized for this project include parabolic bent arches and gothic ones each exhibiting different properties, qualities and limitations for the drone spraying technique that will be detailed in this paper.

The project also provided the opportunity to map the drone spraying trajectory in real-time and to identify optimum values for parameters such as distance to the surface, angles and more importantly speed. These new processes, developed by a multi-disciplinary team, could open a new page in the shotcrete industry and allow earth architecture to be used in large urban contexts.