Set-on-Demand concrete for Digital construction using Stimuli-responsive additive technologies

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The digital construction methods using the concrete 3D printing (3DCP) is a disruptive technology in the construction industry, creating a unique opportunity for creating a digital platform towards a new way of integrating various sectors (design, architecture and fabrication). These construction methods have many benefits in the productivity and efficiency, such as greater design freedom, less material and waste, fast construction, and improved worker safety. For instance, it is estimated that 3DCP could reduce the material consumption by 30–60 % and increase the construction speed by 50–80%. Despite the many advantages, the 3DCP is associated with the challenges of contradicting rheological requirements during the pumping and placement stages. That is, the concrete should have enough flowability to pump through long pumping pipes, while rapidly developing the strength after placement to attain self-stability due to the absence of supporting form work. The introduction of a stimuli responsive technology can overcome this challenge as the responsive additives in concrete responds to an external stimuli to achieve the desired rheological properties. This technology enables on-demand setting of concrete. This paper presents the different stimuli-responsive technologies developed at the Swinburne University of Technology along with the performance of such technologies.The developed technologies can also be benefit to the concrete pumping and form work casting methods, where the intermediate halt in pumping process can be achieved without losing the workability of concrete. Meanwhile, the proposed technology will also aid in reducing the form work pressure due to hydrostatic pressure in the concrete casting technology.