

Seismic Performance of 3D-Printed Construction Materials: A Literature Review

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Abstract:

Earthquakes are a type of natural disaster that can directly threaten buildings. Reinforced concrete is a fundamental material for construction. The steel reinforcement is essential to get a ductile behaviour during an earthquake. However since steel reinforcement cannot be embedded in the concrete during the 3D printing process, other solutions in regard to materials and design have started to arise. In this paper, the English literature published between 2015 and 2025 on the seismic behavior of 3D-printed construction materials was reviewed through the Web of Science (WOS) and Scopus databases. A thematic analysis approach was adopted as the range of measurement methods, testing conditions and reporting processes adopted in the studies made direct comparison difficult. In this approach, each article was classified according to the subject matter it addressed. The findings were synthesized and presented based on material composition, additives, mechanical properties, and behavior under seismic loading. The review identified four distinct material groups in the existing literature: self-reinforced engineered cementitious composites (ECC), geopolymer-based printing materials, fiber-reinforced composites, and hybrid systems incorporating embedded steel or carbon fiber strands during printing. Two key factors were identified as primary determinants of the seismic performance of these material groups: anisotropic mechanical behavior dependent on printing layer orientation and the relative weakness of the interlayer interface. Additionally, the study found that the production of self-sensing and self-healing composites via 3D printing technology has established itself in the literature as a distinct area of research focused on the development of multifunctional structural elements.

Keywords:

Anisotropy, Cementitious Composite, Energy Dissipation, Seismic Performance.