THERMOELECTRIC CONCRETE AND ITS POTENTIAL AS A NEW ENERGY HARVESTING TECHNOLOGY

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This paper presents the potential for harvesting electrical energy from cementitious materials via the Seebeck effect. The Seebeck effect is a material property involving the movement of electrons "n" or holes "p" between hot and cold electrodes within a semiconducting material, resulting in a voltage difference, across the thermal gradient, between the two electrodes. The Seebeck effect in cementitious materials has been investigated only to a limited degree thus far; most prior research has focused simply on enhancing the Seebeck coefficient, but research on energy harvesting capabilities and assessment of its potential use in civil infrastructure has been scarce.

Here, we introduce a numerical model to calculate the theoretical output energy of a thermoelectric concrete as a function of the Seebeck coefficient, electrical resistivity and thermal conductivity and correlate this output energy with CO_2 abatement offset potential and lifetime cost/benefit. We show that at a practical applications scale and using material properties demonstrated experimentally, thermoelectric concrete could significantly contribute towards addressing the pressing global challenges related to increasing energy demand and CO_2 abatement, presenting an alternative for continuous renewable energy generation by a sustainable and passive technology using natural temperature gradients. Thermoelectric concrete could have significant implications for the lifetime energy use and environmental sustainability of built infrastructure, such as pavements, bridges, façades, and other buildings; it has the potential to be used on a large scale while keeping physical and mechanical performance in harsh environments for an extended period.