Thermoelectric energy harvesting using cement-based composites: A review

Kate Caulfield, Yenthy Luong, and Haroon Ehsan
Governor School at Innovation Park

COS120: Introduction to Research

Dr. Ales Psaker

October 2, 2025

Abstract

The article “Thermoelectric energy harvesting using cement-based composites: a Review” first describes the wide applications that energy-harvesting cement could have. Some examples include its usage in civil infrastructure, such as buildings, roads, and dams. In addition, it shows the promise of applying thermoelectric energy to concrete by explaining the differences in temperature of concrete that is exposed to the outside and the side that can be utilized to create energy via the Seebeck effect. The article then describes how previous studies have shown how adding carbon fiber to the concrete in an admixture, thus creating a concrete composite, has proven to be effective at the percolation threshold- where the electron contributions and holes are the same.

The study described how it was found that a carbon fiber admixture composed of approximately 1% of the concrete’s weight was best for producing thermoelectric power. In addition, the article found that the addition of other metallic compounds could further increase the total thermoelectric power produced, with Bi_2O_3 and Fe_2O_3 showing an almost 500% increase totaling 100.28 μV/°C. Other add-ons, such as graphene and steel, proved to also increase the total power produced but were overall less effective. The article particularly highlights how the addition of graphene-metallic compounds in compounds, specifically ones like Fe_2O_3, ZnO, and MnO_2, may enhance the observed Seebeck effect by approximately 300% when the compounds are added as a quantity amounting to 10% of the total mixture.

When discussing the limitations and possible future work related to this article, the authors criticized the lack of studies testing the structural properties and stability of the concrete after the admixture was added in comparison to regular concrete, along with how economically feasible the solution could be- accounting for a possible increase in erosion over time if the

composite is not durable. This article also reflects on the lack of studies that explored the potential cooling capabilities that thermoelectric concrete could have when it comes to its usage in civil infrastructures such as buildings.

In our current study group’s current prospects for our research, this article will be deemed useful when considering which materials will be effective to add to concrete or asphalt to most effectively generate thermoelectric power. In addition, it will guide us to account for changes in the structural properties of the concrete or asphalt when the admixture is added and to account for the economic feasibility of the system created.

References

Singh, V. P., Kumar, M., Srivastava, R. S., & Vaish, R. (2021). Thermoelectric energy harvesting using cement-based composites: a review. *ScienceDirect*, *21*, 11. https://doi.org/10.1016/j.mtener.2021.100714.