Alternative binders to improve hempcrete material properties and microbial viability.

Masters Defense

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Conventional insulation materials have high embodied energy and carbon. Hempcrete is a carbon-neutral to carbon-negative insulation material commonly made from hemp hurd and lime and offers a sustainable alternative to conventional insulation materials. Hempcrete achieves its low carbon footprint through carbon sequestration during hemp growth and binder carbonation over its material lifespan. However, traditional hempcrete's low compressive strength limits its utilization primarily to wall infill insulation. Improving hempcrete's compressive strength could expand its utility and durability. Efforts to improve the strength of hempcrete have included using mechanical compaction and a reduction in hurd content. However, while these methods can improve the compressive strength of hempcrete, they increase the thermal conductivity and material requirements needed to achieve the same level of insulation performance. Additionally, it may be beneficial to leverage microbial functionalities such as biomineralization, crack healing, or environmental sensing by creating "living building materials." This study investigated how hempcrete binders rich in silica fume, an industrial byproduct, and metakaolin affect the pH and strength of hempcrete. This work will demonstrate how silica fume and metakaolin can be used to strengthen hempcrete without diminishing its sustainability as well as how it can be used to reduce hempcrete pH. pH reduction may be relevant for improving microbial viability. This study additionally evaluated the viability of biomineralizing microorganisms within hempcrete. Improved microbial viability in hempcrete is relevant for utilizing microbial functionalities, such as biomineralization, crack healing or environmental sensing.

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