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Enhancing the Sustainability and Performance of Building Materials: Hemp Hurd Aggregates bound by Magnesium Oxychloride Cement

Each year, approximately 30 billion tons of concrete are consumed globally, only continuing to increase as the world's population grows. This fundamental building material manufactures the buildings, freeways, pavements of our civilization's infrastructure. Yet, it has devastating impacts on the environment: 1) the production of concrete binder—Portland cement—produces nearly 9% of global CO_2 emissions and 2) mining concrete aggregate—sand—destroys coastal ecosystems. This problem is not new, and much research has gone into producing a more sustainable building material; however, most competitive materials cannot compete with the cost and efficacy of the current status quo concrete. This study develops concrete that replaces each of these problematic materials with a more sustainable and effective alternative. Portland cement is replaced with magnesium oxychloride cement (MOC), a binder with high carbon sequestration potential with incredibly high compressive strength. Sand aggregates are replaced with hemp hurd aggregates, a renewable carbon sequestering biomaterial with high endurance. The purposeful pairing of MOC and hemp hurds accounts for the limitations of each material, balancing compressive strength and water resistance between the two materials. The synthesized concrete is tested for compressive strength utilizing a hydraulic compression testing machine: if the compressive strength is >20 MPa and its softening coefficient is calculated to be >0.8, the building material is determined to be both sustainable and effective.