Title: Development of Agro-Industrial Waste Based Sustainable Building Materials Through Carbonation Process (OLP 2601)

Abstract:

Over the last decade, significant progress has been made in developing technologies to reduce greenhouse gas (GHG) emissions and move toward Net Zero Carbon Emissions (NZCE) by 2030, with CO_2 sequestration emerging as a particularly promising pathway. Numerous calcium-rich industrial by-products including coal fly ash, cement kiln dust, gasification cinder, steel slag, etc. offer considerable potential for permanent CO2 fixation in construction materials. Among the available processing routes, cold bonding process of developing lightweight aggregates has gained prominence as an energy-efficient and environmentally friendly alternative to sintering and autoclaving, although challenges remain in achieving high early strength and long-term durability. Biochar-modified bioconcrete has introduced a novel paradigm, where biochar acts as both a sustainable additive and an active carbon sink, opening the possibility of producing carbon-negative concrete. Similarly, carbonation of steel slag has shown unique promise due to its high reactivity and abundance, though scaling and process optimization remain areas for further study. Collectively, these approaches reflect exciting advances that combine waste valorization, structural performance, and ecological responsibility, while highlighting the need for deeper investigation into durability, and lifecycle impacts before widespread implementation.

Objectives:

- To assess the application of CO2-sequestered lightweight aggregates in precast building elements and evaluate pilot-scale upscaling feasibility through techno-economic analysis of CO_2 procurement, transport, and storage.
- Carbonation of steel slag and its utilization in cement based materials
- Development of carbon negative self-healing bio-engineered concrete (Bio-mimic concrete).

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