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Department: **Civil and Environmental Engineering**

Project Title: **Engineered Concerete as a solid state thermal battery for next generation concentrated soalr power (CSP) plant**.

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Sanction Amount: **5124480 Lakhs**

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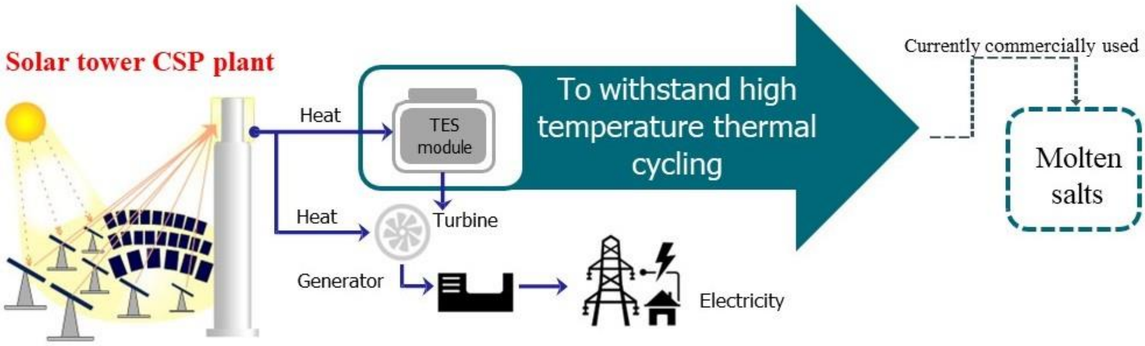
Abstract:



The transition to a renewable-energy-based power sector requires reliable and cost-effective energy storage systems (ESS). According to India's Energy Storage Roadmap (2019–2032), the nation aims to reduce carbon emissions by 33–35% while integrating 40% non-fossil-fuel-based electricity (≈350–500 GW). With nearly 300 annual sunny days, Concentrated Solar Power (CSP) could be an attractive technology to support these goals due to its scalability and low operating cost. However, CSP performance is hindered by solar intermittency, resulting in supply–demand fluctuations and increased electricity cost. Thermal Energy Storage (TES) is therefore essential to smooth temporal variations by storing excess heat and delivering it during periods of reduced solar irradiation.

Current TES systems predominantly use molten salts (e.g., nitrate salts, freezing point ≈220 °C), but they suffer from high material and anti-freezing costs, corrosion, and low thermal conductivity. Solid-state TES materials such as concrete offer a promising alternative due to their low cost, non-toxicity, abundance, formability, and favourable thermal properties. But Ordinary Portland Cement (OPC) based concrete binders undergo structural degradation between 100–400 °C, limiting their viability for next-generation CSP tower plants with operating temperatures of 400–700 °C.

This project proposes to develop an **optimized geopolymer concrete engineered as a solid-state thermal battery for second-generation CSP systems**. Geopolymers synthesized from industrial by-products such as fly ash, GGBS, and metakaolin, activated with alkaline solutions, form an amorphous aluminosilicate network known for its high thermal stability (≈800 °C), tuneable chemistry, and reduced carbon footprint compared to OPC. However, their application as high-temperature TES remains less underexplored.