EcoComposite – Development of Eco-Efficient Bio-composites for Structural Applications in Civil Engineering

Summary

The construction industry is responsible for a very significant portion of our society's environmental impacts. Reducing these impacts and making this industry more sustainable is one of today's greatest societal challenges. In the EcoComposite project, innovative eco-efficient fibre reinforced polymer (FRP) bio-composite components, produced with bio-based resins, will be developed for specific structural applications in civil engineering, aiming to achieve high mechanical performance and durability, low weight, and simultaneously low environmental impacts.

New bio-resin chemical structures and formulations will be developed and assessed, aiming at partial or total substitution of oil-based resin systems. The production of cross-linkable resins by modification of unsaturated polyester resins with bio-based monomers will be assessed.

Using a cradle-to-cradle Life-Cycle Assessment (LCA) methodology in combination with Multi-Criteria Optimization (MCO), innovative bio-composites will be developed for four key applications in civil engineering, for both new construction and rehabilitation: (i) strengthening of concrete beams and slabs; (ii) confinement of concrete columns; (iii) new sandwich panel structures; and (iv) new pultruded profiles. The components optimisation will integrate bio-resins, fibre reinforcements, laminate architecture, and manufacturing methods to achieve maximum eco-efficiency. Aspects such as carbon emissions, embodied energy, and end-of-life impact will be minimised and compared to those of conventional FRP composites used in construction.

The bio-resins and bio-composites will be produced in-house, ensuring the production quality control, and their short- and long-term behaviour will be experimentally investigated. The neat bio-resins and the resulting composites will be tested to assess their mechanical and thermo-physical properties, creep behaviour, and durability.

To maximise the economic and environmental benefits that may stem from this project's results, industry outreach actions will be undertaken aiming at transferring the generated knowledge to the composites industry. This will be promoted through contacts with industrial partners, media awareness actions, and through the drafting of open-access technical guidelines. As a result of preliminary contacts with industrial partners, declarations of interest have already been obtained from the two largest national composites manufacturers for the construction sector, who recognize the high potential of this project and the possibility of industrial pilot implementations of bio-composite products. Given the transversal applicability of the bio-composites to be developed, additional contacts will be established to further disseminate the research results among industry partners linked to other sectors, such as aeronautics, naval, and automotive.

Figure 1. Left to right and top to bottom: reactor for resin synthesis; vacuum infusion of a GFRP plate using a bio-based unsaturated polyester (UPE) resin; bio-based UPE resin; GFRP bio-composite in a tensile test.

Project Reference

PTDC/ECI-EGC/29597/2017

Leading Institution

IST-ID – Associação do Instituto Superior Técnico para a Investigação e Desenvolvimento (Portugal)

Partners

-

CERIS Principal Investigator

Mário Garrido (mario.garrido@tecnico.ulisboa.pt)

CERIS Research Team

João Ramôa Correia, Fernando Branco, José Dinis Silvestre, João Firmo, Mário Sá, Mário Arruda, José Gonilha, Abu Toyob Shahid

Funding

FCT – Fundação para a Ciência e a Tecnologia

Period

2019-2023

Total

239 881.28€

CERIS

239 881.28€

Project Website

coregroup.tecnico.ulisboa.pt/research-projects/on-going/ecocomposite