MATERIALS SCIENCE AND TECHNOLOGY

AMMIN - Advanced and Sustainable Construction Materials from Recycled, Low-Carbon and High-Performance Sources

Funded By	Politecnico di TORINO [P.iva/CF:00518460019]
Supervisor	PAVESE MATTEO - matteo.pavese@polito.it
Contact	LAVAGNA LUCA - luca.lavagna@polito.it
Context of the research activity	This research focuses on the development of advanced and sustainable construction materials based on recycled aggregates, industrial by-products, low-clinker cements, and high-performance functional materials. The project aims to reduce environmental impact while enhancing mechanical performance, durability, and multifunctional properties through experimental validation and life cycle assessment.
	The research activity focuses on the development, optimization, and validation of advanced and sustainable construction materials characterized by reduced environmental impact, enhanced performance, and improved durability. The study addresses key challenges in the construction sector, including the reduction of carbon emissions, the efficient use of resources, and the transition toward circular economy models, while also integrating advanced material technologies. The scope of the research encompasses three main areas: low-carbon cementitious systems, concrete and composite materials incorporating recycled and industrial by-products, and advanced functional materials for construction and infrastructure applications. The project promotes the substitution of natural raw materials with End-of-Waste (EoW) materials, secondary raw materials, and industrial residues, combined with the integration of high-performance and engineered materials. A primary objective is the development of innovative cement formulations with reduced clinker content through the incorporation of supplementary cementitious materials with pozzolanic and hydraulic activity. This approach significantly lowers greenhouse gas emissions associated with cement production while maintaining or improving mechanical properties and long-term durability. In parallel, the research investigates the design of sustainable concrete mixtures integrating recycled aggregates, industrial by-products, and advanced additives. The activity aims to overcome current technical limitations by generating comprehensive experimental data on fresh and hardened properties, durability performance, and long-term reliability. Particular attention is given to optimizing mix design to ensure structural

Objectives	performance comparable or superior to conventional materials. A further key objective is the integration of advanced materials and technologies into construction systems. These include high-performance composites (such as fiber-reinforced materials), functionalized materials with enhanced mechanical, durability, or self-sensing properties, and innovative additives capable of improving rheology, resistance, and environmental performance. The use of such advanced materials enables the development of multifunctional construction solutions with improved lifecycle performance. The research also includes extensive experimental validation through advanced laboratory testing and pilot-scale applications. Materials are characterized in terms of physical, mechanical, rheological, and durability properties using both standardized and innovative testing methods. This ensures reliability, reproducibility, and compliance with technical standards. In addition, Life Cycle Assessment (LCA) methodologies are applied to quantify the environmental benefits of the developed materials. The analysis considers carbon footprint reduction, energy efficiency, and resource optimization over the entire lifecycle, supporting the identification of optimal material solutions and demonstrating alignment with sustainability targets. The project further aims to ensure compliance with current regulatory frameworks, including environmental minimum criteria and green public procurement requirements. This facilitates the adoption of the developed materials in real-world applications and supports their integration into the construction market. Finally, the research supports the industrial scalability and market uptake of innovative materials by providing validated data, technical guidelines, and performance benchmarks. The expected outcome is the development of a new generation of construction materials that combine sustainability, high performance, and advanced functionalities, contributing to a more resilient, efficient, and circular construction sector.

Skills and competencies for the development of the activity	The candidate should have expertise in construction materials science, with knowledge of cementitious systems, recycled materials, and advanced composites. Skills in experimental testing, material characterization, and data analysis are required. Familiarity with sustainability assessment and standards for construction materials is desirable, along with strong problem-solving abilities and interdisciplinary research skills.