



Mechanical and durability performance of concrete incorporating Coal Mining Waste Geomaterials (CMWGs).

- General context of the thesis

The proposed PhD thesis is related to the European project MINRESUCUE which aims to develop innovative concepts for managing, recycling and upcycling waste geomaterials generated by coal mining activities across Europe for sustainable construction purposes. The thesis will be carried out at the Laboratory of Mechanics and Materials of Civil Engineering (L2MGC) of CY Cergy-Paris university at the site of Neuville-sur-Oise.

- **Keywords:** Coal Mining Waste Geomaterials (CMWGs), Concrete, Mechanical behaviour, Durability.

- Description

The recycling and the reuse of waste is fully in line with the concepts of the circular economy linked to sustainable development and the preservation of the environment. The application of the circular economy principles for the good management of waste allows the maintenance of secondary resources in the production circuit and the preservation of primary natural resources. Turning coal mining waste geomaterials into valuable resources, particularly for construction, will thus perfectly serve the purpose of creating a circular economy and reduce the impact of coal mining as well as construction activities. It also provides significant savings in the demand and use of natural raw materials for construction works in nearby areas for a long-time post-mining, when sustainable solutions for the use of CMWGs are defined.

Concrete is known as the most extensively used commodity after water in the world. However, its production is associated with huge amounts of carbon dioxide (CO₂) emission where the production of cement alone releases an average of one ton of CO₂ into the atmosphere per ton of cement produced. Therefore, the valorization of CMWGs in new concrete mixtures not only serves the circular economy targets but also minimizes the adverse environmental impacts of both coal mining and concrete productions. The possible valorization of CMWGs is envisaged through two ways: the reuse of fine as cement substitute and the reuse of coarse gravel as alternative to coarse natural aggregates.

The work program is essentially experimental and starts by the characterization of CMWGs in terms of physical, mineralogical and mechanical properties of both fine and coarse materials. The obtained results will be considered in the development of a new cementitious binder containing a part of CMWGs powder and in the development of concrete mixtures containing fine and coarse based CMWGs aggregates. The effect of CMWGs incorporation on the hydration kinematics and the fresh

properties of cementitious materials will be considered for the upcycling and the adaption of CMWGs as constituents in construction materials.

The instantaneous and long terms properties of concrete products at hardened state as well as the durability properties will be studied. The instantaneous performance of concrete-like products will be investigated by means of compressive, tensile and fracture tests while long term behavior will be investigated by means of creep and shrinkage test.

The interaction of aggressive environments with concrete will be characterized through the measurement of permeability, porosity, concrete volume changes, change in microstructure and cracks patterns and locations before and after submitting the products to severe thermal cycles.

All experimental results will be compared the analytical results predicted using design standards in order to verify the applicability of these standards and to propose the necessary modifications if any.

Numerical approach should be used to predict the behavior of reinforced concretes.

- **Profile and requested skills:**

- Master of Science in Mechanics of Materials
- Master in civil engineering or equivalent.
- English level B2 TOEIC or equivalent level

- **Application:**

The applicant should send the following documents in English

- A Curriculum Vitae and a motivation letter
- A copy of obtained diplomas or a certificate of success for the students registered in MSc degree during the scholar year 2020-2021
- A letter of recommendation from the MSc advisor
- Extended abstract of the MSc thesis (maximum 4 pages)

- **Supervisors of the thesis and contact**

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- **Laboratory**

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