Wrocław University of Science and Technology

WCTT
Wrocław Centre for Technology Transfer

REDUCING THE CARBON FOOTPRINT OF CONCRETE.
REDUCING EMISSION OF CO2 IN CONCRETE PRODUCTION, CONSTRUCTION INDUSTRY.

STATUS IP: The know-how and inventions entitled 'Method of Chemical Activation of Rock Powder and "Innovative method of chemical activation of a mixture of technical gases of waste, amorphous copper slag for use in cement composites" booth submitted for patent protection to the Patent Office of the Republic of Poland under application number P.449965 and P.447578 respectively.

COMMERCIALIZATION FORM: License, Spin-off, Startup.

TECHNOLOGY READINESS LEVEL (TRL): TRL 5 – technology validated in relevant environment.

The team of inventors consists of:
Dr. Eng. Adrian Chajec, Prof. Dr. Hab. Eng. Łukasz Sadowski and M.Sc. Eng. Agnieszka Chowaniec-Michalak, M.Sc. Eng. Martyna Nieświec, who conduct R&D work in the fields of construction materials engineering, carbon materials engineering, and surface engineering.

BRIEF DATA

The technology enables the utilization of waste materials (e.g., rocks, rubble, slag, copper slag, etc.) and CO2 gas (as a waste material) for production of decreased emission – nearly zero emission additives to concrete mixes or cement substitutes.

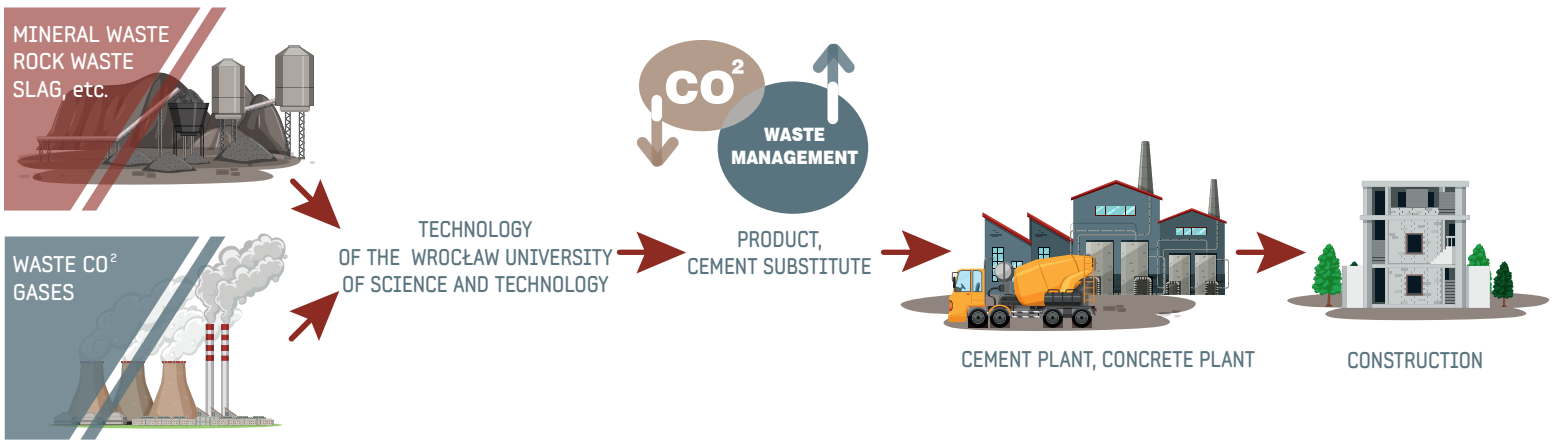
The technology is based on a carbonation process involving the chemical activation of a mixture of technical gases and waste solid materials. This process results in the formation of calcium carbonate on the surface of powder grains. The mineral wastes activated in this way can partially replace cement in cementitious composites without compromising their properties and be using as additives to concrete reducing its emissivity.

This method employs a direct carbonation process using technical gases in an alkaline aqueous environment and involves the following stages:

1.Mixing solid powder wastes with a sodium hydroxide (NaOH) solution.

2.Introducing gaseous nitrogen and carbon dioxide into the mixture (under continuous stirring) in a volume ratio of 1:1.5 to 1:3, until calcium carbonates will be crystalised on the surface of the powder grains. The process is carried out at a temperature of approximately 20°C.

3.Filtering the solid waste powder from the mixture and drying it.



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Laboratory tests were conducted on granite, basalt, feldspar-quartz powders and copper slags.

Example using basalt powder: Basalt powder processed according to the invention was used to partially replace cement in a cementitious mixture (e.g., 20% replacement). A reference series (REF) and a series modified according to the invention (SMB) were prepared based on the compositions outlined in Table 1. Cement composites were produced and tested for various properties, including mixture slump flow and compressive strength (see Fig. 1).

Reseach series	Cement CEM I 42,5 R (g)	Quartz sand 0-1,4 mm (g)	Water (g)	Carbonated basalt powder (g)
REF	400	1000	200	0
SMB	320	1000	200	80

Table 1. Composition of cement mixtures used in the verification test

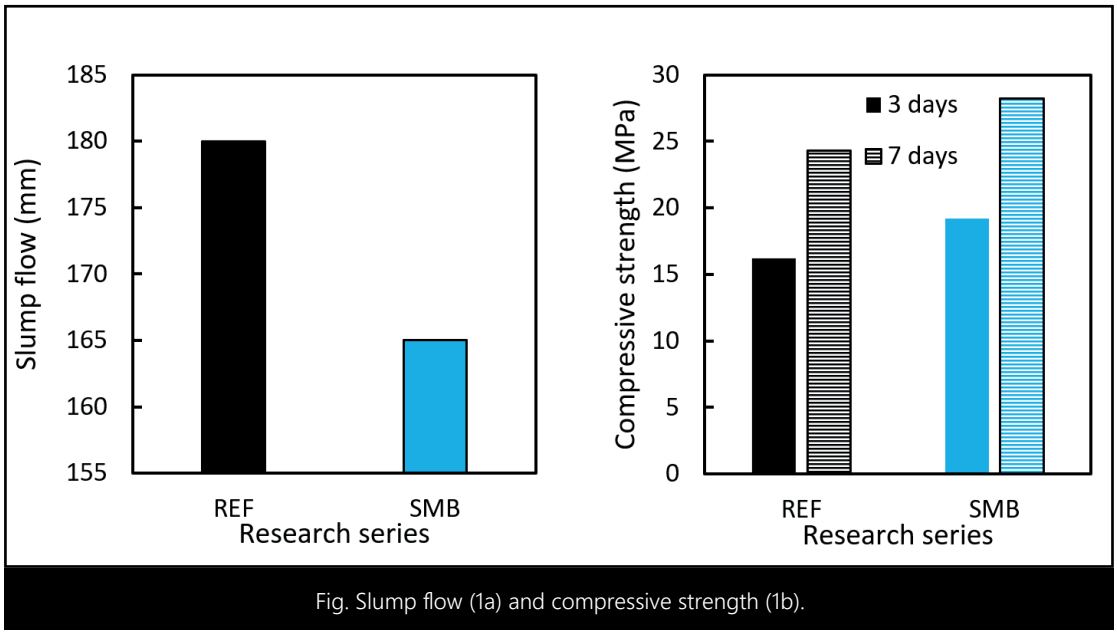

Fig. Slump flow (1a) and compressive strength (1b).

Conclusions:

The modification of the mixture by adding basalt powder, as described in the invention, resulted in a reduction in mixture slump flow by approximately 8% compared to the reference series (REF).

Additionally, samples prepared with the mixture containing basalt powder according to the invention exhibited significantly higher compressive strength values than the reference samples, both after 3 and 7 days of curing (by 18% and 16%, respectively).

APPLICATIONS

> Production of cementitious composites with reduced cement content (without compromising strength properties).

> Production of additives (rock powders according to the invention) for cementitious composites, partially replacing cement (laboratory tests for approximately 20% replacement).

> Utilization of mineral and solid waste to produce valuable products for the construction industry.

INNOVATION

> Possibility of using waste materials (such as rocks, rubble, slag, copper slag, etc.) as a substitute for cement.

> Despite the reduction in cement content (20%), cementitious composites with higher strength were obtained.

> The powder production process does not require high temperatures, thus reducing significant energy consumption.

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