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Reduction of carbon footprint in cementitious composites by incorporating chemically activated waste granite dust

The invention relates to a method for the chemical activation of waste granite dust originating from the process of cutting rocks of various types and origins, or from their crushing during aggregate production, intended for use in cement composites.

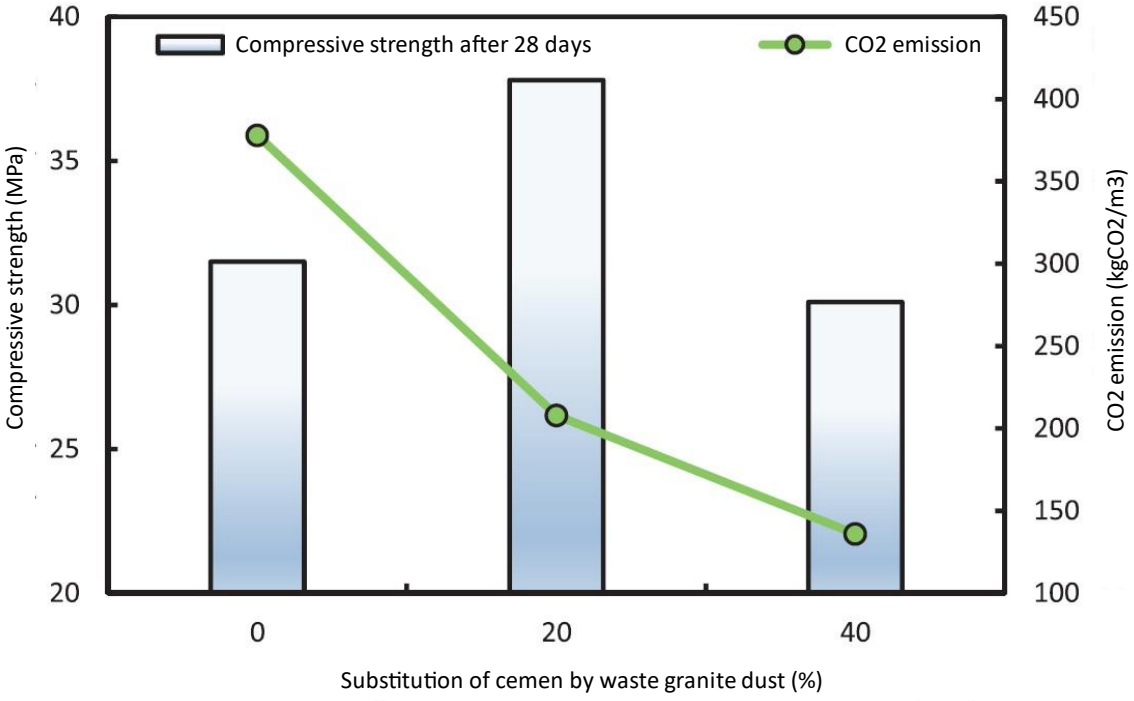
There are various methods for the activation or functionalization of the surfaces of powdered materials in construction industry. Currently, the most common methods are physical, such as grinding and texturing, and chemical, using carbon particles, such as nanotubes, for surface activation. Other chemicals (e.g., TiO_2, microsilica, nanosilica) are also used to modify grain surfaces with active agents that, upon contact with cement paste, enhance the bonding process of modified grains with the cement matrix.

Cement composites significantly impact the environment, contributing 6-8% of global CO_2 emissions, mainly from Portland clinker production and emissions during hydration. To address this, methods have emerged to reduce clinker use by incorporating secondary components that preserve the hardened composite's properties. Research shows that direct carbonation of particulate materials containing crystalline phases like calcite in an alkaline environment can form calcium carbonate on their surface, which enhances the composite's mechanical properties, especially in the first 7 days. This approach allows for up to a 30% reduction in Portland clinker in multi-component cement.

The technical issue addressed by this invention is due date the limited potential for utilizing waste rock dust to replace part of the cement in a cement composite without compromising its properties. The invention develops a new method for the chemical activation of rock dust using a technical gas mixture. It has been done by using the chemical activation of the rock dust, characterized by subjecting the rock dust to a direct carbonation process using technical gases in an alkaline aqueous environment, comprising the following steps:

- In the first step, the rock dust is mixed with a sodium hydroxide solution to obtain a mixture.
- Next, during the mixing process, the mixture is flushed with a solution of nitrogen and carbon dioxide supplied in a volumetric ratio within the range of 1:1.5 to 1:3, until aragonite crystals (a polymorphic form of calcium carbonate) crystallize on the surface of the rock dust grains.
- In the following step, the mixture is filtered.
- Finally, the powder obtained after filtration is dried.

An advantage of the solution is that the carbonation process results in changes to the morphology of the granite dust grains, a by-product of stone-cutting processes, which enhances its bonding with the cement matrix. The use of 20% carbonated granite dust increases the compressive strength of the hardened cement composite by 20% and reduces CO_2 emissions by over 40%. Moreover, it was also proved that substitution of 40% of cement by such prepared dust maintain the compressive strength of hardened cementitious composite.



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