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Special Edition “Concrete sustainability”

It is a pleasure to edit the IBRACON Journal special issue on Concrete sustainability in the year the Brazilian Concrete Institute – IBRACON – celebrates its golden jubilee. This grand achievement represents 50 years of dedication to concrete, a durable material that is widely used globally.

Due to its abundant stock of natural raw materials, ease of production, adaptation to shapes, and low manufacturing cost, concrete has become an essential material for the development of humanity, establishing itself as one of the main construction materials today. However, to mitigate anthropogenic carbon emissions, new requirements are needed for the production and use of concrete. Reducing cement consumption and structural optimization are essential factors in reducing its environmental impact. These actions must be taken responsibly, considering the aspects of performance and project lifetime, requiring holistic studies for this scope.

In this context, new cement manufacturing solutions are needed since the largest share of concrete emissions comes from this material. Actions aimed at increasing clinker reactivity and energy efficiency and increase in use of low carbon emission fuels have been implemented by the cement industry to produce cement with lower CO_2 emission. The cement and concrete industries have also taken steps to reduce the clinker content in cement through substitution by supplementary cementitious materials (SCM) and fillers, leading to cements and concretes with lower CO_2 emission. At the same time, the development of new chemical admixtures has responded to the demands for carbon neutralization, allowing the production of concrete and mortars with lower cement consumption and good applicability.

Regarding the design of concrete structures, the use of concretes with higher strengths, as well as structural optimization, help reduce the consumption of materials in the structure, thereby improving the material's environmental performance. The use of reinforcements that are more resistant to corrosion, in addition to contributing to durability aspects, can allow the structure to capture carbon safely in its life cycle, partially offsetting the emissions associated with cement production. For non-structural concretes, CO_2 capture can be implemented in hydration matrices (carbon cure) or hydrated matrices (life cycle), with environmental and technical benefits (e.g. porosity reduction). However, primary data confirming the carbon capture potential of cement-based materials are still needed for this strategy to be considered a compensatory measure.

The production and manufacture of aggregates, formwork, admixtures, water, and concrete and mortar also represent an appreciable share of emissions. These must also be evaluated in the context of the environmental performance of the entire cement and concrete chain, with particular attention to the transport of materials and products, which depending on the region, have significant impacts. Reducing the generation and use of waste should also be prioritized, promoting the circular economy.

In Brazil in 2022, the Construction Environmental Performance Information System (SIDAC) was released, an online platform where information on the main construction materials is available, enabling the calculation of environmental indicators such as CO_2 emission, primary energy demand and water. It is a free accessible tool under development that needs the collaboration of the concrete chain for its dissemination, expansion, and continuous improvement. Notably, the growing global trend of pricing emissions - which has reached around US$ 100 per ton of CO_2 - has motivated the productive sectors to develop product and process solutions aimed at carbon neutralization.

According to the Paris Agreement and the UN Sustainable Development Goals, moving to carbon neutrality is urgent and necessary, and the concrete chain is attentive to this demand. Industry, universities and research centers, and governments must work together to develop engineering solutions that reduce emissions while at the same time provide structures and facilities that serve the needs of populations in durable and sustainable ways. It is intended that this special edition of the IBRACON Journal will move these issues forward in tangible ways and contribute to a more sustainable planet.

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