Towards More Sustainable Concrete: Recent Activities Within ACI and ASTM to Achieve Carbon Neutral Concrete

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In 2023, all industries are being pressed to achieve carbon neutrality but the cement and concrete industries are a high priority for those seeking near-term carbon reductions. On a unit mass basis, concrete has one of the lowest carbon footprints of all manufactured materials. The enormous use of concrete, however, acts as a multiplier and causes concrete to be one of the largest single sources of anthropogenic greenhouse gas (GHG) emissions. The GHG emissions associated with concrete are overwhelmingly due to the process of producing portland cement. The combination of fuel combustion and calcination result in a global warming potential[1] (GWP) of approximately 0.9 kg $CO_{2\ eq}$/kg for portland cement produced in the United States and Canada. For the United States, the production of portland cement produced approximately 0.7 – 1.0% of the total U.S. greenhouse gas emissions in 2020[2]. But world-wide, portland cement production accounts for approximately 7% of the total GHG emissions[3]. There have been numerous roadmaps published for achieving carbon neutrality[4],[5]. These roadmaps share common elements that address the carbon footprint across the entire concrete value chain. In the near term, meaning the next 5-10 years, industry road maps project that significant progress must be achieved through enhancements in concrete production and use. Long-term, meaning 10-30 years out, progress is expected through modification of cement production including incorporating carbon capture, utilization, and storage (CCUS) technologies into portland cement manufacturing as well as major breakthroughs in cement production, including new, lower carbon cements.

The American Concrete Institute (ACI) and ASTM International are both playing a key role in achieving carbon neutrality and supporting these roadmaps through a variety of activities. Foremost in these efforts is the establishment of the ACI Center of Excellence for Carbon Neutral Concrete (NEU). The American Concrete Institute established NEU to collaborate globally and drive education, awareness, and adoption of the use of carbon neutral materials and technologies in the built environment. The Center has seen rapid growth since its founding and will soon be launching its program to assess and validate the claims of innovative and new materials/technologies associated with low-carbon concrete production. Related to sustainability, ACI has launched initiatives to develop new code documents that address durability, as well as a code for carbon reduction. The durability code is the most ambitious, and its development will mark a new approach for designing concrete structures to achieve long life and minimize the life-cycle impact of the structure. Last, ASTM International is developing several new standards that will enable the adoption of emerging, alternative materials. These include specifications and tests for cements that set by carbonation, a performance specification for alkali activated materials, and a performance specification for supplementary cementitious materials (SCMs). Each of these endeavors will be discussed in this presentation.

[1] The global-warming potential (GWP) of various greenhouse gases are equated to the equivalent effect of CO_2 and expressed in terms of the embodied carbon dioxide equivalent ($CO_{2\ eq}$).

[2] EPA, 2020. FastFacts-1990-2020 National-Level Green House Gas Inventory, US Environmental Protection Agency, https://www.epa.gov/system/files/documents/2022-04/fastfacts-1990-2020.pdf

[3] Canadian Government, 2022. ROADMAP TO NET-ZERO CARBON CONCRETE BY 2050, Report by Innovation, Science and Economic Development Canada, https://ised-isde.canada.ca/site/clean-growth-hub/sites/default/files/documents/2022-11/roadmap-net-zero-carbon-concrete-2050_0.pdf

[4] https://www.cement.org/sustainability/roadmap-to-carbon-neutrality

[5] https://gccassociation.org/concretefuture/