White Paper

CarbonX™ Technology and Test Results

CarbonX Technology is a breakthrough technology that targets reductions of up to 50% of the net carbon emissions associated with dry-cast concrete production (typical products include concrete block, retaining wall units and pavers). The current US cement-based products industry-wide carbon emissions are approximately 5 billion tons of carbon dioxide (CO_2) per year. [1]

Part of this breakthrough discovery is the development of a reliable test protocol to measure the amount of carbon dioxide that is sequestered (removed from the atmosphere and permanently captured in the concrete matrix) in manufactured concrete masonry units (CMU) during and immediately following production. While it has been generally believed that concrete sequesters CO_2 during its life cycle, prior to the establishment of this new test protocol, there was no reliable method to accurately measure the amount of CO_2 uptake.

Concrete is the second most consumed material on earth, second only to water. Concrete is popular due to its ability to meet a wide variety of structural, resiliency, aesthetic and energy conservation (due to the benefits of thermal mass) requirements in the built environment. Concrete block is a form of concrete that is typically produced locally and installed using local construction crews. Concrete block also offers the benefits of concrete coupled with the flexibility of modular construction.

Concrete block is made using cement. Cement production is recognized as one of the leading industrial contributors to carbon dioxide emissions.[2] Cement is made through calcination, which occurs when limestone, which is made of calcium carbonate, is heated with other materials from 2500°F (1370°C) to well above 3000°F (1650°C). In the kiln the limestone is broken down into calcium oxide and CO_2. The CO_2 is a waste emission of the process, and the remaining calcium oxide is ground to become cement powder. Additional emissions are a result of the intensive energy usage requirements to heat the kiln to that temperature. For a rough rule of thumb, the production of one ton of cement results in emissions of one ton of carbon dioxide.

Our testing has demonstrated that using CarbonX technology during the manufacture of CMU results in significant levels of carbon sequestration during production and initial storage of the concrete block. Within the first 28 days following production of the block, we have documented carbon sequestration of approximately 10% of the total amount by weight of cement used in the products.

1. EPA Report EPA 430-R-15-004, 2015 (5,505 MMT CO_2 Eq.)
2. EPA Report EPA 430-R-15-004, 2015

Industry estimates are that at least 1 billion concrete blocks (eight inch CMU equivalents) are produced in the United States per year. Concrete block production historically has used Portland cement at approximately a 12.5 % cement to aggregate ratio. This relatively small percentage however, is responsible for 75% of the carbon dioxide emissions associated with concrete block production.[3] Block production's carbon dioxide emissions are actually favorable compared to many alternative construction materials, but there are still approximately 3.3 pounds of carbon emissions from the cement associated with each unit of manufacture. In other words, a 3.3 billion pound overall industry annual total. As a result, there is an opportunity to make a significant improvement in carbon dioxide emissions if we can accomplish meaningful reductions in the net carbon emissions associated with cement usage in concrete block production.

This new technology results in greater reactivity of the cement paste in the mix design, which reduces the amount of unhydrated cement. As a result, greater efficiency is achieved so that the yield of concrete product per input of cement is increased and ASTM Standards are still met.[4] This reduction of the presence of unhydrated cement can also lessen the formation of unsightly efflorescence on the surface of the product (a fine white powder coating that results from water leaching salts out of the concrete mix and onto the surface of the product).

The environmental benefit of this technology is the reduction of greenhouse gas emissions and the amount of embodied energy associated with the cement used in concrete products. Our advances in developing this new production technology have resulted in significant source reduction in the amount of cement that is required while meeting or exceeding the applicable ASTM International Standards. Tests to date have demonstrated cement source reduction of up to 50% from the industry average level.

Our testing has demonstrated that our production methods result in significant levels of carbon sequestration during production and initial storage of the concrete block. Within the first 28 days following production of the block, we have documented carbon sequestration of approximately 10% of the total amount by weight of cement used in the products.

The significance of this discovery is that concrete block made with this method can remove carbon dioxide from the atmosphere even before it leaves the production facility, contributing to reduction of greenhouse gases. This is a major breakthrough development for our industry. Prior EPA studies on sequestration in these types of products assume the net effect of CO_2 sequestration occurs at only the outer 0.2 inches (5mm) of concrete surface area. It is assumed to be so minimal that the EPA does not include it in Greenhouse Gas reduction calculations. We now have the means to demonstrate not only that sequestration is occurring, but that it occurs in significant amounts immediately following production of the concrete product, throughout the matrix of the concrete block. As opposed to poured concrete, it has a void structure that creates greater potential for carbon sequestration due to the greater amount of exposed surface area.

The CarbonX technology was developed in partnership with the Concrete Products Group.

ConcreteProductsGroup.com

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3. EPA Office of Air and Radiation Publication, 2010 and National Concrete Masonry Association ("NCMA") research, unpublished, document number 312101 in NCMA archives.
4. NCMA, Concrete Masonry Design, July-Aug 2012