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Curing of Concrete by Carbon-dioxide [PDF] - The Constructor

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The curing of Concrete elements by diffusing carbon-di-oxide into it under controlled pressure and temperature is one of the popular methods of accelerated curing. The process lets the CO_2 to diffuse into the concrete and undergo carbonation. The carbonation finally results in thermodynamically stable calcium carbonate products.

Cement production alone contributes to 5% of the global CO2 emissions. This emitted CO2 can be partially recycled and used to cure concrete structures. Hence concrete curing by CO2 promotes sustainable construction. The article explains the concept and features behind the use of CO2 for curing concrete elements.

Curing Carbonation Process in Concrete

Carbonation of concrete is the process of reaction between the cement hydration products and the atmospheric carbon-di-oxide. Hence, the concrete structures are not new to the carbonation process. It is a natural reaction happening when the concrete is exposed to atmospheric CO_2 and called weathering carbonation.

Weathering carbonation is a slow process as it decreases the pH value of the concrete structures resulting in the corrosion of steel reinforcement.

When the above-explained carbonation process is performed in a controlled environmental condition in a chamber at the early stages of concrete curing and strength gain, it is called the curing carbonation process. The curing carbonation process is an accelerated curing process that injects carbon-di-oxide into the vessel where the concrete elements are cured. The CO_2 is diffused in the fresh concrete under low pressure. During this process, the cement bogues compound C3S and C2S, and the by-products of hydration Ca (OH) $_2$ react with CO_2 giving solid calcium carbonates ($CaCO_3$) at ambient temperature.

$$Ca(OH)_2 + CO_2 = CaCO_3 + H_2O$$

$$C_3S + 3CO_2 + H_2O = C\text{-}S\text{-}H + 3CaCO_3$$

$$C_2S + 2CO_2 + H_2O = C\text{-}S\text{-}H + 2CaCO_3$$

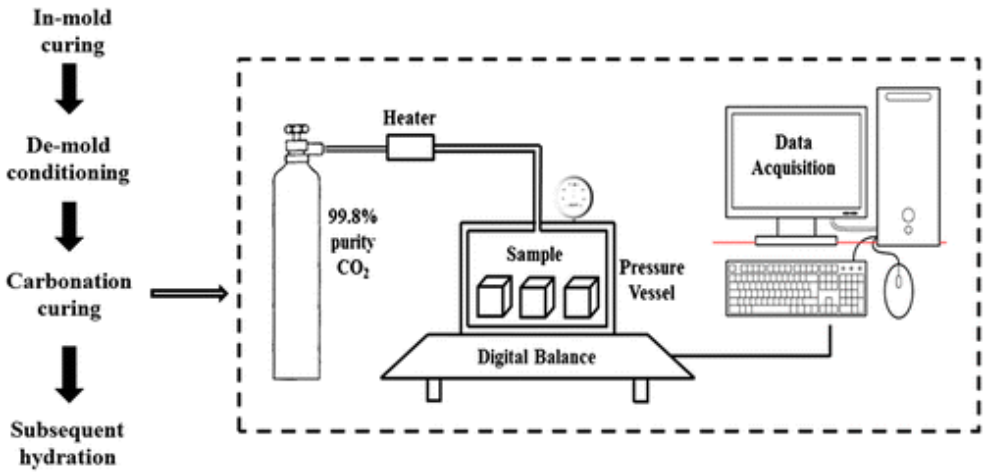

Fig.1. Carbonation Curing Process of a Precast Fly Ash Concrete

The hydration products form at an accelerated rate, and the curing facilitates accelerated strength gain.

CarbonCure Concrete

The name carbon cure is derived from the company CarbonCure, Canada, that uses the sustainable technology of curing the concrete by introducing carbon-dioxide into fresh concrete. This technology is acquiring appreciations worldwide as they do not produce new carbon-dioxide for this curing. Instead, they reuse the CO_2 emitted from industrial and manufacturing units. The technology captures CO_2, which promotes carbon sequestration. It finally embeds the carbon-dioxide within concrete permanently that future emissions of CO_2 are blocked.

> Note: Carbon sequestration, also called carbon-di-oxide removal is a process of capturing CO_2 from the atmosphere to mitigate CO_2 pollution and global warming.

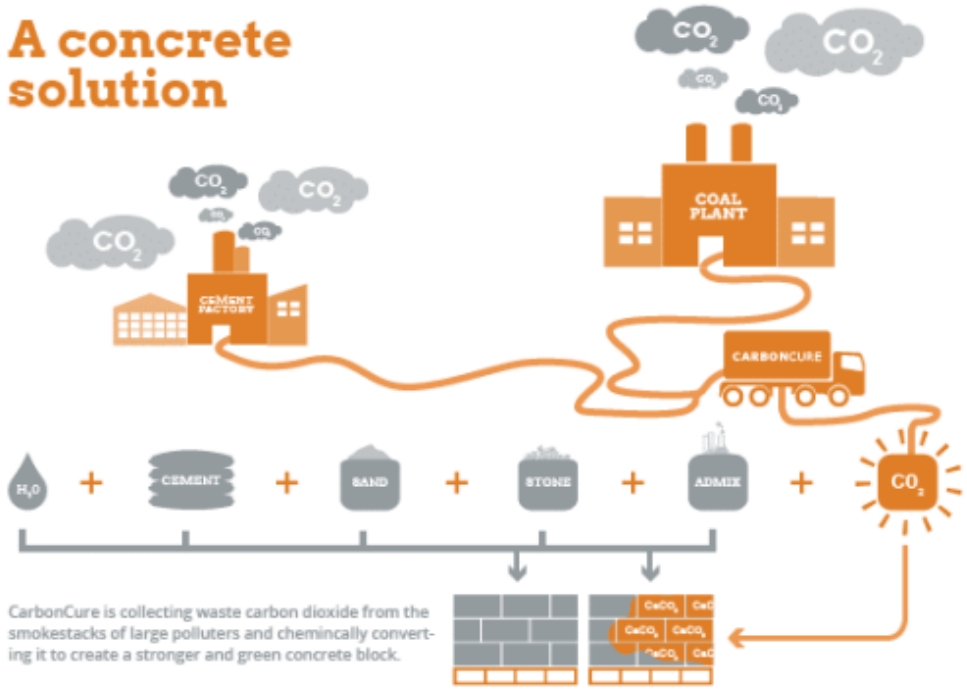

Fig.Green Concrete Block Installation by Concrete Cured By Carbon-dioxide; Image Courtesy-Tower Labs

Even though this technology gains enormous success, it is not fully

implemented by the majority. The study shows that only 90 percent of the concrete plants in the US and Canada use the carbon cure system.

Features of Carbon-dioxide Cured Concrete

The concrete cured by carbon-dioxide does not bring any harmful effect to the concrete compared to the conventionally cured concrete. One notable highlight of using this method is the formation of a solid, stable compound $CaCO_3$ that only helps in rapid strength but also lock further CO_2 emissions.

Carbon-di-oxide being a significant greenhouse flue gas; its emission in the atmosphere is reduced by this method. Hence carbon cure concrete is a sustainable construction practice.

Advantages of Curing Concrete by Carbon-di-oxide

1. Rapid strength gain.
2. The carbonation process due to curing gives stable solid products.
3. Carbon-di-oxide being a significant greenhouse gas, its consumption for curing reduces the carbon content element in the atmosphere.

Disadvantages of Curing Concrete by Carbon-di-oxide

1. The carbon-di-oxide reaction with concrete units lowers the pH. Hence the steel reinforcement in the concrete elements is subjected to corrosion. It is not used for steel-reinforced concrete structures.

2. Used only for precast units. Not applicable for RCC Structure.

Frequently Asked Questions

1. What is Carbon Cure Concrete?

Carbon cure concrete or concrete cured by carbon-dioxide are concrete that undergoes curing by injecting carbon-dioxide. The concrete elements in their fresh state are placed in a chamber on which CO_2 diffused into concrete under constant temperature and pressure. The system undergoes a carbonation reaction and gains strength at a faster rate. It is an accelerated method of curing concrete.

2. How does carbon cure work?

The fresh concrete, when subjected to an environment of carbon-dioxide, undergoes carbonation reaction. In this reaction, the bogues compounds and the hydration products like Ca(OH)2 reacts with CO_2 forming stable solid compound Calcium carbonates

3. How is Carbon di-oxide Concrete cure sustainable?

The curing of concrete by CO_2 is only sustainable if the carbon used for the process is recycled. The use of newly produced CO_2 for this process won't make this a sustainable practice.
The method is sustainable when the CO_2 emitted from industries and manufacturing processes are collected, treated, and used for curing concrete. This way, the amount of CO_2 expelled to the atmosphere is extracted. Hence, this is a carbon sequestration method.

4. What is the by-product of concrete cured by carbonation?

The process of concrete curing by carbon-dioxide undergoes a

carbonation reaction. The by-product of this process is calcium carbonate, which is a thermodynamically stable mineral. It firmly embeds in the concrete without emission of CO_2 into the atmosphere throughout the life of the structure.

Read More:

1. Low Carbon Concrete and Its Advantages
2. Curing of Concrete