SUMMARY WHITE PAPER

VM0043 Verified Carbon Standard (VCS) Methodology for CO_2 Utilization in Concrete Production

CarbonCure, in partnership with Verra, a renowned third-party agency setting global standards for climate action, has developed a robust methodology to validate the carbon credits generated through its cutting-edge technology. This collaborative effort denotes our commitment to transparency, credibility, and environmental impact assessment.

CarbonCure technology introduces CO_2 into fresh concrete to reduce its carbon footprint, without compromising performance. Once injected, the CO_2 undergoes a mineralization process and becomes permanently embedded in the concrete, resulting in carbon emissions savings. It has the added benefit of reducing the amount of cement that is used in concrete, which further reduces emissions.

Comprehensive Data and Third-Party Verification

Our methodology ensures the credibility of carbon credit generation by incorporating data from various stages of the concrete production process. Verra's validation adds a crucial layer of authenticity to our carbon credit claims. With Verra's seal of approval, stakeholders can trust the accuracy and integrity of our carbon capture and removal data.

About VM0043

VM0043 is a VCS methodology that covers CO_2 utilization in concrete production. The methodology measures both the mineralization from the injection of recycled CO_2 into concrete and the carbon reduction created by the ability to reduce carbon-intensive cement content and still achieve equivalent or superior compressive strength compared to regular concrete mix designs.

Methodology Components

Baseline Emissions

The methodology begins with a thorough assessment of the baseline emissions associated with conventional concrete production (i.e., not using CO_2 capture and utilization technology), against which to measure the effectiveness of our technology in reducing carbon emissions.

The formula is:
BEy = BEACU,y + BECO$_2$,cap,y

Where:

BEy = Baseline emissions in a given year (y) (tCO_2e)

BEACU,y = Emissions from the production of Portland cement that would have been used in the absence of the project activity (avoided cement usage) (tCO_2e) in year y

BECO$_2$,cap,y = Emissions from the capture of CO_2 (tCO_2e) in year y

Project Emissions

Project emissions include the emissions associated with the production of the Portland cement used in the project activity concrete (which should be less than cement used in the baseline concrete). Project emissions also include any additional electricity or fossil fuels used at the concrete manufacturing facility, used by the CO_2 injection equipment, as well as the emissions from the processing and transport of the CO_2.

The formula is:
PEy = PEcement,y + PEelec,y + PEffc,y + PECO$_2$,y

Where:

PEy = Project emissions in year y (tCO_2e)

PEcement,y = Emissions from the production of cement used at the project facility in year y (tCO_2e)

PEelec,y = Emissions from the incremental use of electricity by the CO_2 injection equipment at the project facility in year y (tCO_2e)

PEffc,y = Emissions from the incremental combustion of fossil fuels by the CO_2 injection equipment at the project facility in year y (tCO_2e)

PECO$_2$,y = Emissions associated with the capture, compression and transport of CO_2 to the location where it will be sequestered in concrete in year y (tCO_2e)

Leakages

Leakages — or unintended releases of CO_2 — were carefully considered during the development of the methodology. However, no sources of leakage have been identified for this project activity.

Net GHG Reductions and Removals

The net reduction and removal of greenhouse gas (GHG) emissions is the most critical metric, and our methodology calculates this by subtracting the emissions reduction achieved from the baseline emissions.

The formula is:
$ERy = BEy - PEy$

Where:
ERy = Net GHG emissions reductions and removals in year y (tCO_2e)

BEy = Baseline emissions in year y (tCO_2e)

PEy = Project emissions in year y (tCO_2e)

Testing Procedures in VM0043

To create concrete of consistent quality, both conventional and CO_2-optimized mix designs must undergo specific tests aligned with standard ASTM or CSA methods, according to VM0043. These tests can be one or more of the following:

- **ASTM C39:** Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
- **Global ACI 214R-11:** Guide to Evaluation of Strength Test Results of Concrete
- **Global ACI 214.4R-10:** Guide for Obtaining Cores and Interpreting Compressive Strength Results
- **Europe EN 12390-3:2019:** Testing hardened concrete. Compressive strength of test specimens

Steps in a Typical Testing Procedure

1. Testing the Conventional (Baseline) Mix
Firstly, the cement quantity in the conventional mix is measured and documented. Then the mix is tested using one or more of the approved strength tests. The test is repeated at least three times to ensure consistent results (within 10% of one another).

2. Testing the CO_2 Mix
Then, the cement quantity in the CO_2 mix is measured (typically ~20% less than the conventional mix). The strength is tested in the same manner as the conventional mix.

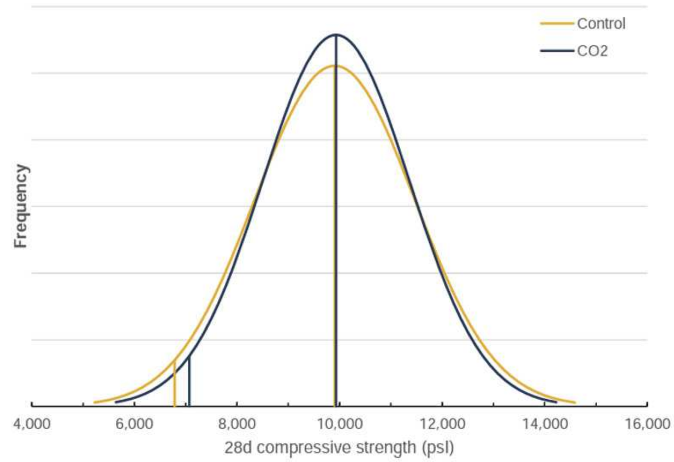
3. Comparison
The strength of the CO_2 mix should match or exceed the conventional mix, and the relevant amount of tests are completed to indicate this performance.

Results from a Sample Test Using the VM0043 Methodology

Within the methodology, the results of a sample test are included as a reference point. Two concrete mixes were tested and compared:

1. Reference Mix	2. CO_2 Mix
• 470 lbs of cement per cubic yard • 120 lbs of fly ash per cubic yard • 350 lbs of slag per cubic yard	• 78 lbs per cubic yard (20% reduction) • 120 lbs of fly ash per cubic yard • 350 lbs of slag per cubic yard

After multiple tests, the reference mix set had an average 28-day strength of 9,906 psi and a standard deviation of 1,560 psi. The CO_2 mix set had a nearly identical strength of 9,932 psi and a standard deviation of 1,431 psi. In the sample test, the CO_2 concrete has a compressive strength equal to or greater than the reference concrete, and the requirements outlined in the VCS methodology are met.



Read the full VCS Methodology for more details.