WHITE PAPER

VCS Testing Procedures to Compare Strength of Concrete

Introduction

Cement, the key ingredient that gives concrete its strength, is a major source of CO2 emissions. To mitigate these emissions, new processes have been invented that use less cement but still maintain concrete's strength. However, before these processes are adopted, it's vital to test and compare their strength against traditional methods.

Verified Carbon Standard (VCS) methodologies are technical documents used by project developers to quantify the GHG (greenhouse gas) emissions savings of different project types.

VM0043 is the VCS methodology that covers CO_2 utilization in concrete production.

The methodology measures both the carbon removal from the injection of recycled CO2 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.

This short technical whitepaper summarizes the testing procedures used within VM0043.

Testing Procedures

To create concrete of consistent quality, both traditional and new mix designs must undergo specific tests aligned with standard ASTM or CSA methods:

- 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

These tests ensure a new mix design is as strong, if not stronger, than the traditional one.

Steps in the Testing Process

1. **Testing the Traditional (Baseline) Mix**
   - Measure the cement quantity in the mix.
   - Test the strength of this mix.
   - Repeat the test three times to ensure consistent results (within 10% of one another).
2. **Testing the CO_2 Mix**
   - Measure the cement quantity in the mix.
   - Test its strength in the same manner as the traditional mix.
   - Repeat the test three times to ensure consistent results (within 10% of one another).
3. **Comparison**
   - The strength of the CO_2 mix should match or exceed the traditional mix.
   - If it doesn't, further tests are conducted until the desired strength is achieved.

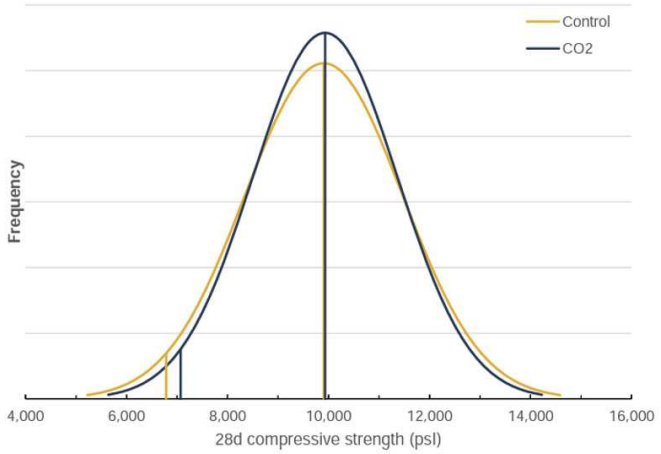
Methodology Testing Criteria: Both mixes must yield roughly equivalent strength.

Results from Sample Test

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 regular 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.



Conclusion

Because the CO_2 concrete has a compressive strength equal to or greater than the reference concrete, the requirements in the methodology are met. By using this testing procedure, it's possible to validate that concrete produced using less cement (for environmental or cost-saving reasons) does not compromise structural strength. This ensures the safety and durability of the infrastructure while making strides toward more sustainable construction practices.

For a detailed breakdown of the methodology, including specifics of the tests, and other technical details, please refer to the comprehensive Verified Carbon Standard: Methodology for CO_2 Utilization in Concrete Production.