## Concrete Made with CarbonCure is Compliant with AASHTO Standards

CarbonCure has been evaluated to ensure it meets the stringent requirements of the American Association of State Highway and Transportation Officials (AASHTO) as an admixture for concrete (M194 or ASTM C494 Type S). This summary report outlines the compliance of CarbonCure in accordance with AASHTO's specified tests, as well as additional durability tests performed to demonstrate the effectiveness of the solution.

#### **CarbonCure Overview**

CarbonCure introduces recycled  $CO_2$  into a concrete mixture during the mixing cycle. Once injected into the mix, the  $CO_2$  undergoes a mineralization process (i.e., it chemically converts into a nano-scale calcium carbonate mineral) and becomes permanently embedded in the concrete and aids in cement hydration efficiency. This allows for a reduction in cement use — and a reduced carbon footprint — without compromising the fresh properties, strength, or durability performance of the concrete.

### **CarbonCure Benefits in Civil Projects**



Cement reduction by 5-6% with no loss in strength or durability.



Environmental benefits due to  $\rm{CO}_2$  reuse and reduction of cement.

### **AASHTO Compliance Verification Testing**

CarbonCure's AASHTO compliance verification was performed by **SGS TEC Services** in Lawrenceville, Georgia — an independent laboratory accredited by AASHTO R18, ANS/ISO/IEC 17025:2005, and the Army Corps of Engineers.

It is worth reiterating that CarbonCure's value proposition is to support a more efficient use of cement (reduced amount thanks to enhanced cement hydration efficiency). This AASHTO verification testing program did not address that scenario; rather, the study was confined to assessing the effect of adding  $CO_2$  in concrete. Future work is underway to evaluate these concrete properties in a cement-reduced concrete mix.

#### Testing

The concrete batching took place at **Thomas Concrete's** Norcross facility before the concrete properties of three control mixtures and three CarbonCure mixtures were tested in accordance with AASHTO M194 (ASTM C494) by the independent laboratory. Properties tested include:

- **AASHTO T119 (ASTM C143)**: Slump of Hydraulic Cement Concrete
- AASHTO T152 (ASTM C231): Air Content
- AASHTO T309 (ASTM C1064): Temperature
- **AASHTO T121 (ASTM C138)**: Density, Yield, and Air Content of Concrete
- AASHTO T22 (ASTM C39): Compressive Strength
- AASHTO T97: Flexural Strength
- **AASHTO T161 (ASTM C666)**: Resistance to Rapid Freezing and Thawing

Additional durability test specimens were cast from both the control and CarbonCure mixtures and evaluated at a later date for:

- **ASTM C157-17**: Standard Test Method for Length Change Of Hardened Cement Mortar And Concrete
- ASTM C1585-20: Standard Test Method for Measurement of Rate of Absorption of Water by Hydraulic-Cement Concretes
- AASHTO T358: Standard Method of Test for Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration
- **ASTM C1556**: Standard Test Method for Determining the Apparent Chloride Diffusion Coefficient of Cementitious Mixtures by Bulk Diffusion to compute Mean D



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- **ASTM C457**: Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete
- **AASHTO T365**: Quantifying Calcium Oxychloride Amounts in Cement Pastes Exposed to Deicing Salts
- **ASTM G109**: Standard Test Method for Determining Effects of Chemical Admixtures on Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments

#### Results

The AASHTO M194 (ASTM C494) test results shown in the table below demonstrate that the CarbonCure mixes performed as well as the control mixes and met or exceeded the job requirements specified by AASHTO.

Like the results of the mandatory tests, the results of the additional durability tests also confirm no negative impact on fresh or hardened concrete properties and confirm the efficacy of CarbonCure in meeting and, in some instances, exceeding industry standards.

Test Results	CarbonCure	Job Requirements
Water Content (percent of control)	99	n/a
Time of setting, deviation of control		
Initial (hr:min)	-0:11	-1:00 to +1:30
Final (hr:min)	-0:10	-1:00 to +1:30
Compressive Strength		
1 day		n/a
3 days	108	90 (min)
7 days	101	90 (min)
28 days	106	90 (min)
56 days	104	90 (min)
90 days	107	n/a
6 months	97	90 (min)
1 year	96	90 (min)
Flexural Strength (percent of control)		
3 days	100	90 (min)
7 days	104	90 (min)
28 days	101	90 (min)
56 days	101	90 (min)
Length Change (increase over control)	0.0006	0.010 (max)
Relative durability factor	101	80 (min)

# Detailed results from SGS TEC Services laboratory testing — including tables and figures — are available in <u>the full report</u>.

