Low-cost, High Yield and Scalable Carbon Dioxide Mineralization to Invent Novel Carbon-Negative Concrete

C-Crete
TECHNOLOGIES

C-Crete: Cement-free Concrete

2024 FECM/NETL Carbon Management Research Project Review Meeting August 5 – 9, 2024
Pittsburgh, Pennsylvania
Conference Sponsor: DOE

PI: Dr. Rouzbeh Savary, Award FE-0032396
Aug 6, 2024

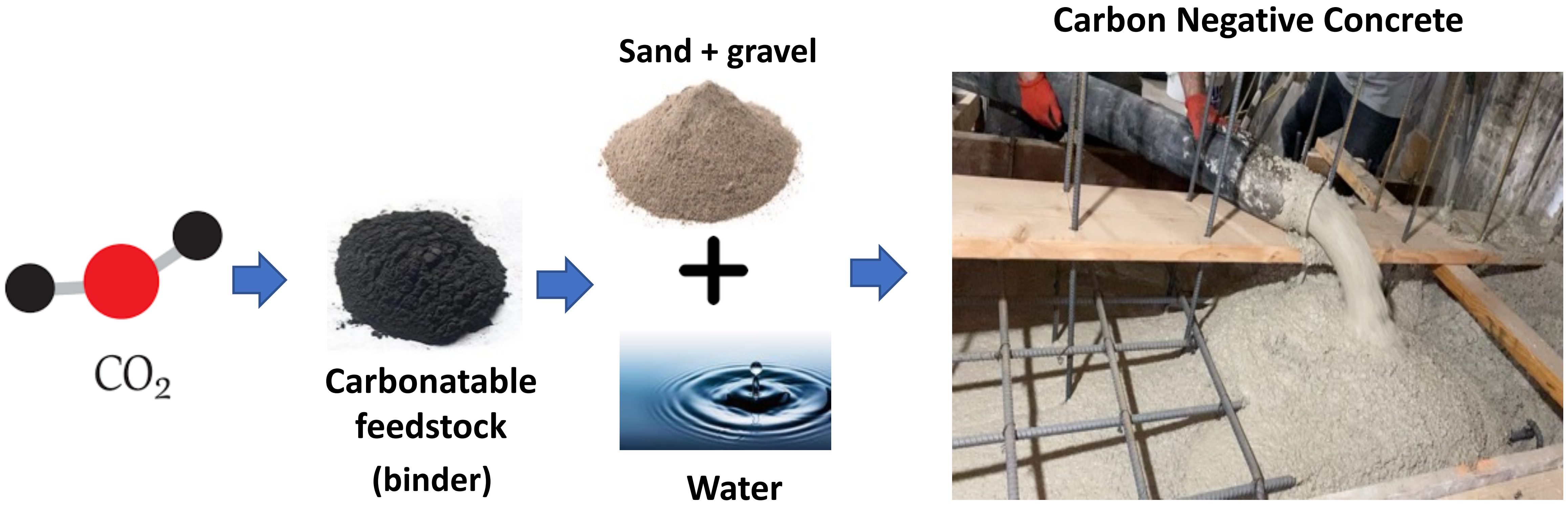
Project Overview

Funding (DOE and Cost Share): $2,000,000 Fed Share: $500,000 (cost-share by C-Crete)

Overall Project Performance Dates: 10/1/23 to 9/30/25

Project Participant: C-Crete Technologies

Technology Background: How does it work?



Technology Background: Product Features

C-Crete TECHNOLOGIES

- ✓ Zero use of Ordinary Portland Cement (OPC)
- ✓ Decarbonizing concrete: saving up to 1 tons CO_2 per ton of binder
- ✓ Ultra-low embodied energy by using natural rocks/industrial by-products as a binder
- ✓ Saving Water: Our concrete product requires up to ~15% less water, helping environment
- ✓ Meeting standards: ASTM C1157, Freeze-Thaw, Alkali-Silica Reaction, Chloride/Acid resistance, etc
- ✓ No need for new code development: Our product falls perfectly under existing ASTM C1157
- ✓ Optimal heat of hydration: meeting ACI 301, even for large mat foundations
- ✓ Easy implementation: a drop-in technology, and easily pumpable concrete via line/boom pumps
- ✓ Superior properties: mechanical strength, durability, etc
- ✓ Compatibility with conventional admixtures (superplasticizers, air entrainment, retarders, extenders, etc)
- ✓ High solar reflectance: Minimal heat island effect
- ✓ Scalable: both in feedstocks and manufacturing process

Project Objectives and Major Tasks

C-Crete TECHNOLOGIES

- The first objective is full synthesis control over the reaction parameters to maximize conversions and efficiencies.

- The second objective is to fabricate optimal 2” cube mortars, 4”x8” concrete cylinders, and 4”x4”x14” prismatic beams and perform several ASTM standard testings to ensure the products meet the industry codes.

- The third objective is reproduceable scale-up of the optimal synthesis protocols, perform small pilot testing and full TEA, LCA, and technology gap analysis towards commercial deployment.

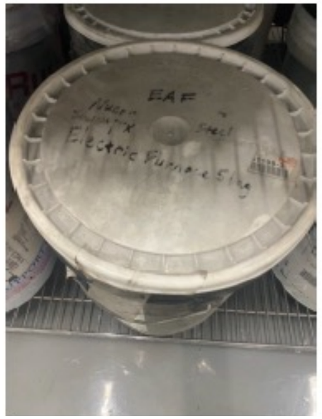
Project Objectives and Major Tasks

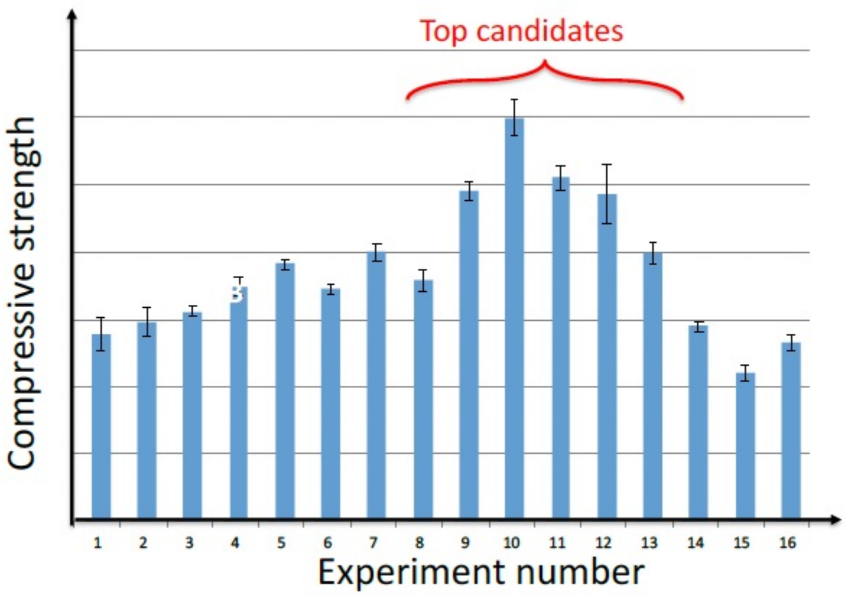
C-Crete TECHNOLOGIES

	BP 1 (Year 1)				BP2 (Year 2)			
Task	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**
Task 1 - Project Managemnt and Planning								
Task 1.5 Community Benefit Plan								
Task 2 - Synthesis control over the carbonation process								
Task 3 - Fabricate Binder and concrete samples			M3					
Task 4 - Meeting ASTM Performanced-based Standards								
Go/no Go				◆				
Task 5 - Scale-up and Small Pilot Scale Demonstration								
Task 6 - TEA and LCA								

Task 2: Synthesis control over carbonation process

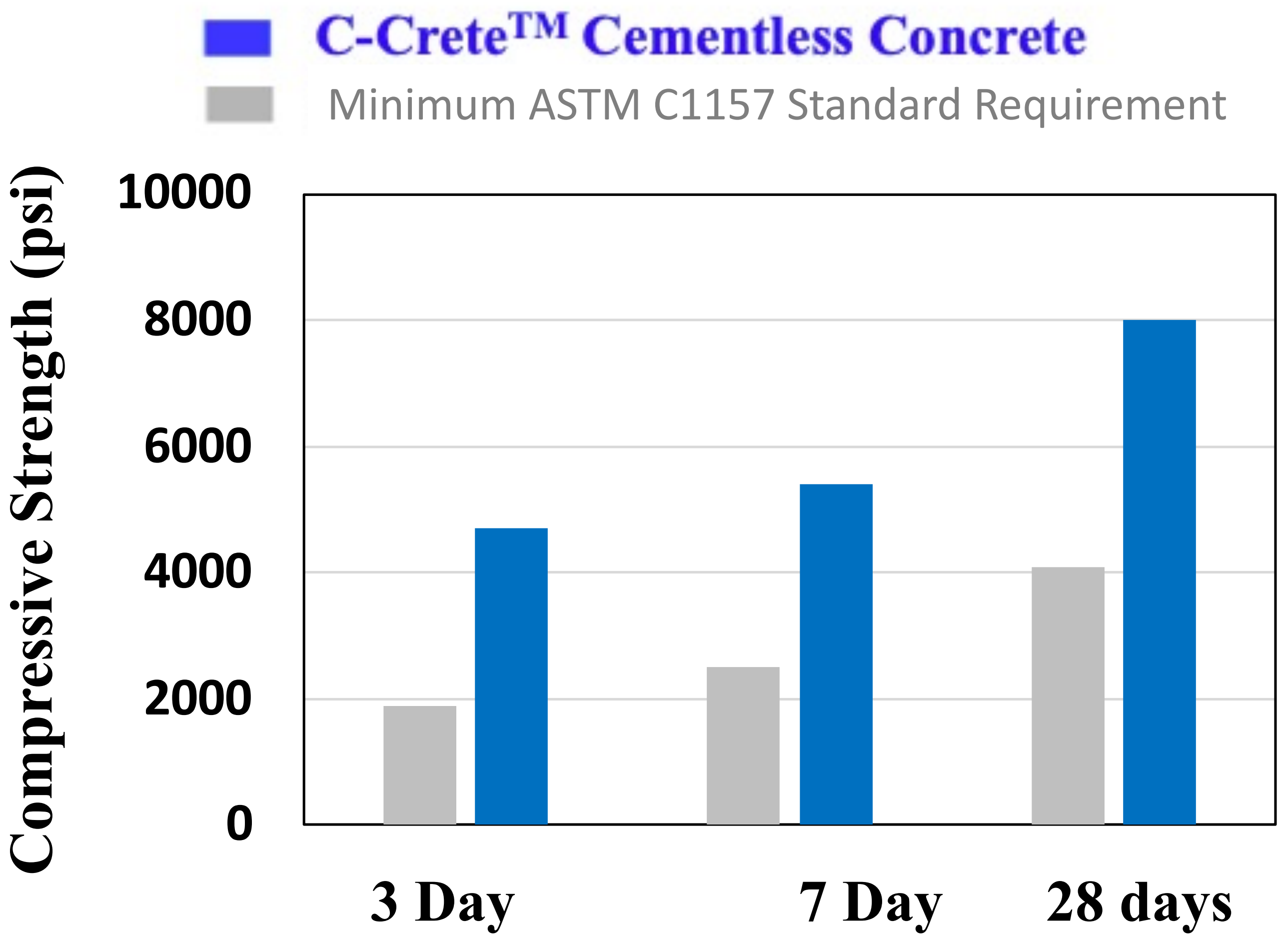
C-Crete TECHNOLOGIES





Task 3: Fabricate binder and concrete samples

Representative Mechanical Properties*



***Some of our latest mix design can reach ~12,000 psi in compressive strength or potentially more.**

Task 4: Meeting ASTM Performance-based Standards

ASTM C1157: Standard Performance Specification for Hydraulic Cement

Typical results

Property	ASTM/AASHTO Standards	Protocol	C-Crete™	Min or Max per Standard	Unit
Compressive Strength @ 3 days	ASTM C1157	C109/C109M	>4500	>1900	PSI
Compressive Strength @ 7 days	ASTM C1157	C109/C109M	>5200	>2900	PSI
Compressive Strength @ 28 days	ASTM C1157	C109/C109M	>7000	>4060	PSI
Mortar Bar Expansion @ 14 days	ASTM C1157	C1038/C1038M	0.012	<0.02	%
Time of Setting, Vicat Test (initial set time)	ASTM C1157	C191	165	>45 and <420	minutes
Air Content	ASTM C1157	C185	2.5	<12	%
Autoclave Length Change	ASTM C1157	C151/C151M	0.21	<0.8	%
Alkali Silica Reaction @ 14 days	ASTM C1157	C227	0.01	<0.02	%
Alkali Silica Reaction @ 56 days	ASTM C1157	C227	0.02	<0.06	%
Drying Shrinkage @ 28 days	ASTM C157	-	0.03	<0.05	%
Chloride Diffusivity (Acid soluble chloride ion)	AASHTO T 260-97	-	0.2	<0.4	%
Freeze-Thaw Resistance	ASTM C666/C666M	-	>90%	>60%	%




* The value of OPC was taken as the limit.

Success Criteria

C-Crete TECHNOLOGIES

Criteria: Optimized process conditions to create 10+ standard size formulated concretes that exhibit the following:

1) Compressive strength of >4060 psi for 4”x8” cylinders at 28 days,
2) Standard mortar bar expansion to be less than <0.02% at 14 days

Completion Date for Both: End of BP 1 (Month 12)

Key Project Risks and Mitigation Strategies

Perceived Risk	Risk Rating			Mitigation and Response Strategy
	Probability	Impact	Overall	
	(Low, Medium, High)			
Cost/Schedule Risks:				
Delay in lab-scale design and lead times	Low	Medium	Low	Start the design using free-issued instruments, valves and off-the shelve components
Management, Planning and Oversight Risks:				
Project falling behind schedule	Low	Low	Low	The PI Savary will communicate with the NETL program manager on how to resolve the issue in the best possible way.
Financial Risk:				
N/A				
ES&H Risks:				
Working with chemicals	Low	Low	Low	We have strict lab safety protocols in place

Summary of Community Benefits

-Hired an employee from under-represented groups

-Hired a micro/small business

-Designated one gender-indifferent bathroom for disabled/LGBT employees

-Hired an electrical technician from low income communities

-Communicated/arranged with local institutions for outreach

Technology / Site Selection

This project will be performed at the following location

C-Crete Technologies

14421 Catalina St

San Leandro, CA 94577

Different Surface Finishes

Exposed Aggregate Finish

Polished Finish

Terrazzo Floor

Lessons learned

-The availability of the feedstock is of at most importance when it comes to new technologies related to CO2 mineralization and concrete. C-Crete is only using materials that scale at different geographies

-The technology should have a low yield loss in order to be economically competitive to conventional Portland cement concrete. Unlike conventional limestone processing in cement plants, C-Crete's process has minimal yield loss, and all the feedstock that comes in goes out as the product.

Plans for future testing/development/commercialization

-Ensure all reactions and processes have high yield

-Continue focusing on scalable feedstocks and processes

-Monitor and influence the market in terms of adoption of cement-free concrete

Acknowledgments

- This project was supported by DOE award number NETL FE0032396. All data and information presented on this document represent the opinion of C-Crete Technologies and not DOE.