

A construction site featuring a large, angled concrete slab being hoisted by a crane. Several workers in safety gear are visible on the ground, and stacks of construction materials are on the right. The background shows trees and a clear sky.

CLAYCO

THE ART & SCIENCE OF BUILDING

CONCRETE
STRATEGIES
MORE TO THE POUR

Adapting Low Carbon Concrete Mix Designs for Improved Workability and Finishing

2025

AGENDA

A. Case Study

- i. Goals
- ii. Process
- iii. Takeaways
- iv. Next steps

B. Best Practices (in a rapidly evolving market)

C. Workflow Nuts & Bolts (Specification/Submittals/Reviews)



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VP of Technical
Services, Ozinga



Kyle Kammer
Director of Quality,
Concrete Strategies

ORGANIZATIONS INVOLVED



**General Contractor
with a Large
Industrial Portfolio**



**In-house Concrete
Placement and
Erection Subsidiary
of Clayco**



**Forensic Engineering
Firm & Laboratory
Testing Partner**



**Ready-Mix Supplier
(Supplier of Mix for
Panel 3)**



**Laboratory Testing
Partner**



**Ready-Mix Supplier
(Supplier of Mix for
Panels 1 and 2)**



**Technical guidance
and material science
inputs to testing
program and report**



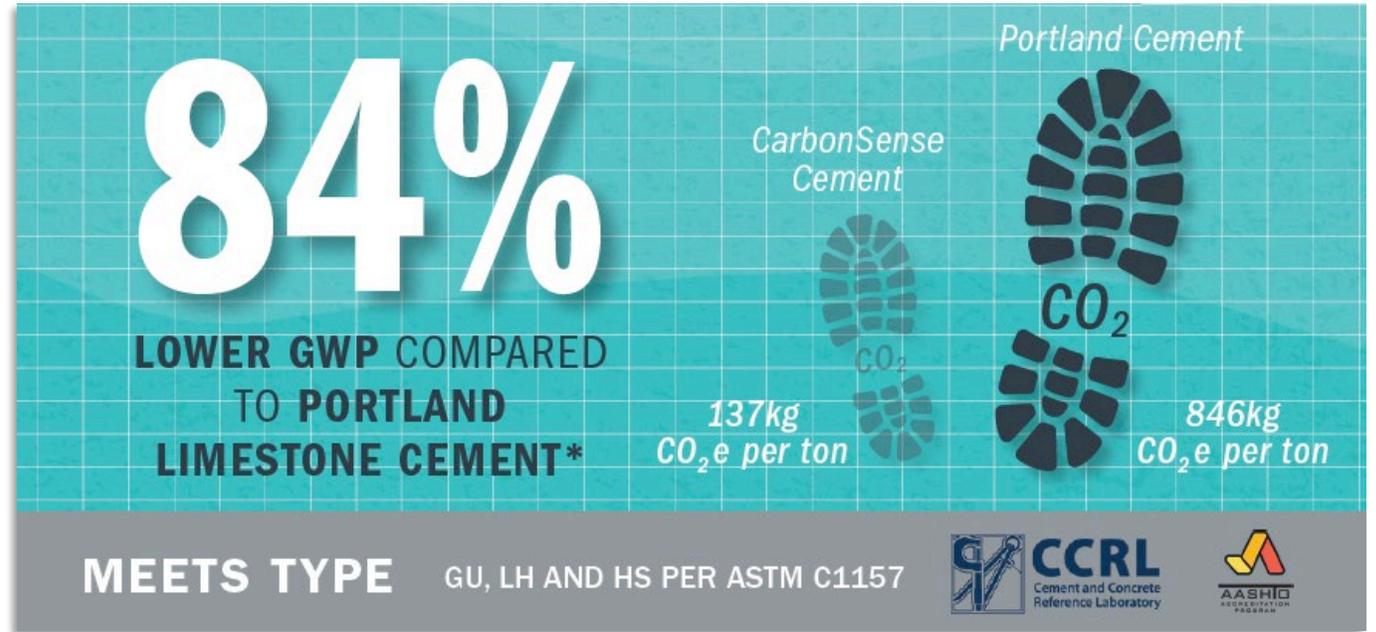
**Technical guidance
and engineering
review inputs to
testing program and
report**

CHARGE FROM CLIENT

**What's available NOW, AT SCALE,
that will reduce our carbon footprint
but not compromise
schedule and durability?**



- CarbonSense® Ready Mix
- CarbonSense® Cement
- Recycled Materials



		CEMENT REPLACEMENT		
		30% CARBONSENSE*	50% CARBONSENSE* PLUS	70% CARBONSENSE* ULTIMATE
3000 PSI	GWP	120	96	74
	NRMCA GREAT LAKES REGION	195	195	195
	% DIFFERENCE OZINGA/GREAT LAKES	-38%	-51%	-61%

Ozinga Breaks Ground on Low-Carbon Cement Plant in East Chicago

Indiana plant will have access to rail and waterway transport



BARRIERS TO USING LOW CARBON CONCRETE IN TILT WALL CONSTRUCTION

- Perceived cost
- Perceived schedule impacts
- “Unknown” factor
- Reliable & available SCMs
- Big picture - is this a worthy effort?



CEMENT TYPES FOR CONCRETE MIXES EVALUATED

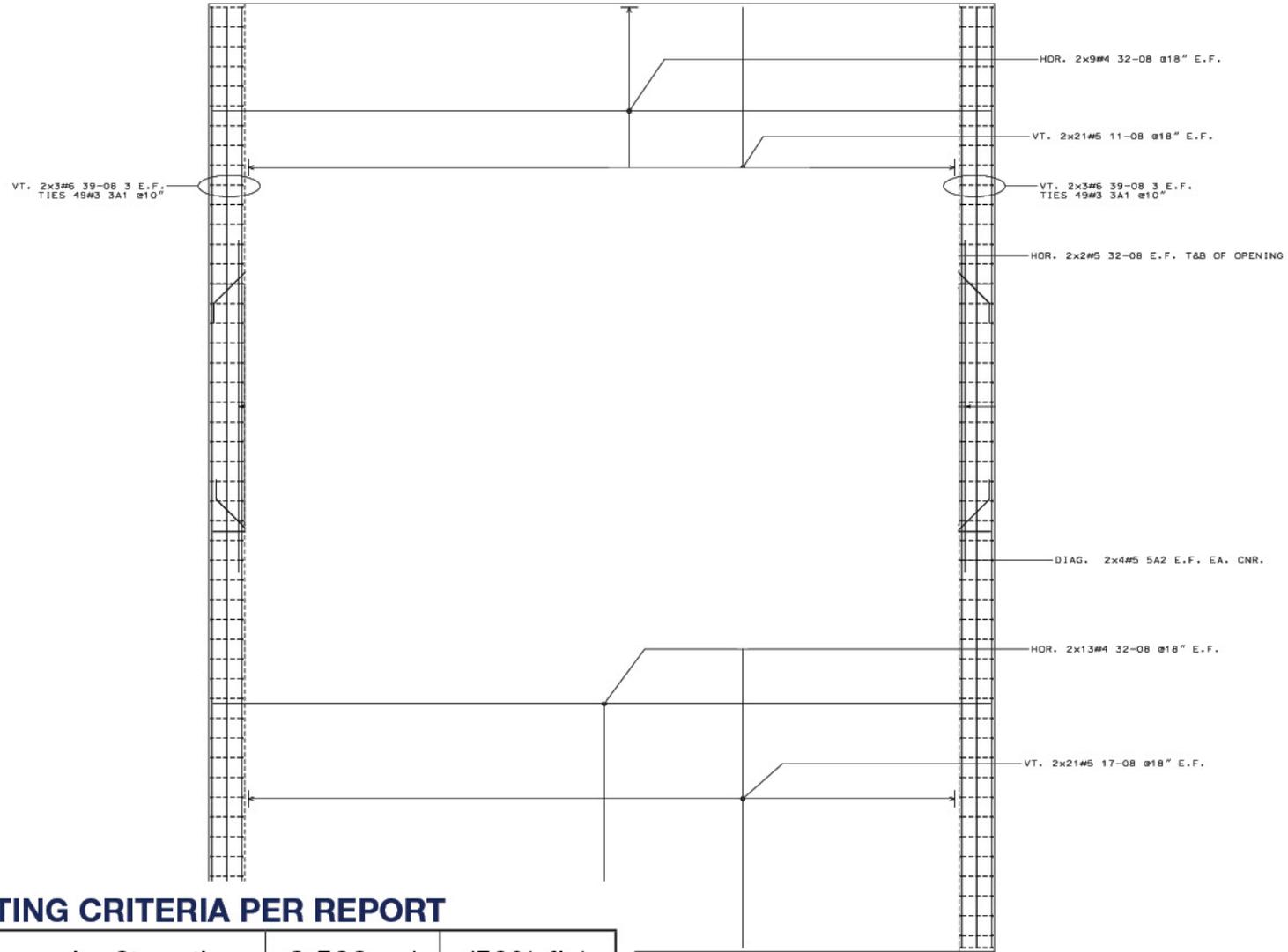
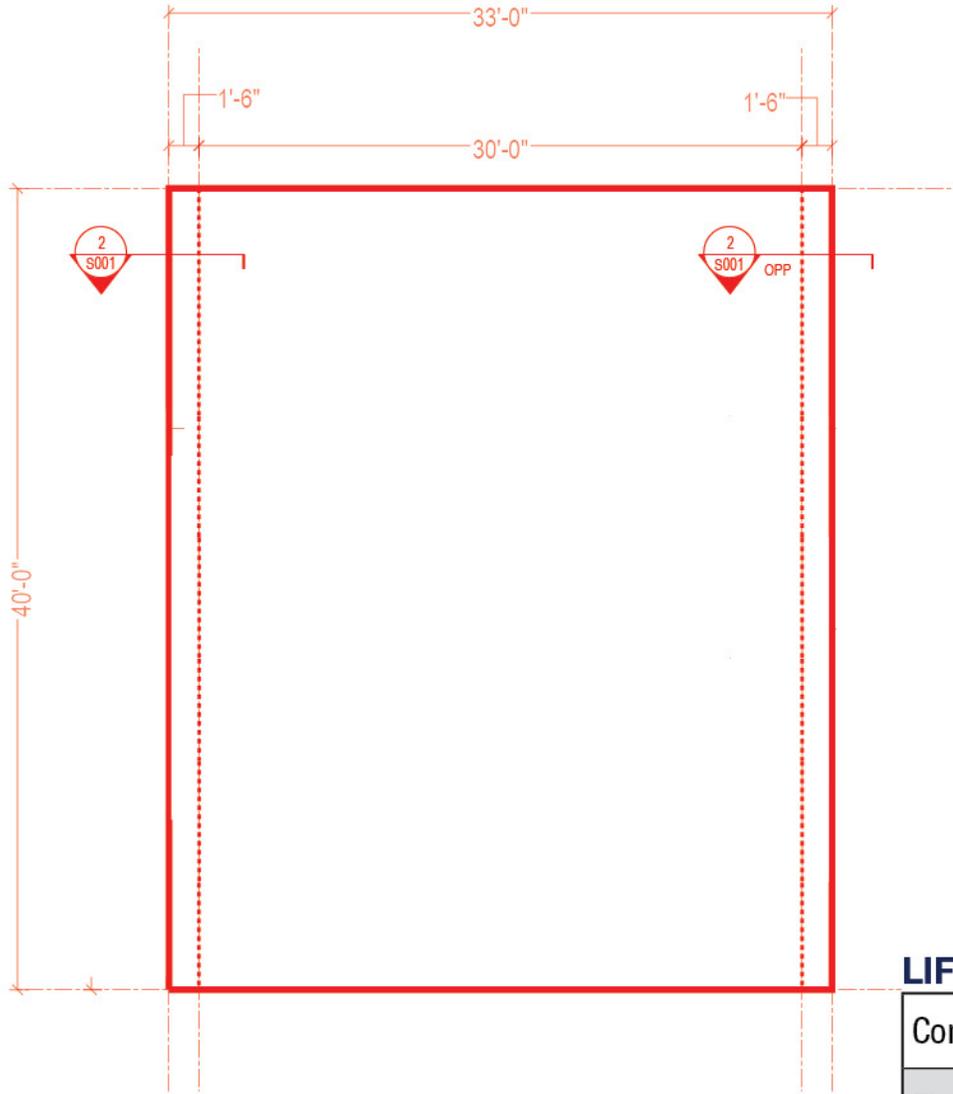
	Cement Type	Embodied Carbon
Baseline	NRMCA V3.2, Great Lakes Region	Baseline
Panel 1	100% type 1L cement, Holcim St. Genevieve Plant	25% reduction
Panel 2	Blended cement - 25% blast furnace slag, 75% type 1L cement, Holcim St. Genevieve Plant	39% reduction
Panel 3	Proprietary blended 1157 cement mix 1	64% reduction



MIX DESIGNS

Constituent	Description or Source	Units	Mix 1 - 1L St. Gen	Mix 2 - 25%	Mix 3 - C1157
Type II Cement	St. Genevieve, MO	lbs/yd ³	564	423	--
Slag Cement	Holcim, Chicago, IL	lbs/yd ³	--	141	--
C1157 Cement	Ozinga	lbs/yd ³	--	--	750
Coarse Aggregate	Bluff City Materials, Alton, IL	lbs/yd ³	1775	1780	1740
Fine Aggregate	Madison County Sand, Collinsville, IL	lbs/yd ³	1420	1400	1240
Water	N/A	lbs/yd ³	271	271	237
High-Range Water Reducer	ADVACAST 600, GCP	fl. oz.	26	26	30
Workability Enhancing Admixture	ADVA XT, GCP	fl. oz.	--	--	22
Rheology Modifying Mixture	V-MAR F100, GCP	fl. oz.	--	--	45
Accelerating Admixture	OZ Set	fl. oz.	--	--	262.5
Target Air Content	--	%	1.5	1.5	1.5
W/CM (not including admixtures)	--	--	0.48	0.48	0.32
W/CM (including admixtures)	--	--	0.48	0.8	0.34

BASIC LAYOUT



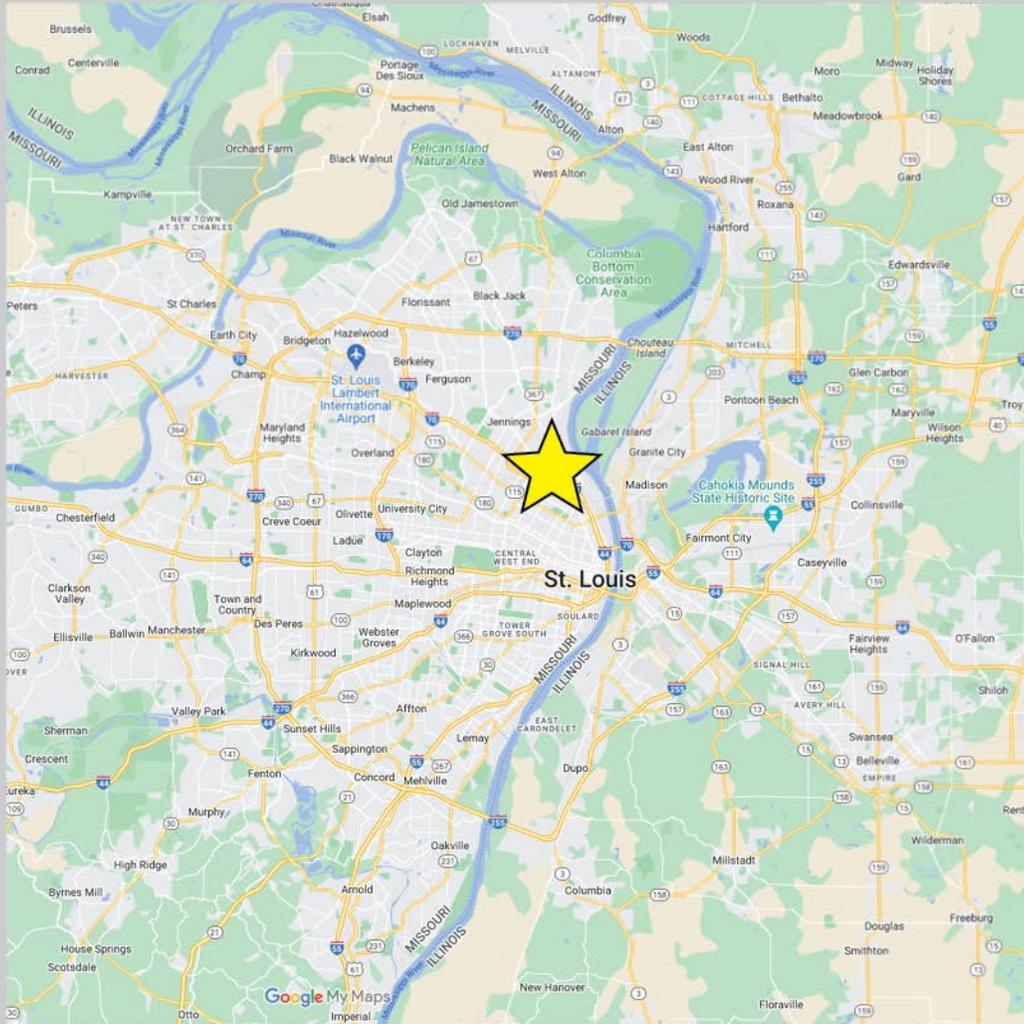
LIFTING CRITERIA PER REPORT

Compressive Strength	2,500 psi	(50% f'c)
Flexural Strength	500 psi	(10% f'c)

TYPICAL WALL PANEL ELEVATION (3) THIS

SUPPORTS: 270 I/F
 1" S.B. ALL PLASTIC
 160 I/F @ TIES
 1 1/2" S.B. ALL PLASTIC
 240 I/F BETWEEN LAYERS
 4" S.B.U.

POUR LOCATION



IN THE FIELD

White wire and device
Smartrock™ in-situ maturity
sensor installed within panel.



IN THE FIELD

	TESTING DAYS						
	1	2	3	5 [†]	7 [†]	14	28*
Field-cured Cylinders	X	X	X	X	X	X	X
Lab-cured Cylinders					X		X
Field-cured Beams (Panels 1 & 2)		X	X		X		X
Field-cured Beams (Panel 3)		X	X	X	X		X

***Note:** All 28 day actions & testing were performed on day 29 (12/26) due to the holiday.

†Note: Panel 3 only.



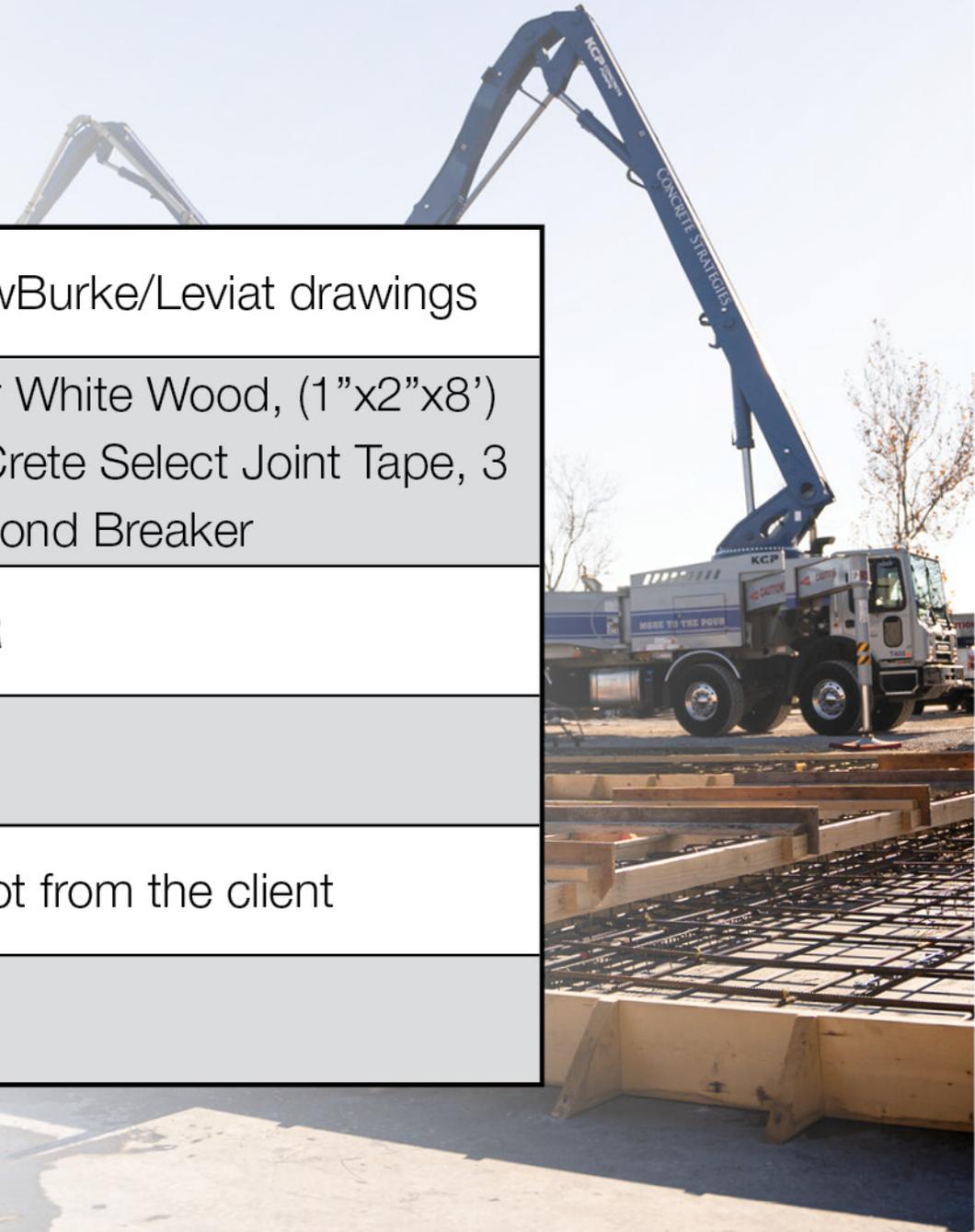
Cores were taken from each panel to verify in-situ compression strength.



Cylinder Samples

CASTING SLAB/FORMWORK INFORMATION

Panel Layout	Based off the client's and MeadowBurke/Leviat drawings
Material for Formwork	(2"x10"x16') (2"x12"x16') Lumber White Wood, (1"x2"x8') Lumber Furring Strip, Nails, Nox Crete Select Joint Tape, 3 ½ gal. Sprayer Viton, Nox Crete Bond Breaker
Strip Footing	4000 PSI SR(Stone/Rock) NO AIR
Casting Slab Mix	3000 PSI SR(Stone/Rock) AIR
Rebar Layout	Subbed to American Steel Fab. not from the client
Pump Length	46 M



TESTING, POURING, FINISHING

PANEL 2 - FIELD OBSERVATIONS

“25% mix acted similar to standard. Placed, finished and cured the same. Less cracking that straight cement.”

“25% was not bad – placed and finished like straight cement.”

“25% mix gave the crew a bit extra time to finish, which was good. Still set and finished within a reasonable time.”

“A bit sticky and harder to finish.”



Concrete washout area demonstrating color difference between Panels 1 & 2 (darker) and Panel 3 (lighter).



PANEL 3 - FIELD OBSERVATIONS

“Once you used the VibraStrike, it finished well. You need to keep it moving.”

“Would need more moisture to work well in the field.”

“Finished well – final product looked good. Difficult to pour, move around and place.”

“Seemed to set up hard on top but was soft underneath. Top inch was hard but you could put a dent in it.”

“Difficult to place and finish.”





IN-PLACE STRENGTH VERIFICATION



Cores were taken from each panel to verify in-situ compression strength.

Erection of Panel 3: 1157 Mix



RESULTS



	Cement Type	Embodied Carbon
Baseline	Baseline	Baseline
Panel 1	100% Type 1L	25% reduction
Panel 2	25% Slag + 1L	39% reduction
Panel 3	Proprietary 1157	64% reduction

Panel 2 (25% slag) attained lifting strength and was erected on Day 3. Good to use even in poor weather.

Panel 3 attained lifting strength at day 3 in lab setting. In cold weather attained strength at 7 days. Further testing to determine “sweet spot” of conditions for use.



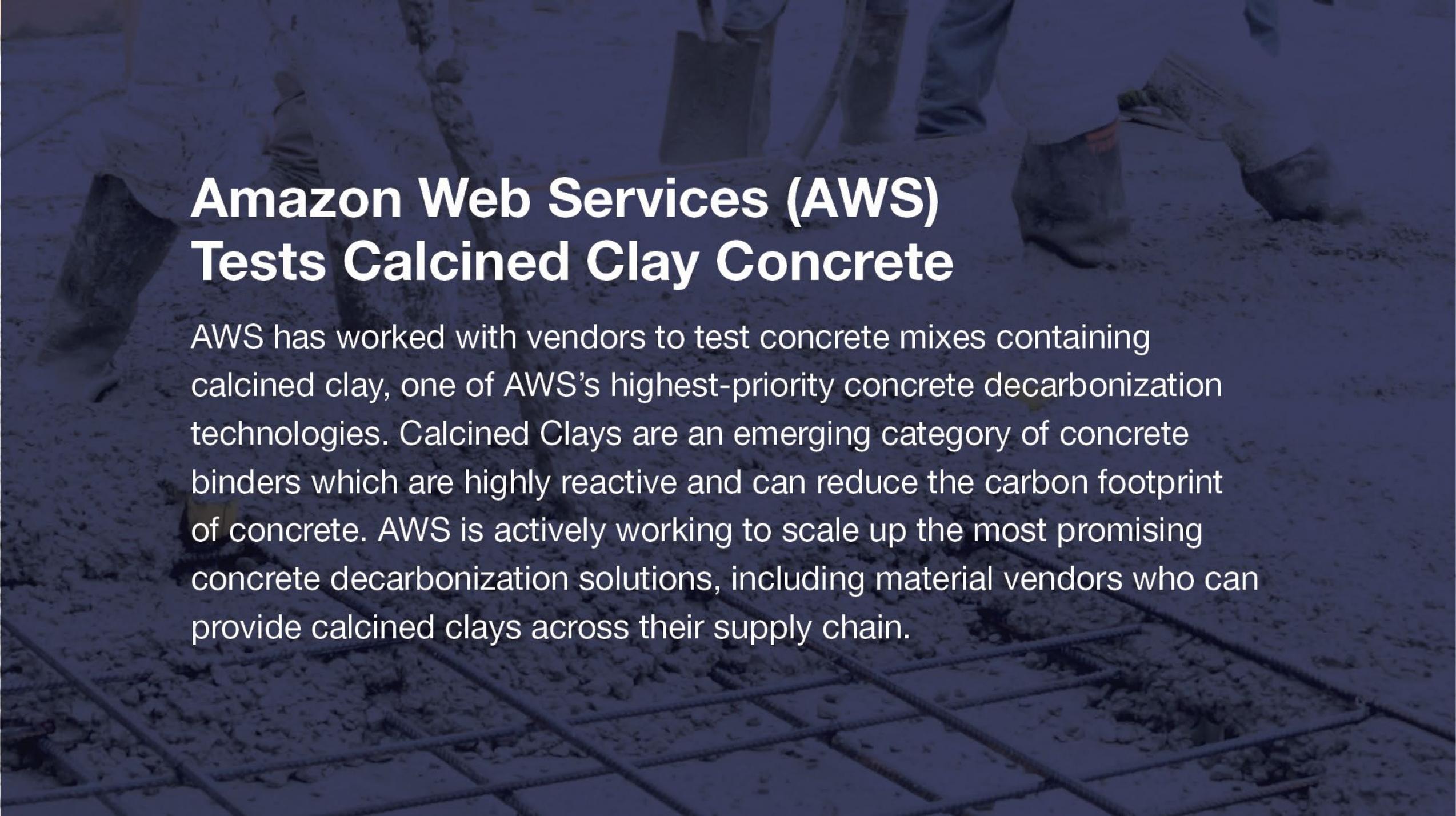
NEXT STEPS

- Incorporation of 1157 mix at Midwest site for foundations
- 1157 Slab on Grade mock-up at Midwest site
- Working with client on further novel mix testing
- Structure Magazine Article – Low-Carbon concrete mixes from a Contractor's perspective



FURTHER TESTING OF NOVEL MIX FOR SLAB APPLICATIONS





Amazon Web Services (AWS) Tests Calcined Clay Concrete

AWS has worked with vendors to test concrete mixes containing calcined clay, one of AWS's highest-priority concrete decarbonization technologies. Calcined Clays are an emerging category of concrete binders which are highly reactive and can reduce the carbon footprint of concrete. AWS is actively working to scale up the most promising concrete decarbonization solutions, including material vendors who can provide calcined clays across their supply chain.

ORGANIZATIONS INVOLVED - AUGUST 2024



*General Contractor
with a Large
Industrial Portfolio*



*In-house Concrete
Placement and
Erection Subsidiary
of Clayco*



*Forensic Engineering
Firm & Laboratory
Testing Partner*



*Laboratory Testing
Partner*



Ready-Mix Supplier



MIX DESIGNS

Constituent	Description or Source	Units	Tilt Wall 1 - 100% 1L	Tilt Wall 2 - 20% CC	Tilt Wall 3 - Ternary
Type IL C595 Cement	Argos Calera, AL	lbs./yd. ³	√	√	√
Slag Cement	Heidelberg Materials	lbs./yd. ³	--	--	√
Natural Pozzolan N (L3?)	Argos USA	lbs./yd. ³	--	√	√
Coarse Aggregate	Vulcan Materials Stockbridge, GA (manufactured sand)	lbs./yd. ³	√	√	√
Fine Aggregate	Atlanta Sand & Supply Roberta, GA (natural sand)	lbs./yd. ³	√	√	√
Coarse Aggregate	Vulcan Materials #89 Stockbridge, GA	lbs./yd. ³	--	--	--
Coarse Aggregate	Vulcan Materials #57 Stockbridge, GA	lbs./yd. ³	√	√	√
Water	City	lbs./yd. ³	√	√	√
Type A Water Reducer	GCP Applied Technologies Lithonia, GA	oz./cwt.	√	√	√
Type F (High-Range) Water Reducer	GCP Applied Technologies Lithonia, GA	oz./cwt.	√	√	√
Target Air Content	--	%	√	√	√
Target Water/Cement Ratio	--	--	√	√	√

SLAB TESTING, POURING, FINISHING

SLAB 1 - FIELD OBSERVATIONS

“Mix 1 performed as expected, except for a small area that didn't quite set right in the center. Delayed setting of portion could be due to High Range Water Reducer (HRWR) or lack of proper mixing at batch plant.”

SLAB 2 - FIELD OBSERVATIONS

“Mix 2 was sticky at first due to the Super (Super Plasticizer).”

“Mix 2 had a white residue that would appear on the surface, would go away once you ‘panned’ across it.”

“Last few trucks of mix 2 seemed to have the mix proportions dialed in better.”



SLAB 3 - FIELD OBSERVATIONS

“Mix 3 performed better than mix 2. It pumped well and laid down well, overall was better to place and finish.”

“Mix 3 took longer to get to saw cutting stage.”

“Machining was the same for all mixes once poured.”

“Set times were varied mix to mix and truck to truck. This affected finishing.”

“Hand finishing edges was sticky but not unworkable.”

“All the mixes poured were something we could work with on a normal job.”

TILT WALL TESTING, POURING, FINISHING

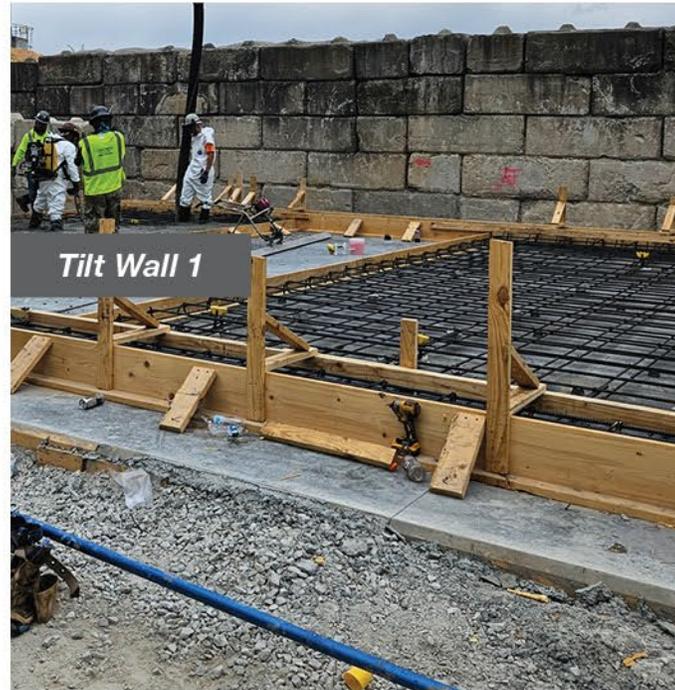
TILT WALL 1 - FIELD OBSERVATIONS

"The mix was fine, nothing out of the ordinary noted. The day was hot so set time was quick, but within expected ranges."

SLAB 2 - FIELD OBSERVATIONS

"Mix for tilt wall 2 was easier to work with than tilt wall 1."

"No notable finish issues other than a few hot spots with the high range water reducer."



TILT WALL 3 - FIELD OBSERVATIONS

"Mix for tilt wall 3 pumped and placed well but was very sticky."

"Mix for tilt wall 3 had a lot of tearing when we were trying to pan it and hand-finish the edges."

"There were two or three large spots (about 5'x2') that were not setting by the time everything else was being troweled."





Meta Datacenter | Dekalb, IL

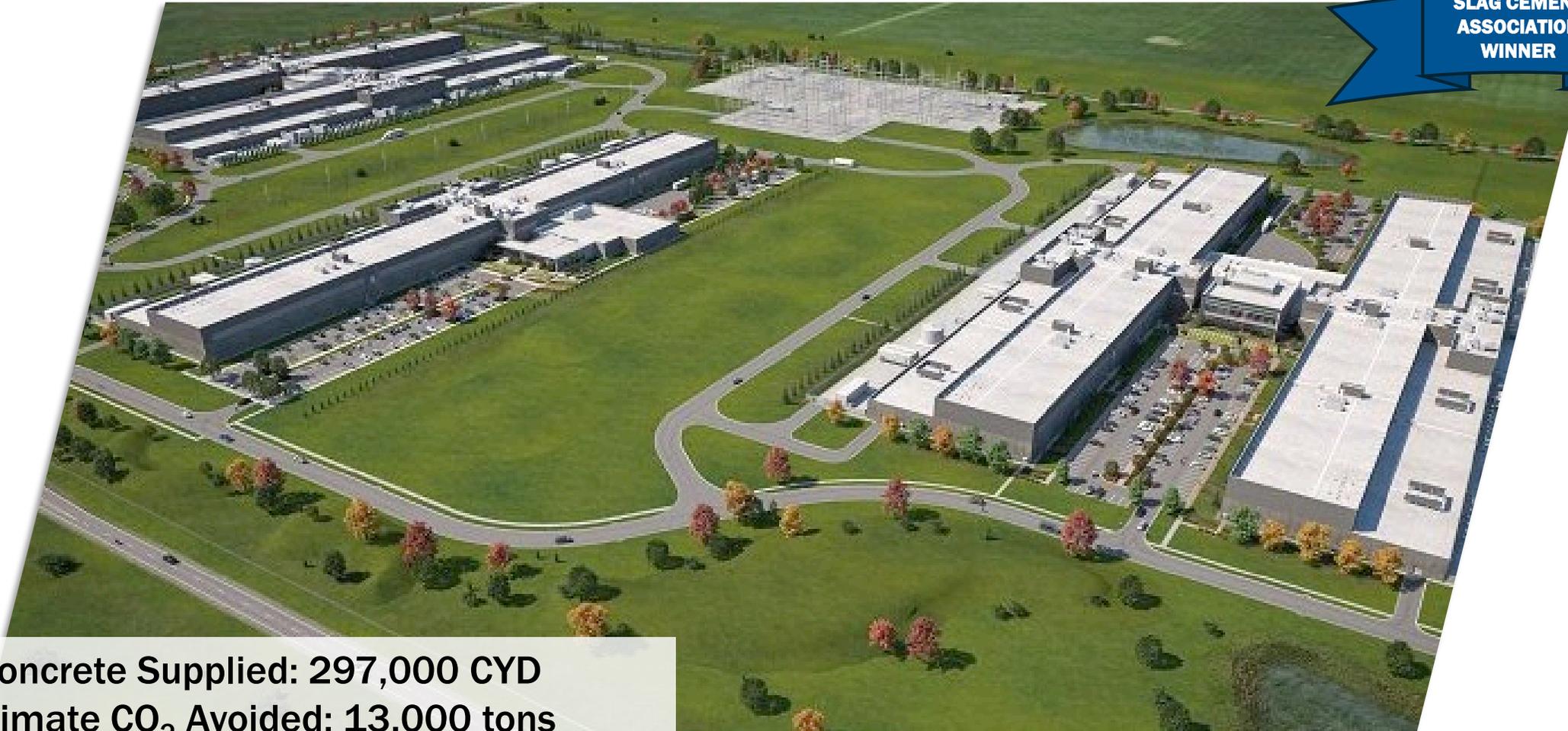


Open Commute Pilot



AWS Data Center

**SLAG CEMENT
ASSOCIATION
WINNER**



Total Concrete Supplied: 297,000 CYD
Approximate CO₂ Avoided: 13,000 tons
Offsetting Forests: 13,040 Acres



ASTM C1157 – CarbonSense[®] Cement



Foundations



Challenges



59% CO₂ reduction from NRMCA regional





**NRMCA CONCRETE
INNOVATION AWARD**

**SCA SUSTAINABLE
CONCRETE AWARD**

Total Concrete Supplied: 130,000 CYD
Approximate CO₂ Avoided: 2,962 tons
Offsetting Forests: 2,700 Acres



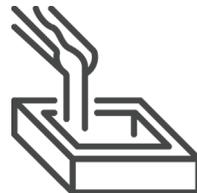
40% slag was ideal mix



Workability



Placeability

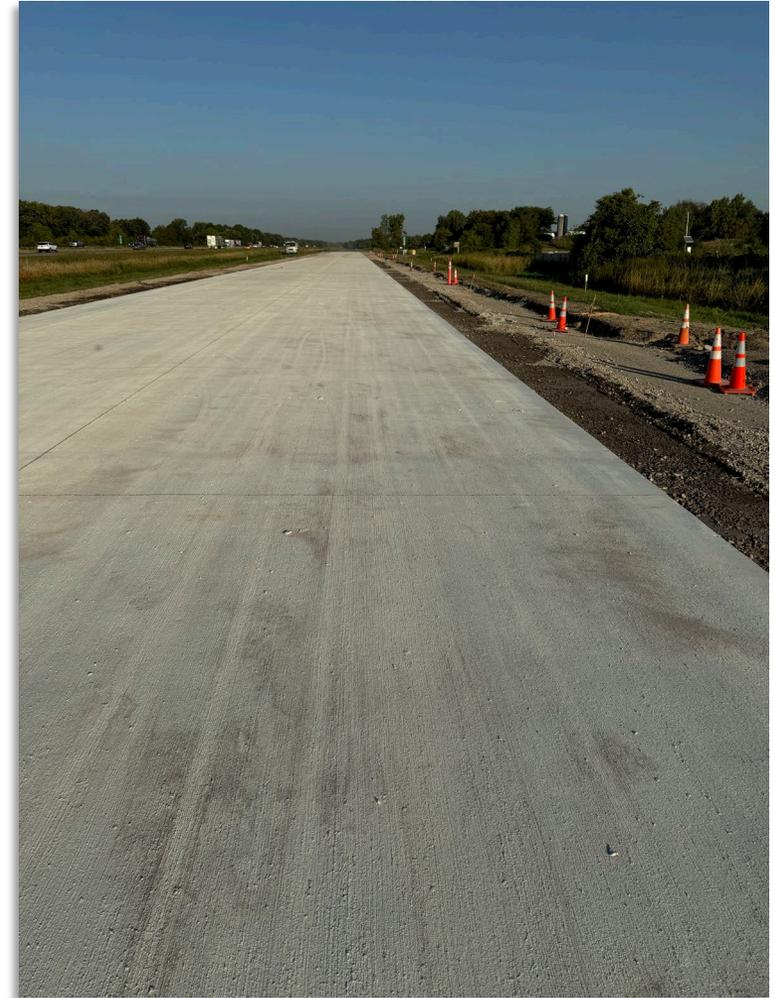
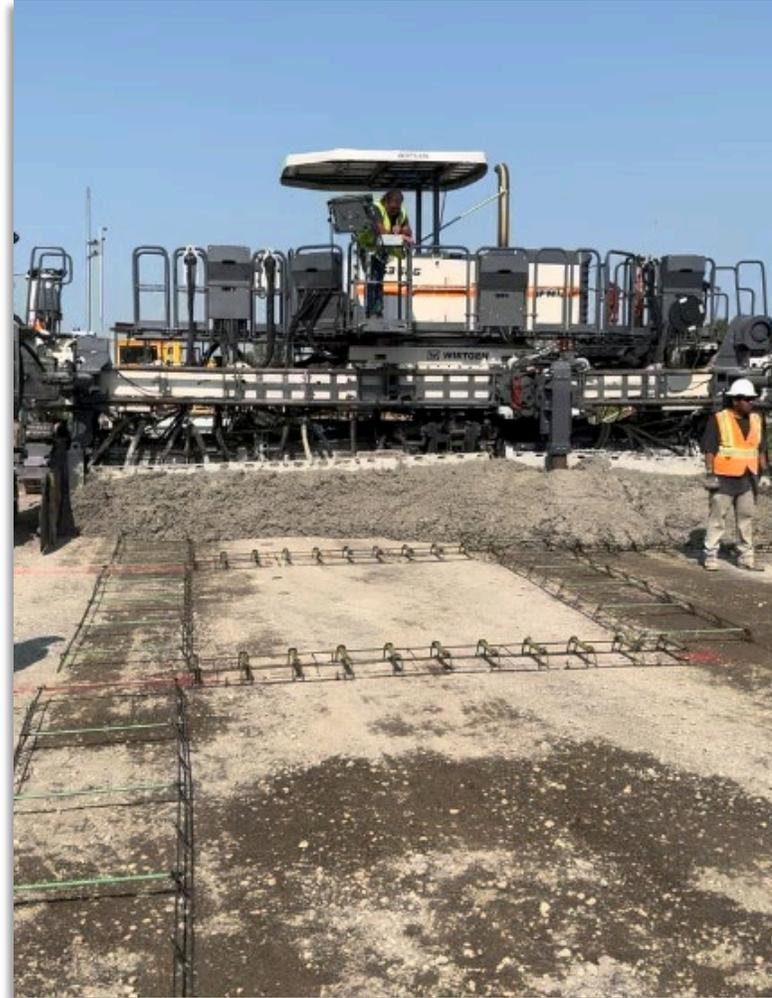


Finishability



■ MnRoads

- 80% ASTM C1157
- First Mainline Paving



Subsustainable Concrete Communication Recommendations

- Don't approach your project with a boilerplate spec. Examine your general notes.
- Get to know and keep open communication with local contractors and suppliers.



Subsustainable Concrete Communication Recommendations

Let the materials engineering happen!

- Exposure Category
- w/cm ratio
- 28 vs 56
- Schedule

Strength is great, but other properties like pumpability, workability, and finishability need to be considered. Blended cements and some SCMs have high water demand. Even with a higher water-cementitious ratio they can still have adequate permeability. Do you need 28 day strength? Can the schedule allow for 56 day strengths? This can really open up options.



Subsustainable Concrete Communication Recommendations



- Time/budget for mix testing
- Curing methodologies
- Be open to new materials/products...
but prepared to pivot
- **Talk to the Finishers...**
- **Ask them questions**
 - Set time
 - Workability
 - Finishability
 - Did you notice anything strange?
- **Share the feedback with the ready-mix supplier**
- **Pre Con Meetings are key**

CHECK YOUR SPEC!

- Do you still list C150 Type I/II Cement?
- Specify f'c and Exposure
- Remove notes requiring minimum cement
- ADD notes requiring minimum cement replacement
- Add a dedicated “Embodied Carbon” page to your sets (Special Inspection)
- Understand baselines – NRMCA vs CLF vs EC3 etc
- Budget for testing of novel mixes
- Approve back up mixes
- **EXPERIENCED REVIEWERS ON SUBMITTALS!**



Specification Examples

- Performance not prescriptive
- Not to exceed values
- Reduction % from Baseline
 - What's the baseline?

Compressive Strength	1 - Eastern	2 - Great Lakes Midwest Region	3 - North Central	4 - Pacific North West	5 - Pacific South West	6 - Rocky Mountains Region	7 - South Central	8 - South Eastern
2500 psi	197	192	197	206	210	198	183	200
3000 psi	217	211	216	228	229	217	200	218
4000 psi	261	252	257	275	267	256	235	254
5000 psi	315	304	308	333	314	305	279	298
6000 psi	333	321	327	352	333	323	295	316
8000 psi	395	380	383	420	381	376	341	361
3000 psi Lightweight	399	401	395	422	394	396	378	383
4000 psi Lightweight	446	445	437	470	433	437	415	421
5000 psi Lightweight	493	489	482	519	474	478	453	455

f. Submittal shall include a statement from the cement supplier certifying that no hazardous waste materials are used in the fuel mix or raw materials for production of cement. **Submit Environmental Product declaration, in compliance with ISO 14025:2006 Type III, third-party verified eco-label, for each mix and have at least a cradle to gate scope. Industry-wide EPDs are acceptable as an alternate to product-specific EPDs upon request. If EPDs cannot be provided, submit written documentation from the product supplier stating the exclusion for Engineer's approval. Submit a letter of compliance of Global Warming Potential limits for Engineer's review as stated in Section 1.3 Note A.5**

5. **Embodied Carbon Limits Compliance:**
 This project has a goal of reducing the embodied carbon footprint relative to a benchmark or typical project by _____%. To accomplish this goal, the target carbon footprint reduction for concrete is _____% below benchmark established in the NRMCA Cradle-to-Gate Life Cycle Assessment of Ready-Mixed Concrete Version 3 (or later). Specific targets for Global Warming Potential (GWP) are provided in Section 1.4 CONCRETE MIX DESIGNS.

THANK YOU

