2024 NORTH AMERICAN BIOCHAR CONFERENCE

— USBI —

CALIFORNIA, USA

USBI • **BIOCHARCONFERENCE.COM** • FEB. 12–15, 2024

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Glanris

Cement Applications

Glanris Experience

- We have been designing, building, and operating pyrolysis facilities since 2019
- Glanris has been awarded 2 patents in the US and patents in Japan, India, Vietnam, Malaysia and China
- Completed LCA in 2021 and credits are listed on Puro
- Application Experience
  - Worked with almost a dozen universities on biochar applications in water filtration, concrete, asphalt, soil amendment, anodes and others
  - Dozens of commercial customers - water, concrete and soil amendment
- Kiln Experience
  - Worked with BET to customize their PRD kiln for rice hulls in 2020
  - Working on designs for larger-volume kilns now
  - 12 units sold in US since 2021

CONCRETE + ASPHALT

INDUSTRIAL WATER

Concrete industry

- Concrete is the most widely-used substance on Earth after water growing at 2.5% annually
- Responsible for between 5 - 9% of CO_2 emissions
  - Aviation is 2%
- 1 ton of cement production = 0.9 tons of CO_2 released
- Around 4.25 billion tons of cement are produced annually
- We may have already passed the point where concrete outweighs the combined carbon mass of every tree, bush and shrub on the planet

Concrete

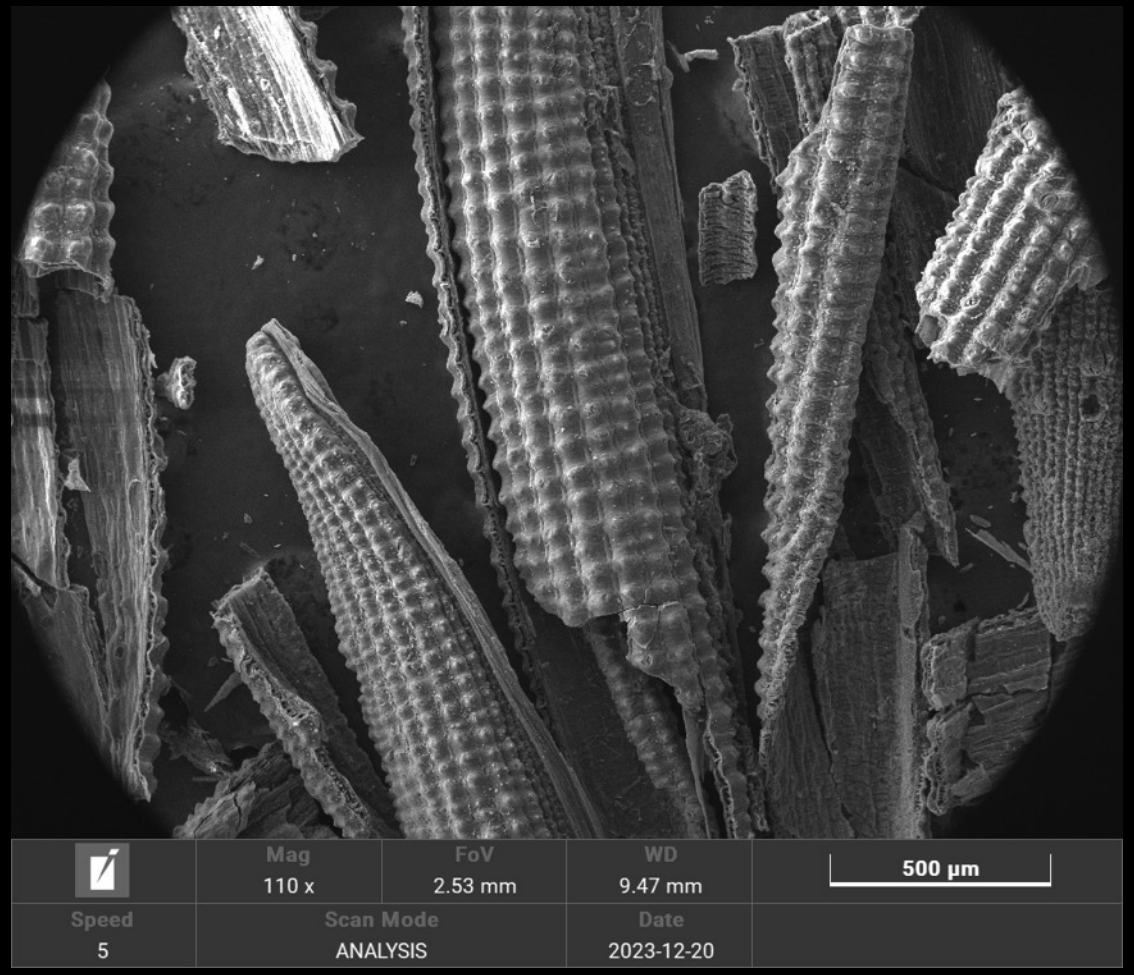
- 41% gravel or crushed stone (coarse aggregate)
- 26% sand (fine aggregate)
- 16% water
- 11% Portland cement
- 6% air
- 0.06-0.6% super-plasticizer

Roughly 70-90% of the embodied carbon in concrete comes from the cement

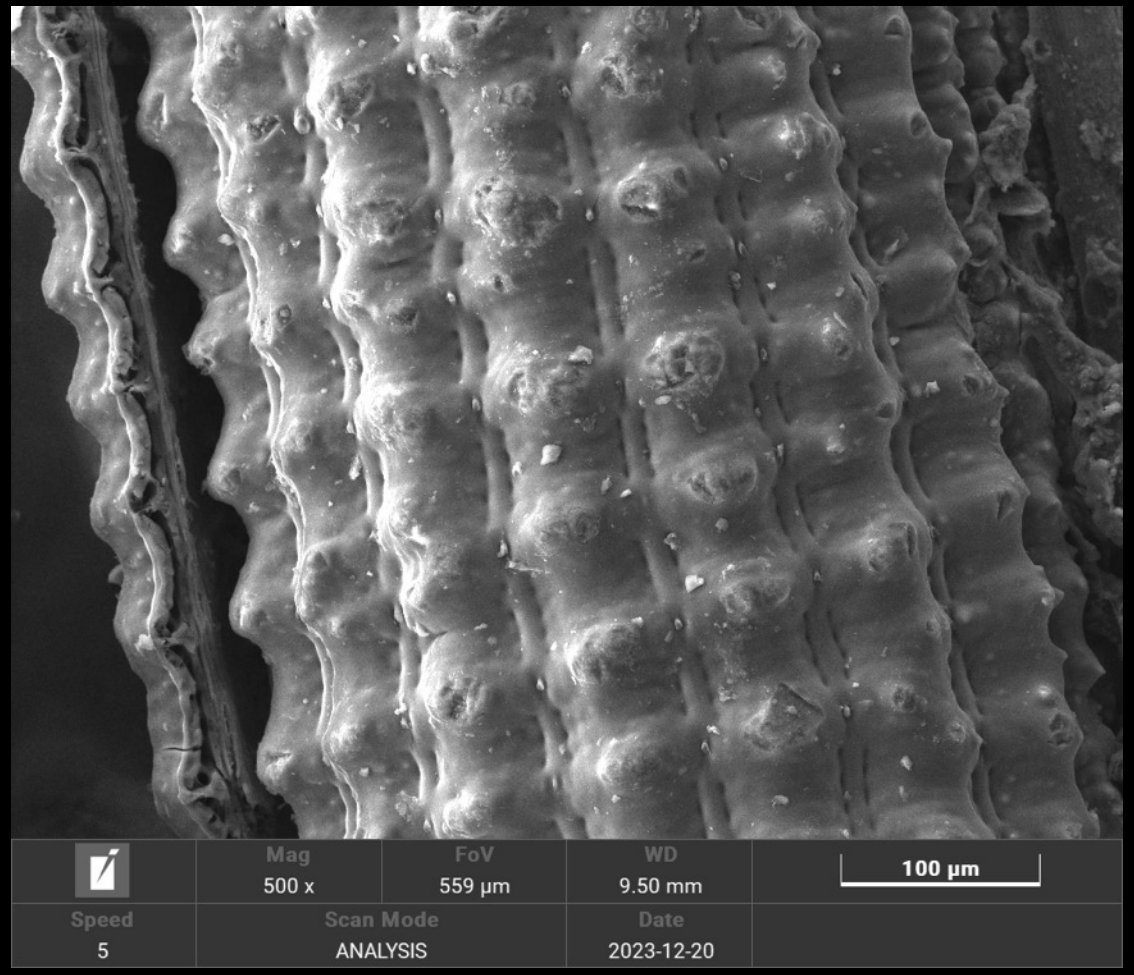
Rice Hull Biochar

- Composition
  - ~45% carbon
  - ~45% ash
    - 98% of the ash is SiO_2+Al_2O_3+Fe_2O_3
- IBI certified
- h/c ratio of 0.35
- Carbon negative process
  - 1.2 tons of CO_2 sequester/ton of biochar
- Carbon credits on Puro

SEM images



Mag	FoV	WD	500 µm
110 x	2.53 mm	9.47 mm	
Speed	**Scan Mode**	**Date**	
5	ANALYSIS	2023-12-20	

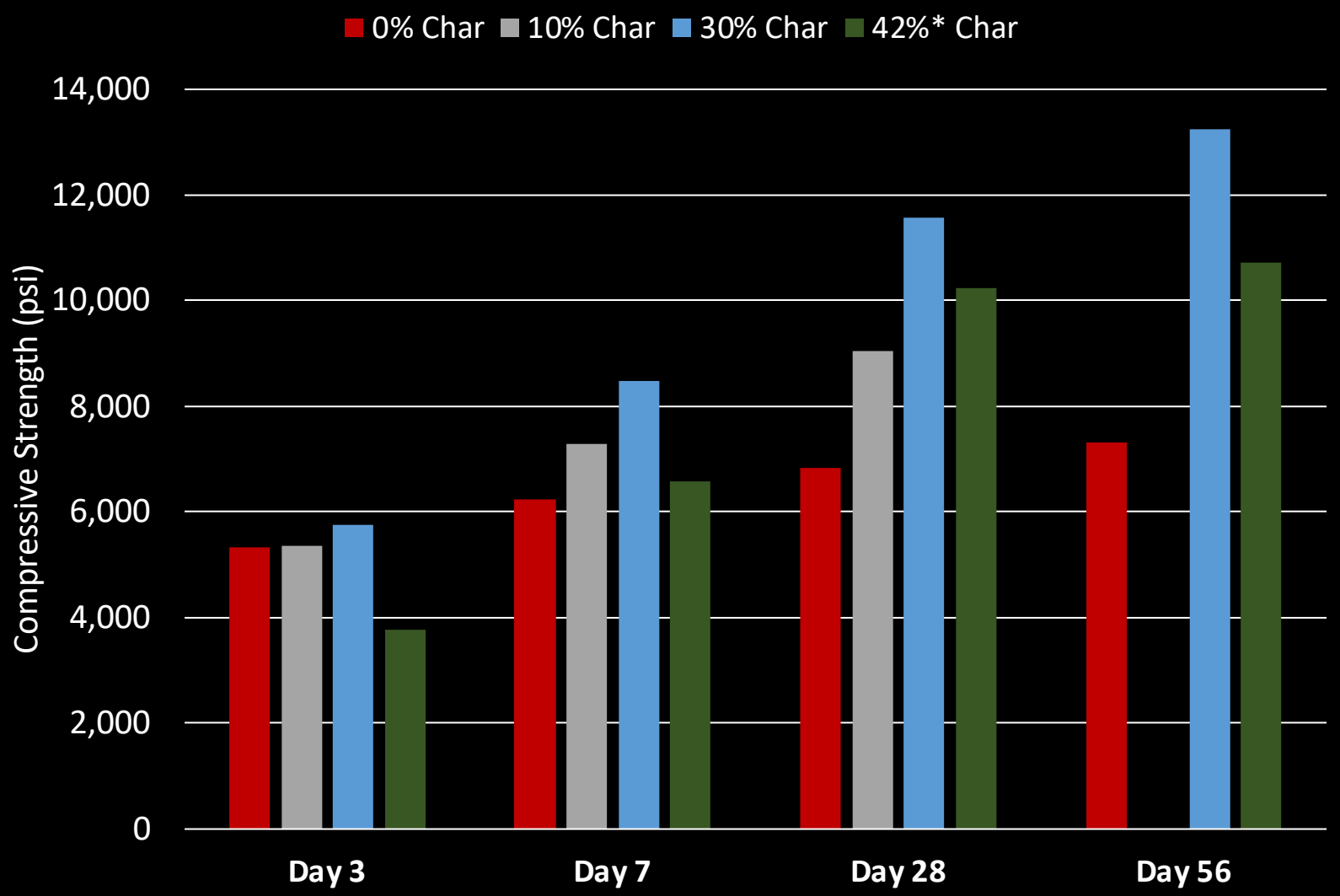


Mag	FoV	WD	100 µm
500 x	559 µm	9.50 mm	
Speed	**Scan Mode**	**Date**	
5	ANALYSIS	2023-12-20	

Cement Testing

- Universities
  - Colorado School of Mines (Tunstall Materials Research Group)
  - UC Davis
  - Mississippi State University
- The compression tests on mortar cubes following ASTM C109 or cylinders for ASTM C494
- Measured pozzolanic reactivity (ASTM C1897)
- ASTM C618 Compliance

Colorado School of Mines



10% Glanris: 90% of cement used in the control and 10% replaced with Glanris biochar + super plasticizers

30% Char: 70% of the cement used in the control and 30% replaced with Glanris biochar + super plasticizers

42% Char: 100% of the cement used in the control with an additional 42% of that added Glanris Biochar (as “filler” material)

Environmental Impact

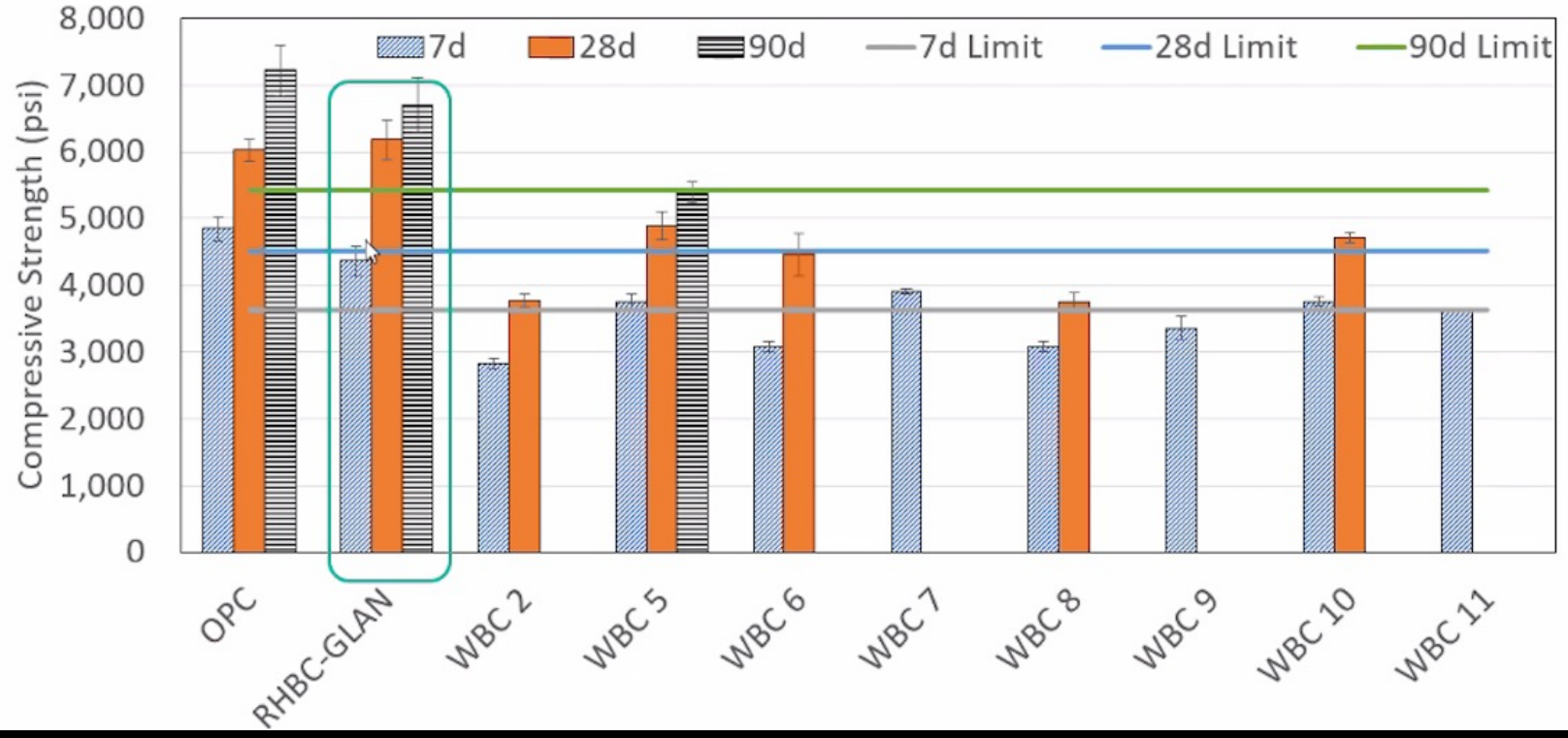
At 1.2 tons of CO_2 sequestered for every ton biochar:

- **Carbon negative at 44% replacement OR 77% filler**
- **10% of cement = 23% reduction in CO_2**
- **30% of cement = 69% reduction in CO_2**
- **42% of filler = 55% reduction in CO2**

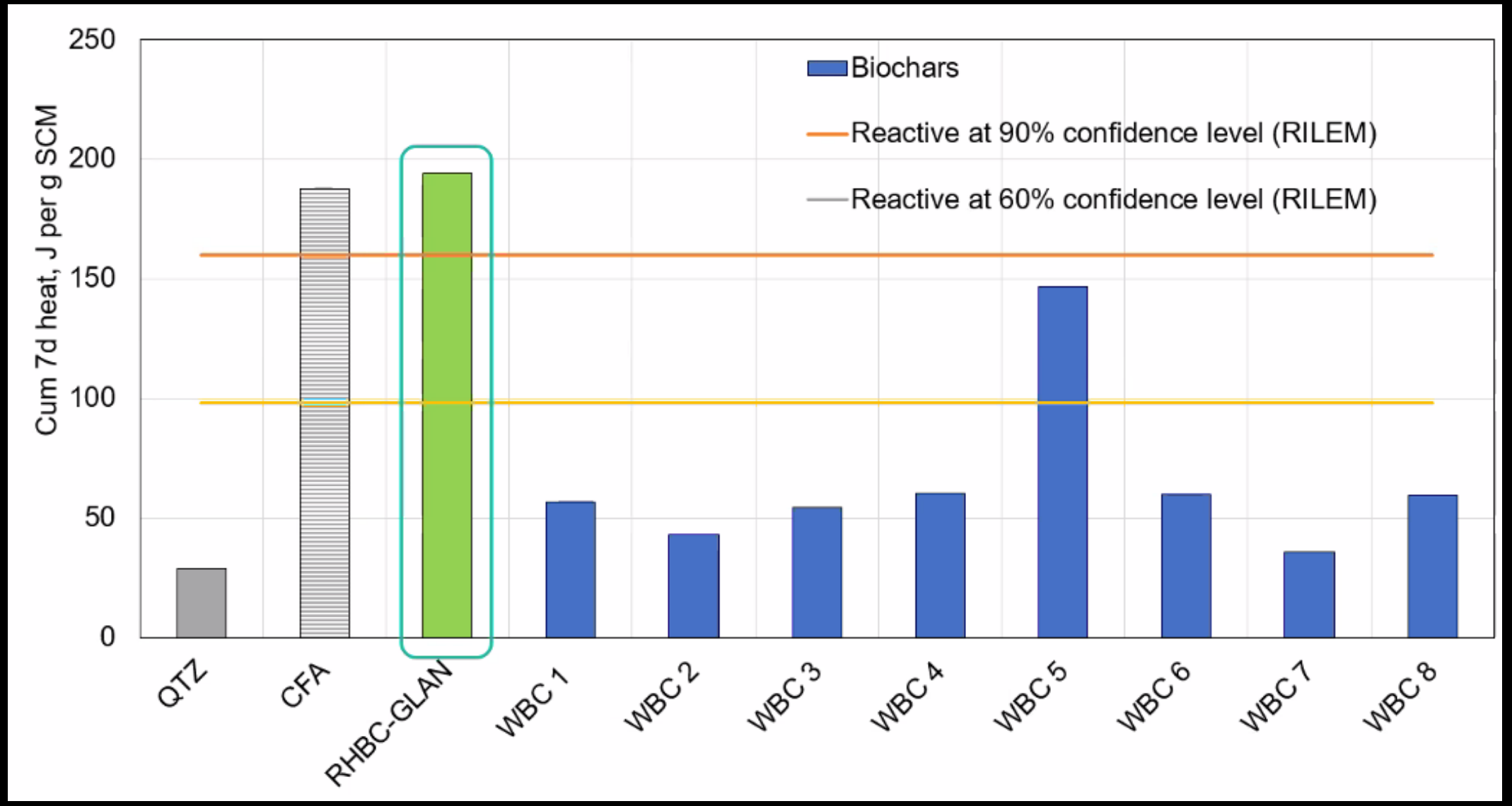
- **US producers are also eligible to register for avoidance credits of 0.517 tCO_2e per ton of biochar used**

UC Davis - Compression Test

- RHBC-GLAN passed the 7d and 28d strength requirement at 20% replacement of OPC.
- Strength activity indices were 90% (7d), 103% (28d), and 93% (90d).



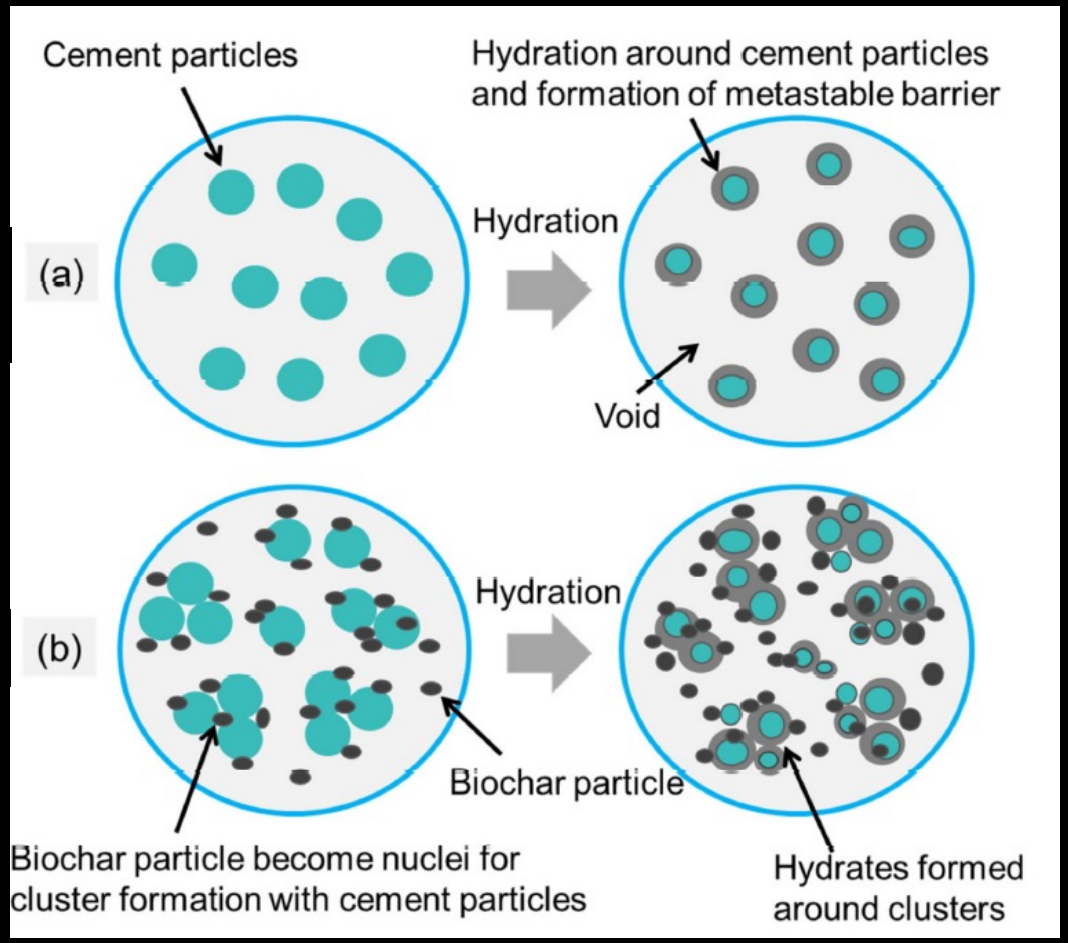
UC Davis – Pozzolanic Reactivity



Miss State findings

Without BC

With BC



Biochar particles accelerated the process of cement hydration and thus hardness

Rice hull biochar exhibited high cationic exchange capacity via binding to other cations in the cement paste

Biochar improves the thermal insulation of concrete

Biochar increases the sound absorption coefficient of concrete

Conclusions

- Biochar can be used as a replacement for fine aggregates
- High silica biochar, like rice hull biochar, works well for cement replacement
- The higher the silica content, the higher the pozzolanic reactivity
- Biochar can improve the hardness of concrete
- Biochar improves the insulating properties of concrete
- Biochar improves the sound absorption properties of concrete

Thank You

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