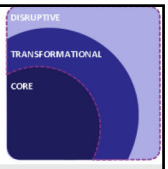
Ash Grove - CRH Approach to Sustainability



Decarbonise
Our commitment to decarbonise our business & society

Preserve & Conserve
Protecting scarce resources & enabling a more sustainable future

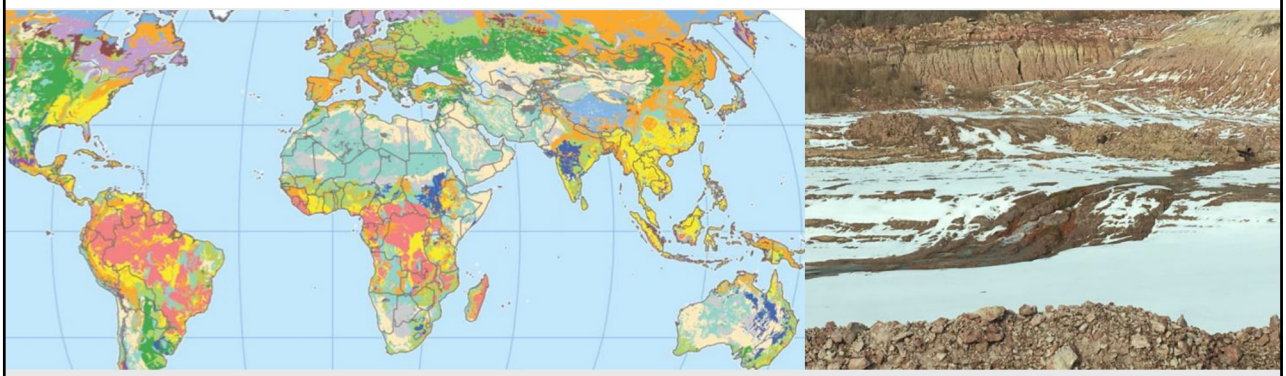
Sustainable Solutions
Products & solutions that contribute to a more sustainable society

People & Community
Empowering our employees & engaging with the community

Calcined Clay: The Old & The New

- In 1930s calcined shale was used in Golden Gate Bridge and Bay Bridge Projects
- In 1997, Ash Grove patented Duracem® cementitious product, by inter-grinding a calcined high-grade kaolin with clinker and optimized gypsum content
- In 2000s, Class F fly ash was abundant in the market at a low cost, achieving similar product performances as Duracem®. Our cementitious product switched to fly ash
- Between 2010 and May 2019, 290 coal-fired power plants have been shutdown or converted to natural gas
- Fly ash is less available and costly, calcined clay came back to Ash Grove discussion in 2017

Clay: Availability vs. Suitability



Low-grade, locally sourced clay when properly calcined delivers excellent strength and durability performances

Understanding the Reserves

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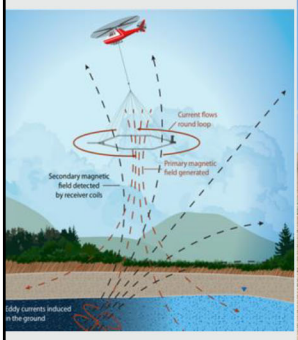

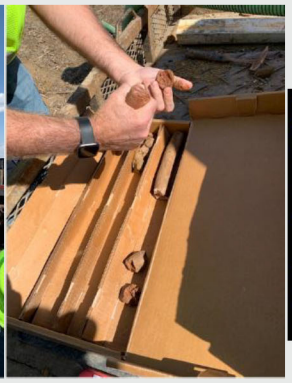

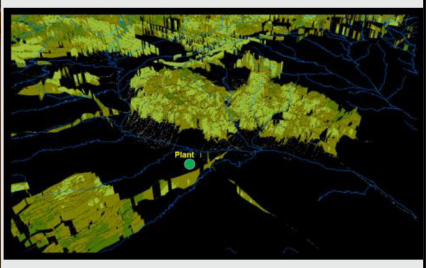

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What Happened in the Calcination/Dehydroxalation Process

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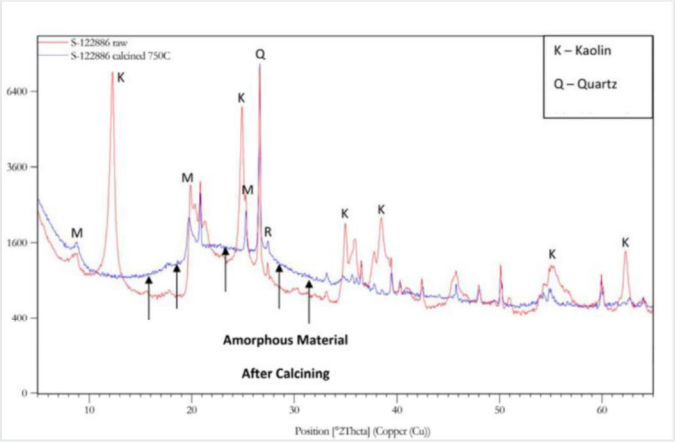

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Calcined Clay: Product Development Process

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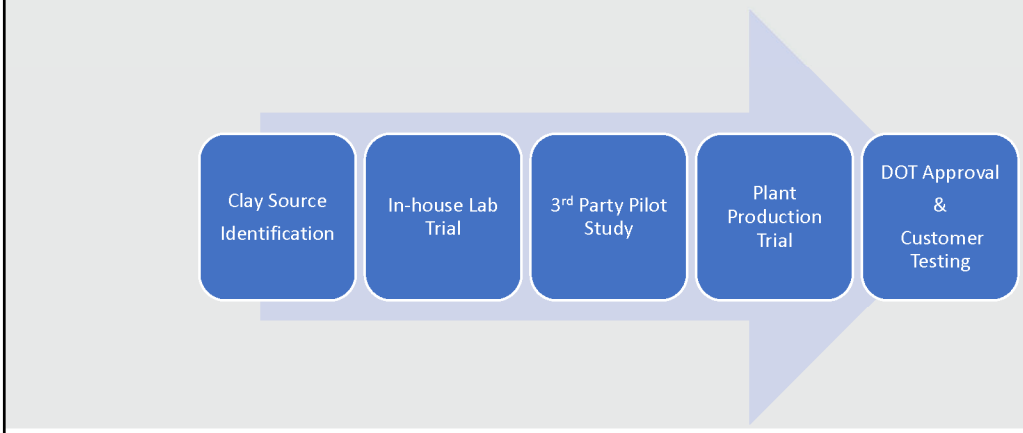

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Calcined Clay: Process Choices

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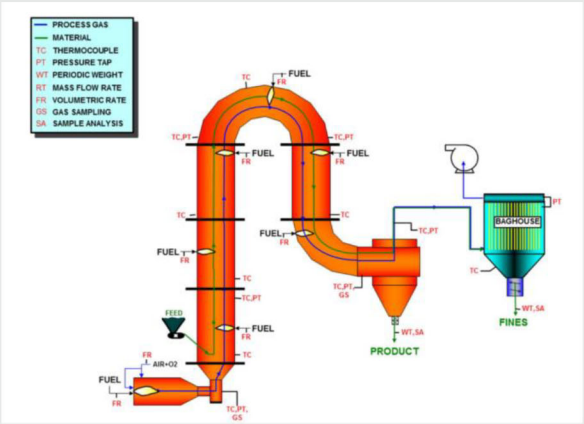

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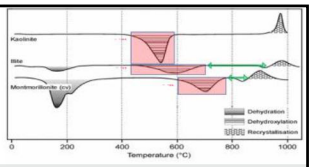
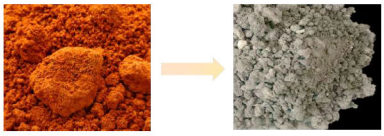
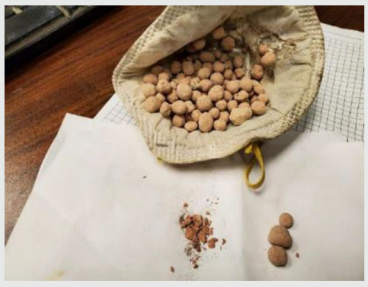
Calcined Clay: Challenges & Solutions



Calcined Clay: Challenges & Solutions





1. Type I/II cement
2. 30% calcined clay
3. 30% color mitigated calcined clay

Calcined Clay: Improves Strengths and Durability

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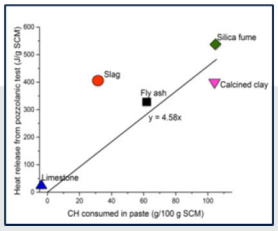

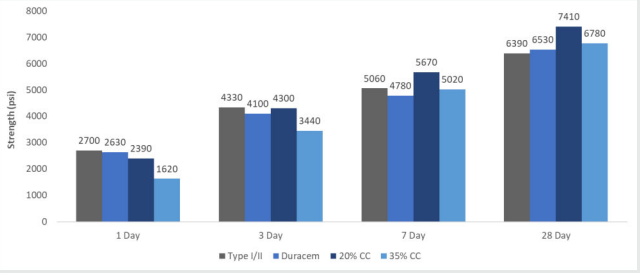

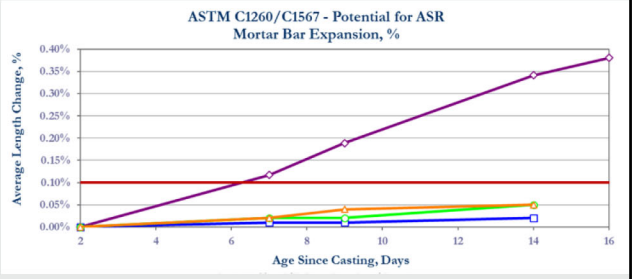

Limestone and Calcined Clay Work Better Together

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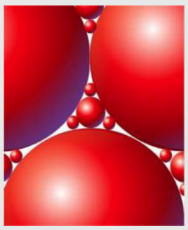
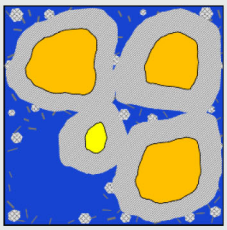
- Particle packing
  - Improved particle size distribution
- Nucleation
  - Surfaces for precipitation
- Chemical reactions

Packing

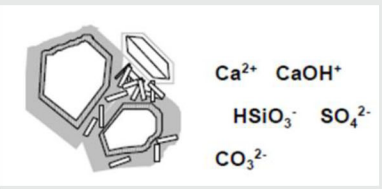


Seeding



Additional Alumina Input and Its Hydration

Mono/hemi Carbo-Aluminate-Hydrate
C-A-H



Limestone + Calcined Clay- A Symbiotic Relationship:

Synergetic reaction of calcined clay and limestone allows high levels of clinker substitution and performance

Sample ID	Date Tested	Diameter, in. (mm)	Length, in. (mm)	Area, in.² (cm²)	Mass, lbs. (kg)	Load, lbf. (N)	Strength, psi (Mpa)	Type of Fracture	Age, days
D-122120-2	12/28/20	4.00	8.10	12.57	8.52	67,600	**5,379**	Type I	7
47B mix		(101.6)	(205.7)	(81.1)	(3.9)	(300,700)	(37.1)		
	12/28/20	4.00	8.06	12.57	8.47	66,580	**5,298**	Type I	7
		(101.6)	(204.7)	(81.1)	(3.9)	(296,163)	(36.5)		
						Average	5,340		
	01/18/21	4.01	8.08	12.63	8.48	87,530	**6,931**	Type I	28
		(101.9)	(205.2)	(81.5)	(3.9)	(389,353)	(47.8)		
	01/18/21	4.00	8.10	12.57	8.53	88,120	**7,012**	Type I	28
		(101.6)	(205.7)	(81.1)	(3.9)	(391,977)	(48.4)		
	01/18/21	4.00	8.07	12.57	8.50	92,160	**7,334**	Type I	28
		(101.6)	(205.0)	(81.1)	(3.9)	(409,948)	(50.6)		
						Average	7,090		
	02/15/21	4.01	8.05	12.63	8.51	97,950	**7,756**	Type I	56
		(101.9)	(204.5)	(81.5)	(3.9)	(435,703)	(53.5)		
						Average	7,760		
	03/22/21	4.01	8.10	12.63	8.49	95,380	**7,552**	Type I	91
		(101.9)	(205.7)	(81.5)	(3.9)	(424,271)	(52.1)		
						Average	7,550		

ASTM C1202 - Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
Standard Curing

Sample No.	Diameter, mm	Charge Passed, C	Corrected Charge, C	Qualitative Equivalent	Date of Test	Age, days
D-122120-1	102	1,063	**922**	Very Low	02/18/2021	59
D-122120-1	102	1,105	**959**	Very Low	02/18/2021	59
D-122120-1	102	1,049	**910**	Very Low	02/18/2021	59
no admixtures 0.50 w/cm		Average	**930**	Very Low		
D-122120-2	102	756	**656**	Very Low	02/18/2021	59
D-122120-2	102	873	**757**	Very Low	02/18/2021	59
D-122120-2	102	676	**586**	Very Low	02/18/2021	59
47B mix		Average	**666**	Very Low		

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Thank You

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