Hyaloclastite based Natural Pozzolanic Material Performance

as a Substitution for Fly Ash, Slag, Silica Fume and Metakaolin in Normal and High Performance Concretes

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&
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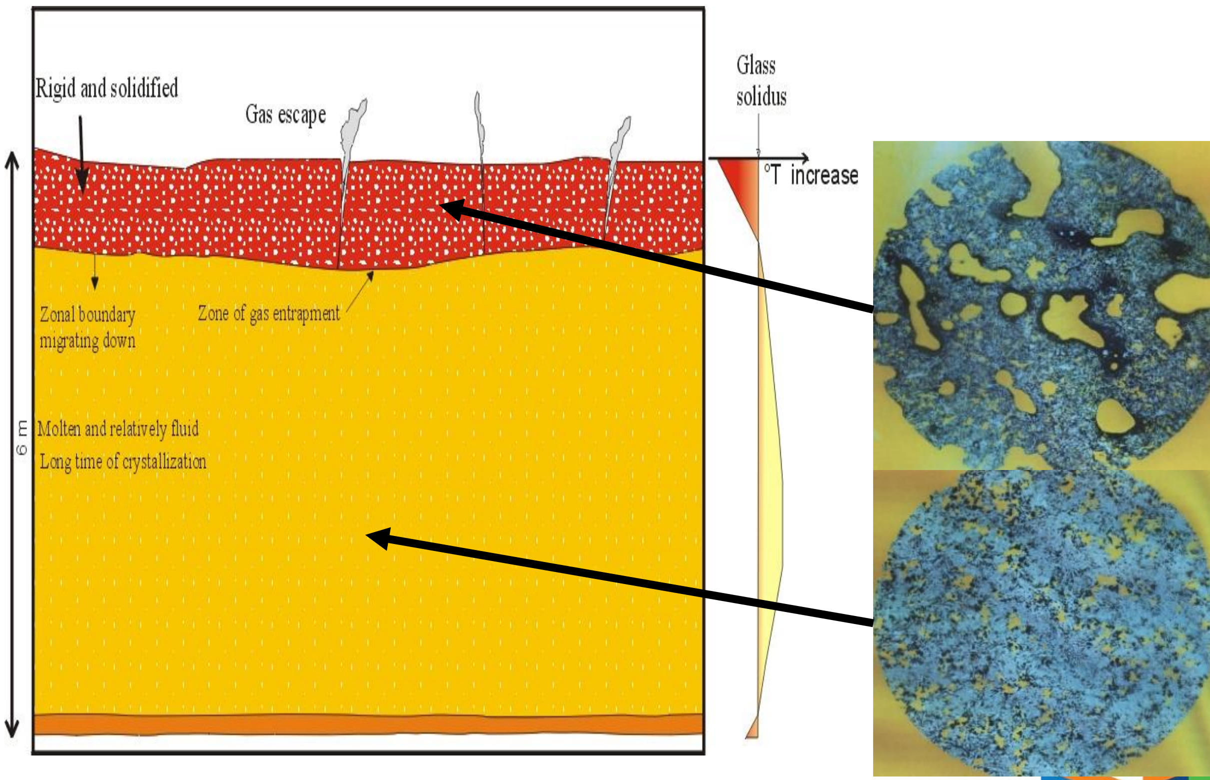
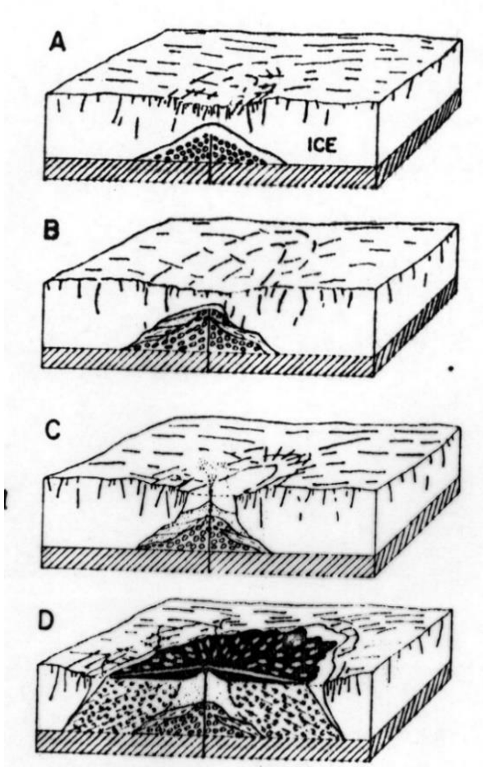
What is Hyaloclastite?

lava quenched by water

- Lava flow showing the relatively rapidly cooled scoraceous top and the more slowly cooled central part of the lava.
- right photos examples of the relatively finely crystallized matrix with more glassy rims around the vesicles, while the picture to the right shows the relatively large crystals due to the longer crystallization time of the magma.



- Hyaloclastite formation is common at the bottom of the ocean where lava is extruded into the sea water, such as at the Mid Atlantic Ocean Ridge, but very rarely occurs on land.
- On land they are dominantly found as ancient volcanic eruptions into thick ice sheets of past glaciations.
- Such Hyaloclastite deposits are found in Iceland, Upper British Columbia and the Central Siberian Plateau



Growth of sub-glacial monogenetic volcano:

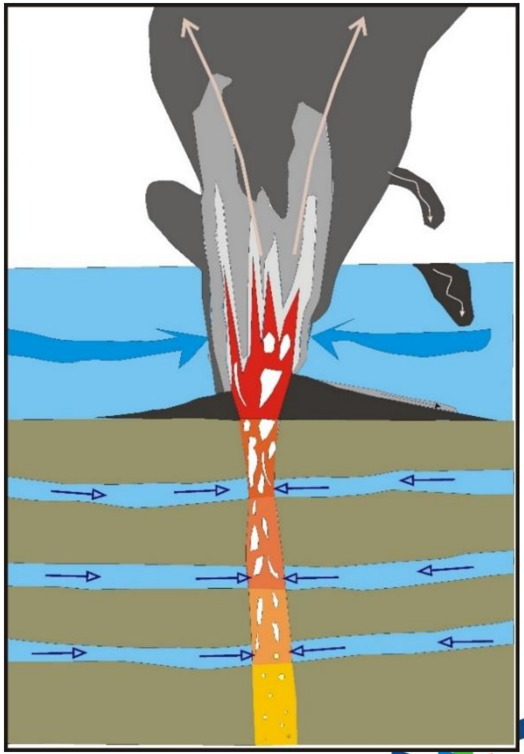
A. Pillow basalt forms in deep meltwater lake

B. Pillow breccia forms by slumping.

C. Hyaloclastite tuffs are erupted at shallow depth

D. Lava cap formed above water table

- Eruption approx. 16,000 years at bottom of Lake Bonneville
- Lake depth approx. 300 feet of glacial cold water
- Lava travels through several aquifers which injects water under pressure into the lava tube, pre-quences the lava
- Lava is intensely and homogeneously quenched to glass-like grains that are largely "pulverized"
- Hyaloclastite deposit is fine sand and some – ¼" gravel
- Single magma chamber, single chemistry
- Unconsolidated, un-altered mineral virtually the same as the time of eruption



- PVT is natural pozzolan that is 70% amorphous and meets the requirements of ASTM C618 Class N.
- PVT 70-4 and PVT 70-8 at particle sizes of 4 µm and 8 µm d50 were compared to Class F fly ash, silica fume and metakaolin for the following properties:
  - ASR Performance (TCG)
  - Mortar Cube Strength Versus Time (TEC)
  - Concrete Testing (TCG)
    - Plastic properties
    - Compressive strength versus time
    - Freezing and thawing resistance
    - Transport properties related to water and chloride ingress
  - Calorimetry (TCG)
- The results in the following slides show that it outperforms fly ash and is comparable to or better than silica fume or metakaolin.

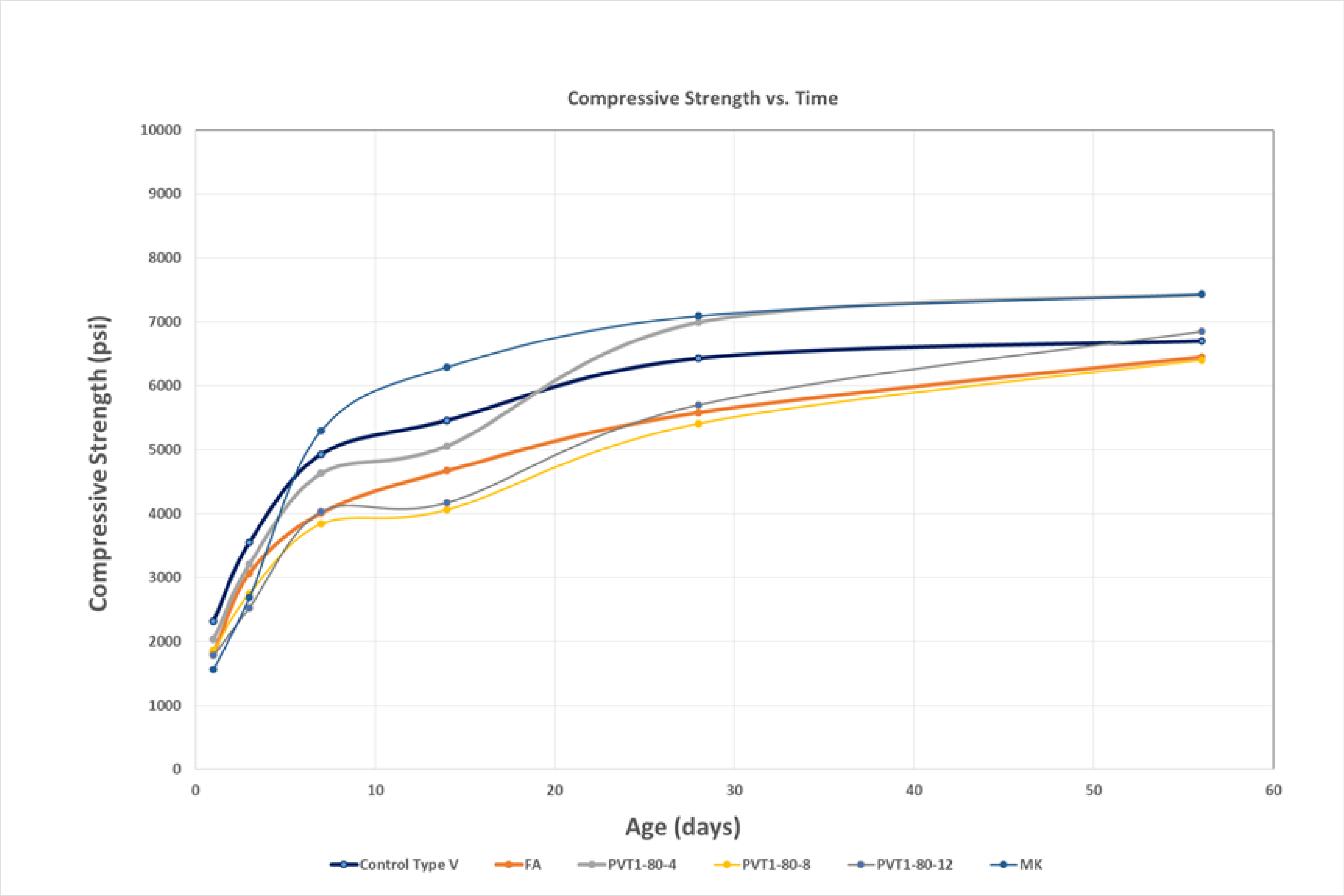
Mortar Cube Results ASTM C618 using Mitsubishi Type II/V Cement

Strength (psi) | % Increase

		Control (Miths V)	FA (Chulla)	PVT1-70-4	PVT1-70-8	PVT1-70-12	MET (BASF)		Control (Miths V)	FA (Chulla)	PVT1-70-4	PVT1-70-8	PVT1-70-12	MET (BASF)
1 Day	1	2320	1820	2030	1860	1780	1560		100	78	88	80	77	67
3 Day	3	3550	3070	3210	2750	2530	2690		100	86	90	77	71	76
7 Day	7	4930	4010	4630	3840	4030	5300		100	81	94	78	82	108
14 Day	14	5460	4670	5060	4060	4170	6290		100	86	93	74	76	115
28 Day	28	6430	5580	6990	5410	5700	7090		100	87	109	84	89	110
56 Day	56	6700	6450	7430	6400	6850	7430		100	96	111	96	102	111

		Control (Miths V)	FA (Chulla)	PVT1-70-4	PVT1-70-8	PVT1-70-12	MET (BASF)
Specific Gravity			2.29	2.83	2.77	2.78	2.48
Soundness			0.01	0.03	0.02	0.02	-0.12
Wash #325			24.16	0.00	0.00	0.00	0.00
Water Req %			98	101	103	104	125

Mortar Cube Results ASTM C618



MITSUBISHI CEMENT CORPORATION
CUSHENBURY PLANT, 5808 STATE HIGHWAY 18, LUCERNE VALLEY, CA 92356-9691 TELEPHONE (760) 248-7373

October 26, 2020

The following data are the chemical and physical analyses of the Greencraft LLC pozzolan sample received in the MCC laboratory on September 3, 2020. The sample was assigned the lab # 20090301 (269-F). This sample was tested in accordance with ASTM C 618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete. The listed results are not a complete evaluation of the sample and is not a certification of the sample as a fly ash. The testing is only an evaluation of the potential for the sample to be used as a fly ash additive with MCC's Type II/V Portland cement.

SiO2	46.39 %
Al2O3	14.78 %
Fe2O3	9.88 %
Sum	71.05 %
CaO	14.23 %
MgO	5.86 %
SO3	0.05 %
Na2O	2.87 %
K2O	1.04 %
TiO2	1.43 %
P2O5	0.27 %
Chlorine	0.000 %
Loss on Ign	3.35 %
Moisture	0.48 %
325 Sieve	0.0 % Retained
Water Requirement	101 %
Strength Activity Index	
@ 7 days	82.4 %
@ 28 Days	97.5 %

C-618 Specification	N	F	C
Sum SiO2, Al2O3, Fe2O3	≥ 70 %	≥ 70 %	≥ 50 %
SO3	≤ 4.0 %	≤ 5.0 %	≤ 5.0 %
Moisture	≤ 3.0 %	≤ 3.0 %	≤ 3.0 %
Loss on Ignition (LOI)	≤ 10 %	≤ 6.0 %	≤ 6.0 %
325 Sieve (% Retained)	≤ 34 %	≤ 34 %	≤ 34 %
Water Requirement	< 115 %	< 105 %	< 105 %
Strength Activity Index at 7 & 28 Day for all types (N,F,C)			≥ 75%

This analysis indicates that the Greencraft pozzolan passes the listed ASTM C 618 specifications and has potential for used as a pozzolan additive in concrete made with MCC's Type II/V Portland cement.

Tom Gepford, Quality Control Manager
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MITSUBISHI CEMENT CORPORATION

CERTIFICATE OF TEST

Portland Cement - Type I, II, II (MH) & V **Date:** 09/08/2021

Source: Cushenbury Plant, 5808 State Highway 18, Lucerne Valley, CA 92356

ASTM designation: C 150 - 16 for Type I, II, II (MH) & V low alkali Cement	Production Period
CALTRANS Specification: Section 90 – 2.01 for Type II modified and V (2006) Specification: Section 90 – 1.02B(2) (2015)	From: 08/01/2021
NDOT Specification: Section 701.03.01 for Type II and V	To: 08/31/2021
AZDOTSpecifications Subsection 1006-2.01 for Type II and V	

Chemical Composition:

	ASTM C-150 Limits Type I	Type II	Type V		Test Results
Silicon Dioxide (SiO_2), %	—	—	—	Min.	20.8
Aluminum Oxide (Al_2O_3), %	—	6.0	—	Max.	4.1
Ferric Oxide (Fe_2O_3), %	—	6.0	—	Max.	3.9
Calcium Oxide (CaO), %	—	—	—		62.8
Magnesium Oxide (MgO), %	6.0	6.0	6.0	Max.	2.7
Sulfur Trioxide (SO_3), %	3.0	3.0	2.3	Max.	2.1
Loss on Ignition (LOI), %	3.5	3.5	3.5	Max.	2.0
Insoluble Residue	1.5	1.5	1.5	Max.	0.52
Total Alkali (%Na_2O + 0.658 * %K_2O)	0.60	0.60	0.60	Max.	0.50
Tricalcium Silicate (C_3S), [b] %	—	—	—		56
Tricalcium Aluminate (C_3A), [b] %	—	8	5	Max.	4
C_4AF + 2*C_3A [b]	—	—	25	Max.	20
C_3S + 4.75*C_3A [b]	—	100	—	Max.	76
CO_2, %	—	—	—		1.1
Limestone, %	5.0	5.0	5.0	Max.	3.0
$CaCO_3$ Limestone Purity, %	70	70	70	Min.	84

PHYSICAL RESULTS:

	Type I	Type II	Type V		Test Results
Blaine Fineness (m^2/kg)	260 / —	260 / 430	260 / —	Min / Max	381
325 Mesh (% Passing)	—	—	—		98.6
Autoclave Expansion (%)	0.80	0.80	0.80	Max.	0.06
Time of Set Initial Vicat (minutes)	45 / 375	45 / 375	45 / 375	Min / Max	125
Air Entrainment (% Volume)	12	12	12	Max.	7.4
C1702 Heat of Hydration at 7 Days (J/g)	—	—	—	[a]	352
False Set, %	50	50	50	Min.	88
Color, (L value)	—	—	—		55

Compressive Strength Test:

	Type I MPA	Type I psi	Type II MPA	Type II psi	Type V MPA	Type V psi		MPA	PSI
1 Day	—	—	—	—	—	—		15.0	2170
3 Day	12.0	1740	10.0	1450	8.0	1160	Min.	26.8	3890
7 Day	19.0	2760	17.0	2470	15.0	2180	Min.	35.9	5200
28 Day July 2021	—	—	—	—	21.0	3050	Min.	40.1	5810

This cement has been sampled and tested in accordance with ASTM standard methods and procedures. All tests results are certified to comply with the type specification designated above. No other warranty is made or implied. We are not responsible for improper use or workmanship. The MCC laboratory is AASHTO accredited.
[a] For information only. [b] Adjusted per ASTM C150 A1.6.

MITSUBISHI CEMENT CORPORATION
Cushenbury plant
Evan Coss
Quality Control Superintendent

SGS TEC SERVICES
Testing • Engineering • Consulting

Client: Mr. Romeo Ciuperca
Greencraft LLC
1831 Warren Place, Suite 200
Norcross, Ga 30093

Date: July 31, 2020
TEC Services I.D.: TEC 10-5575
Lab No.: 20-745-2

REPORT OF NATURAL POZZOLAN TESTS

Client ID: PVT1-70-4 Date Received: June 16, 2020
Manufacturer: Mill Test

Chemical Analysis	Results (wt%)	Specification (Class N) ASTM C618-19	AASHTO M295-19
Silicon Dioxide (SiO_2)	48.7	—	—
Aluminum Oxide (Al_2O_3)	13.0	—	—
Iron Oxide (Fe_2O_3)	12.71	—	—
Sum of Silicon Dioxide, Iron Oxide & Aluminum Oxide (SiO_2+Al_2O_3+Fe_2O_3)	74.5	70 % min.	70 % min.
Calcium Oxide (CaO)	9.6	—	—
Magnesium Oxide (MgO)	6.0	—	—
Sodium Oxide (Na_2O)	2.91	—	—
Potassium Oxide (K_2O)	1.11	—	—
"Sodium Oxide Equivalent (Na_2O+0.658K_2O)"	3.64	—	—
Sulfur Trioxide (SO_3)	0.15	4 % max.	4 % max.
Loss on Ignition	1.5	10 % max.	5 % max.
Moisture Content	0.22	3 % max.	3 % max.
Available Alkalies			
Sodium Oxide (Na_2O) as Available Alkalies	1.33	—	—
Potassium Oxide (K_2O) as Available Alkalies	0.46	—	—
Available Alkalies as "Sodium Oxide Equivalent (Na_2O+0.658K_2O)"	1.65	—	1.5 % max.
Physical Analysis			
Fineness (Amount Retained on #325 Sieve)	0.0%	34 % max.	34 % max.
Strength Activity Index with Portland Cement			
At 7 Days: Control Average, psi: 4930; Test Average, psi: 4630	94%	75 % min.† (of control)	75 % min.† (of control)
At 28 Days: Control Average, psi: 6430; Test Average, psi: 6990	109%	75 % min.† (of control)	75 % min.† (of control)
Water Requirements (Test H_2O/Control H_2O) Control, mls: 242; Test, mls: 244	101%	115 % max. (of control)	115 % max. (of control)
Autoclave Expansion:	0.03%	± 0.8 % max.	± 0.8 % max.
Specific Gravity:	2.83	—	—

† Meeting the 7 day or 28 day strength activity index will indicate specification compliance
* Does not meet Available Alkalies as Na_2O requirements for AASHTO M295-19.

The results of our testing indicate that this sample complies with ASTM C618-119 specifications for Class N pozzolans.

Respectfully Submitted,
SGS TEC Services

Dean Roosa
Project Manager

Shawn McCormick
Laboratory Principal

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Client: Mr. Romeo Ciuperca
Greencraft LLC
1831 Warren Place, Suite 200
Norcross, Ga 30093

Date: July 31, 2020
TEC Services I.D.: TEC 10-5575
Lab No.: 20-745-4

REPORT OF NATURAL POZZOLAN TESTS

Client ID: PVT1-70-12 Date Received: June 16, 2020
Manufacturer: Mill Test

Chemical Analysis	Results (wt%)	Specification (Class N) ASTM C618-19	AASHTO M295-19
Silicon Dioxide (SiO_2)	48.7	—	—
Aluminum Oxide (Al_2O_3)	13.0	—	—
Iron Oxide (Fe_2O_3)	12.71	—	—
Sum of Silicon Dioxide, Iron Oxide & Aluminum Oxide (SiO_2+Al_2O_3+Fe_2O_3)	74.5	70 % min.	70 % min.
Calcium Oxide (CaO)	9.6	—	—
Magnesium Oxide (MgO)	6.0	—	—
Sodium Oxide (Na_2O)	2.91	—	—
Potassium Oxide (K_2O)	1.11	—	—
"Sodium Oxide Equivalent (Na_2O+0.658K_2O)"	3.64	—	—
Sulfur Trioxide (SO_3)	0.15	4 % max.	4 % max.
Loss on Ignition	1.5	10 % max.	5 % max.
Moisture Content	0.22	3 % max.	3 % max.
Available Alkalies			
Sodium Oxide (Na_2O) as Available Alkalies	1.33	—	—
Potassium Oxide (K_2O) as Available Alkalies	0.46	—	—
Available Alkalies as "Sodium Oxide Equivalent (Na_2O+0.658K_2O)"	1.65	—	1.5 % max.
Physical Analysis			
Fineness (Amount Retained on #325 Sieve)	0.0%	34 % max.	34 % max.
Strength Activity Index with Portland Cement			
At 7 Days: Control Average, psi: 4930; Test Average, psi: 4030	82%	75 % min.† (of control)	75 % min.† (of control)
At 28 Days: Control Average, psi: 6430; Test Average, psi: 5700	89%	75 % min.† (of control)	75 % min.† (of control)
Water Requirements (Test H_2O/Control H_2O) Control, mls: 242; Test, mls: 251	104%	115 % max. (of control)	115 % max. (of control)
Autoclave Expansion:	0.02%	± 0.8 % max.	± 0.8 % max.
Specific Gravity:	2.78	—	—

† Meeting the 7 day or 28 day strength activity index will indicate specification compliance
* Does not meet Available Alkalies as Na_2O requirements for AASHTO M295-19.

The results of our testing indicate that this sample complies with ASTM C618-119 specifications for Class N pozzolans.

Respectfully Submitted,
SGS TEC Services

Dean Roosa
Project Manager

Shawn McCormick
Laboratory Principal

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Tests performed by Tourney Consulting Group:

Property	Test Method	Notes
Mortar Mixtures		
ASR	ASTM C1260	For 28 days
	ASTM C1567	For 28 days
Concrete Mixtures		
Slump	ASTM C31	
Air Content	ASTM	
Density	C231	
Temperature	ASTM C1064	
Setting Time	ASTM C403	
Compressive Strength	ASTM C39	Several Ages
Conductivity	ASTM C1760	28, 90 days
Non Steady-State Diffusion	NT Build 492	28 days
Bulk Diffusion	ASTM C1556	28 days
Capiillary Absorption	ASTM C1585	28 days
Freezing and Thawing	ASTM C666	Method A
Isothermal Calorimetry		
Data at 23.0 °C		7 days

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Freezing and Thawing	ASTM C666	Method A
Isothermal Calorimetry		
Data at 23.0 °C		7 days

- Evaluated in ASTM C1260/C1567 (Accelerated mortar bars) (TCG)

Mix Identification :	**CTL**	**FA-25**	**SF-10**	**M-10**	**FA-20**	**70-4**	**70-8**
% Replacement	---	25	10	10	20	20	20
Linear Expansion % @ 14 d	**0.15**	0.02	0.08	0.03	0.08	0.03	0.03
Linear Expansion % @ 28 d	**0.31**	0.04	**0.19**	0.05	**0.15**	0.04	0.04
% Reduction @ 14 d	---	87	47	80	47	80	80
% Reduction @ 28 d	---	87	39	84	52	87	87

Concrete Mixes

Mix Description:	Control	25% Class F Fly Ash Replacement	10% Silica Fume Replacement	10% Metakaolin Replacement	Control	20% PVT-70-4 Replacement	20% PVT-70-8 Replacement
Mix Number:	**CTL**	**FA-25**	**SF-10**	**M-10**	**CTL-0522**	**70-4**	**70-8**
Units	lb/yd^3	lb/yd^3	lb/yd^3	lb/yd^3	lb/yd^3	lb/yd^3	lb/yd^3
Lafarge Alpena Type I/II	658	494	592	592	658	526	526
20% Replacement **PVT-70-4**						132	
20% Replacement **PVT-70-8**							132
Class F Fly Ash Boral St Johns River Park Plt.		165					
Silica Fume Norchem			66				
Metakaolin				66			
Agg. Resource Midway Pit MI **Natural Fine** Agg SSD DOT #39-64	1280	1239	1266	1262	1280	1273	1273
Vulcan Lithia Springs GA Pit 3/4" Crushed **Coarse** Agg SSD	1680	1680	1680	1680	1680	1680	1680
Total Water	250	250	250	250	250	250	250
Designed Air %	6%	6%	6%	6%	6%	6%	6%
Water/Cement Ratio	0.38	0.38	0.38	0.38	0.38	0.38	0.38
Admixtures							
Sika Air 260 Air Entrainment oz./cwt	0.35	0.50	0.35	0.42	0.30	0.35	0.35
Sika Viscocrete 2100 HRWR oz./cwt	1.1	0.8	3.1	3.1	1.1	4.0	2.2

Concrete Plastic Properties

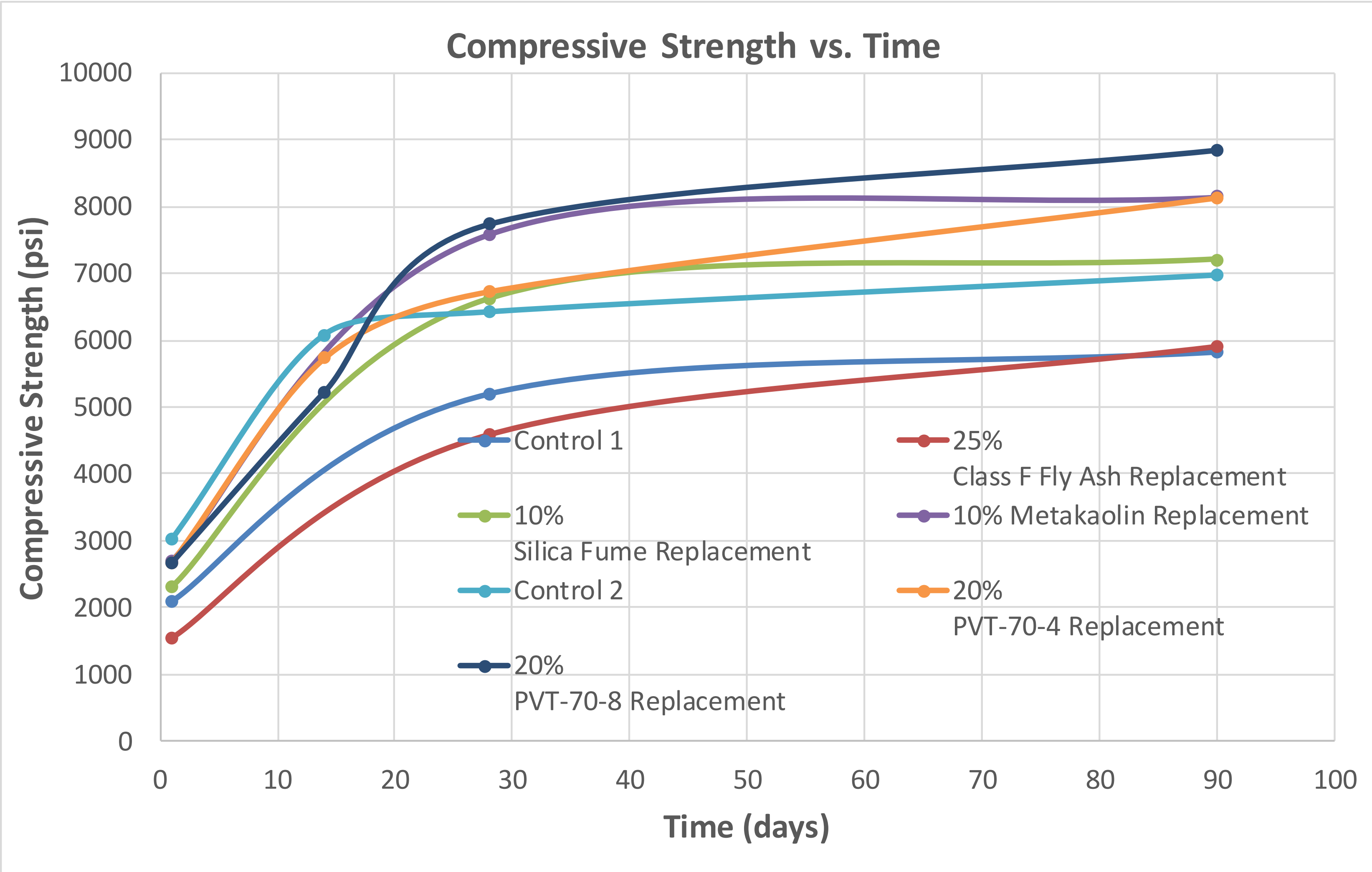
Mix Description:	Control	25% Class F Fly Ash Replacement	10% Silica Fume Replacement	10% Metakaolin Replacement	Control	20% PVT-70-4 Replacement	20% PVT-70-8 Replacement
Mix Number:	**CTL**	**FA-25**	**SF-10**	**M-10**	**CTL-0522**	**70-4**	**70-8**
Plastic Properties							
Slump (in.) ASTM C31	6.00	6.25	3.50	6.75	4.00	4.50	5.50
Air % As Tested ASTM C231	7.4	6.4	6.5	6.8	7.0	5.0	5.5
Density lb/ft^3 ASTM C138	138.3	139.4	140.9	140.0	141.5	143.9	143.1
Concrete Temp °F ASTM C1064	72	71	71	71	72	72	72
Initial Set hours:min	4:55	5:21	4:42	5:13	4:12	4:27	4:11
Final Set hours:min	6:27	7:04	6:11	6:39	5:23	5:42	5:40

- Equivalent setting time to control
- Good workability and air entrainable

Mechanical properties:

Days	Control 1	25% Class F Fly Ash Replacement	10% Silica Fume Replacement	10% Metakaolin Replacement	Control 2	20% PVT-70-4 Replacement	20% PVT-70-8 Replacement
1	2090	1540	2320	2690	3020	2660	2670
14					6080	5730	5230
28	5200	4580	6620	7590	6420	6730	7740
90	5830	5900	7210	8150	6970	8140	8850

- Compressive Strength significantly higher than control and comparable to or better than silica fume or metakaolin



Compressive Strength vs. Time
Compressive Strength (psi)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
50
60
70
80
90
100
Time (days)
Control 1
25% Class F Fly Ash Replacement
10% Silica Fume Replacement
10% Metakaolin Replacement
Control 2
20% PVT-70-4 Replacement
20% PVT-70-8 Replacement

Freezing and Thawing

ASTM C666 Freeze Thaw Method A	**CTL-0522**	**70-4**	**70-8**
Durability Factor Percent	94	93	95
Weight Loss Percent	0.30	1.10	1.30

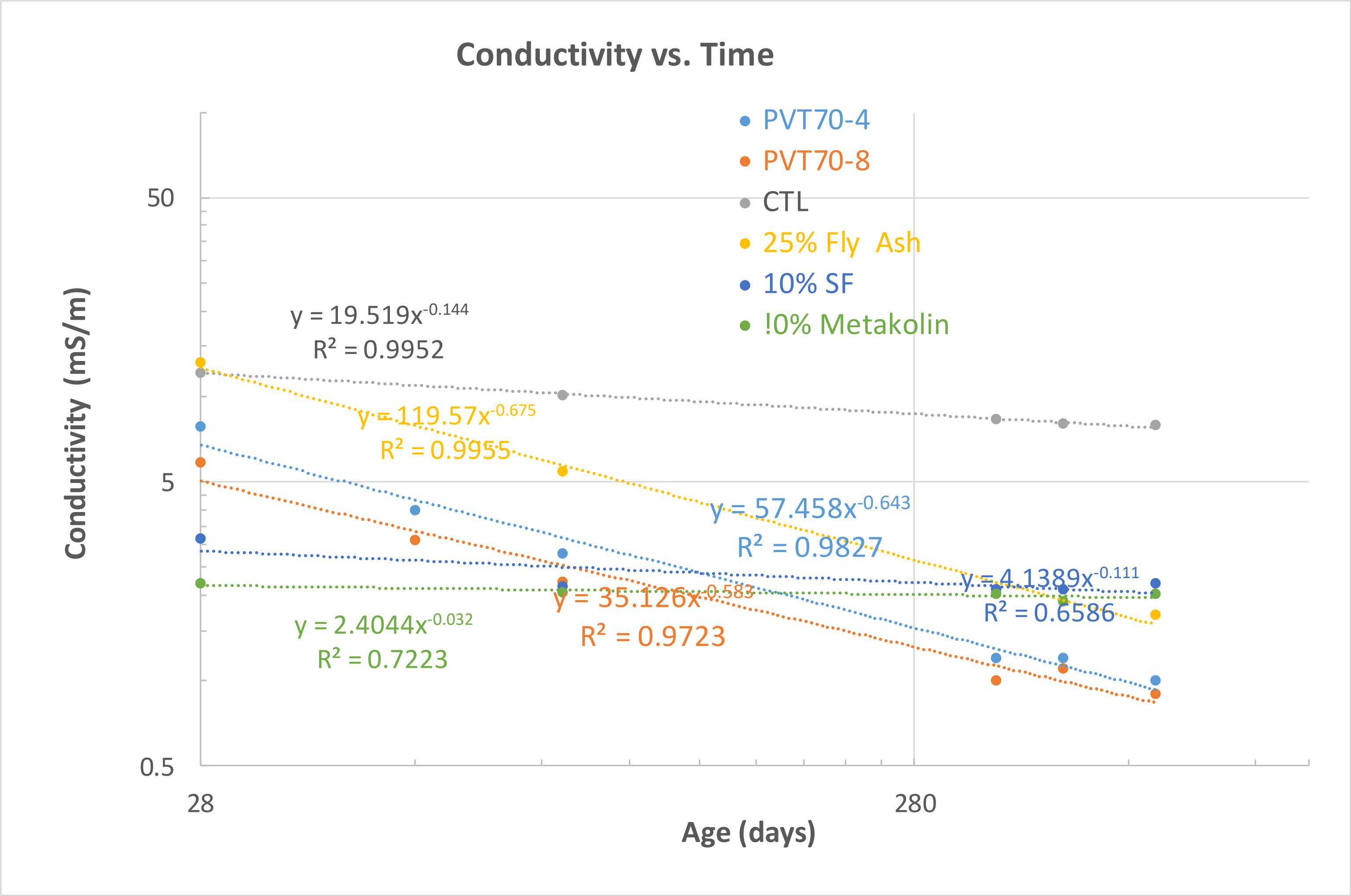
- Excellent Freeze/Thaw Resistance

Transport Properties

Mix Identification :	CTL	FA-25	SF-10	M-10	70-4	70-8
ASTM C1760 Conductivity 4" x 8" cyl.						
28 d Bulk Elect Conductivity (mS/m) C1760	12.18	13.15	3.17	2.19	7.79	5.86
28d STDev (mS/m) C1760	0.16	0.20	0.00	0.03	0.07	0.03
28 d Coulombs C1760	2214	2391	576	397	1415	1065
90 d Bulk Elect Conductivity (mS/m) C1760	10.11	5.43	2.14	2.04	2.81	2.22
90 d STDev (mS/m) C1760	0.18	0.10	0.04	0.04	0.001	0.07
90 days Coulombs C1760	1837	988	389	371	511	404
365 d Bulk Elect Conductivity (mS/m) C1760	8.30	2.10	2.10	2.02	1.20	1.00
365 d STDev (mS/m) C1760	0.32	0.06	0.02	0.04	0.00	0.03
453 d Bulk Elect Conductivity (mS/m) C1760	8.00	1.90	2.10	1.91	1.20	1.10
453 d STDev (mS/m) C1760	0.28	0.02	0.01	0.01	0.01	0.01
609 d Bulk Elect Conductivity (mS/m) C1760	7.90	1.70	2.20	2.01	1.00	0.90
609 d STDev (mS/m) C1760	0.33	0.04	0.00	0.02	0.04	0.02
NT Build 492 Non Steady State Diff. Coeff.						
28 days D_{NSS} (x 10^{-12} m^2/s)	18.2	17.3	6.4	3.3	11.3	6.8
ASTM 1556 Bulk Diffusion						
Surface Concentration (ppm)	9572	9180	10450	10572	12644	13590
Diffusion Coefficient (D_a), (x 10^{-12} m^2/s)	3.9	4.9	1.6	1.1	2.35	2.0
ASTM C1585 Capillary Absorption						
Initial absorption ($mm/s^{0.5}$)	0.00030	0.00194	0.00058	0.00050	0.00029	0.00049
Secondary absorption ($mm/s^{0.5}$)	0.00023	0.00064	0.00022	0.00022	0.00020	0.00022

- Low permeability at early ages (low diffusion, conductivity, Coulombs)
- Continues to improve over time (more so than silica fume or metakaolin)

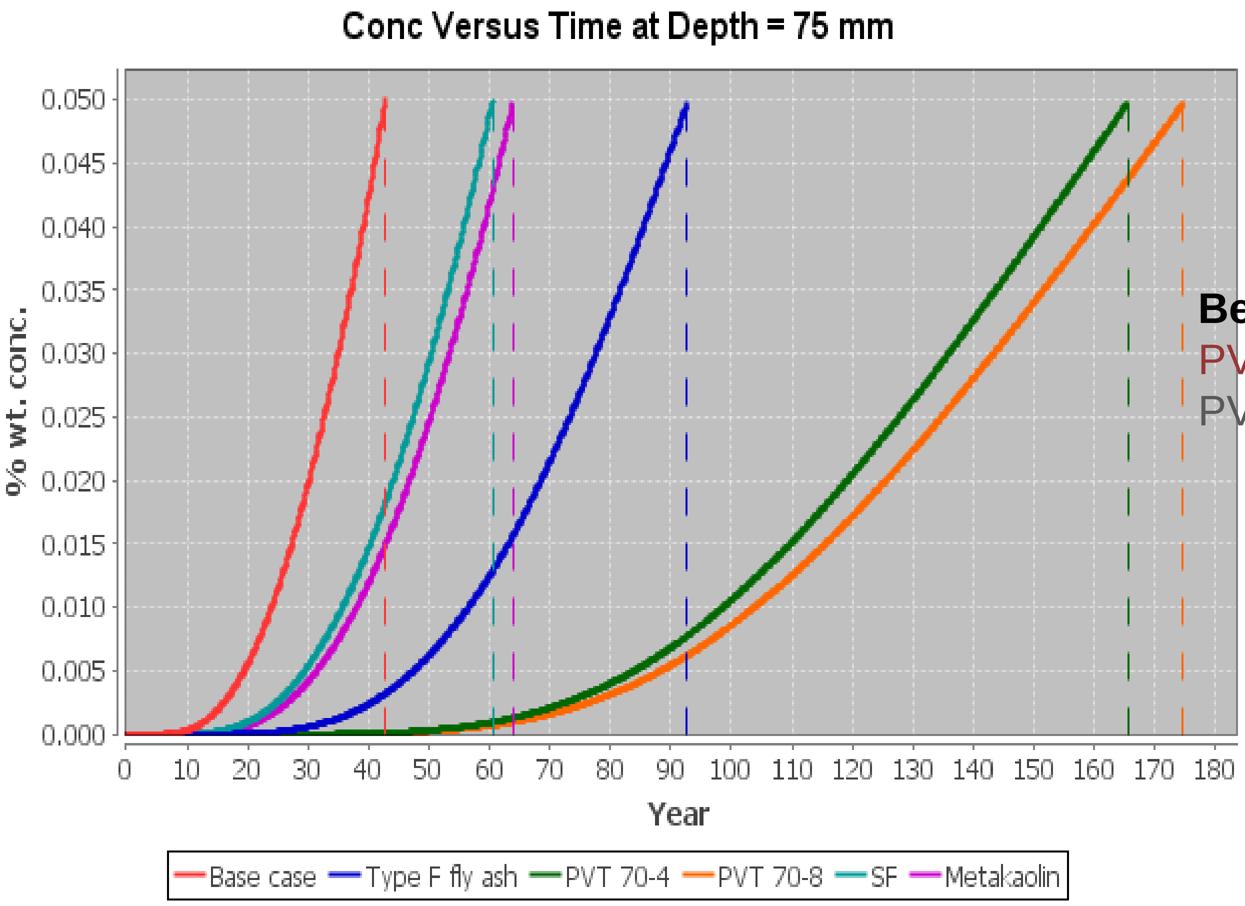
Transport Properties



Predicted Times to Corrosion for Bridge Deck

- Used Salt Lake City as a severe example
- 3” (75 mm) concrete cover
- 250 mm deck thickness
- Modified Life 365™ to be consistent with new data
  - Aging constant and hydration time, based on ASTM 1760 conductivity data
  - Aging factor was limited to a maximum of 0.6 which is a constraint in the Life-365 software.
  - Diffusion Coefficients, based on ASTM C1556
  - Surface buildup, based on ASTM C1585 capillary absorption results
  - This series of tests indicated that the hydration period did not extend beyond 3 years.

Predicted Time to Corrosion Initiation Curves



Best Predicted Performance

PVT 70-8

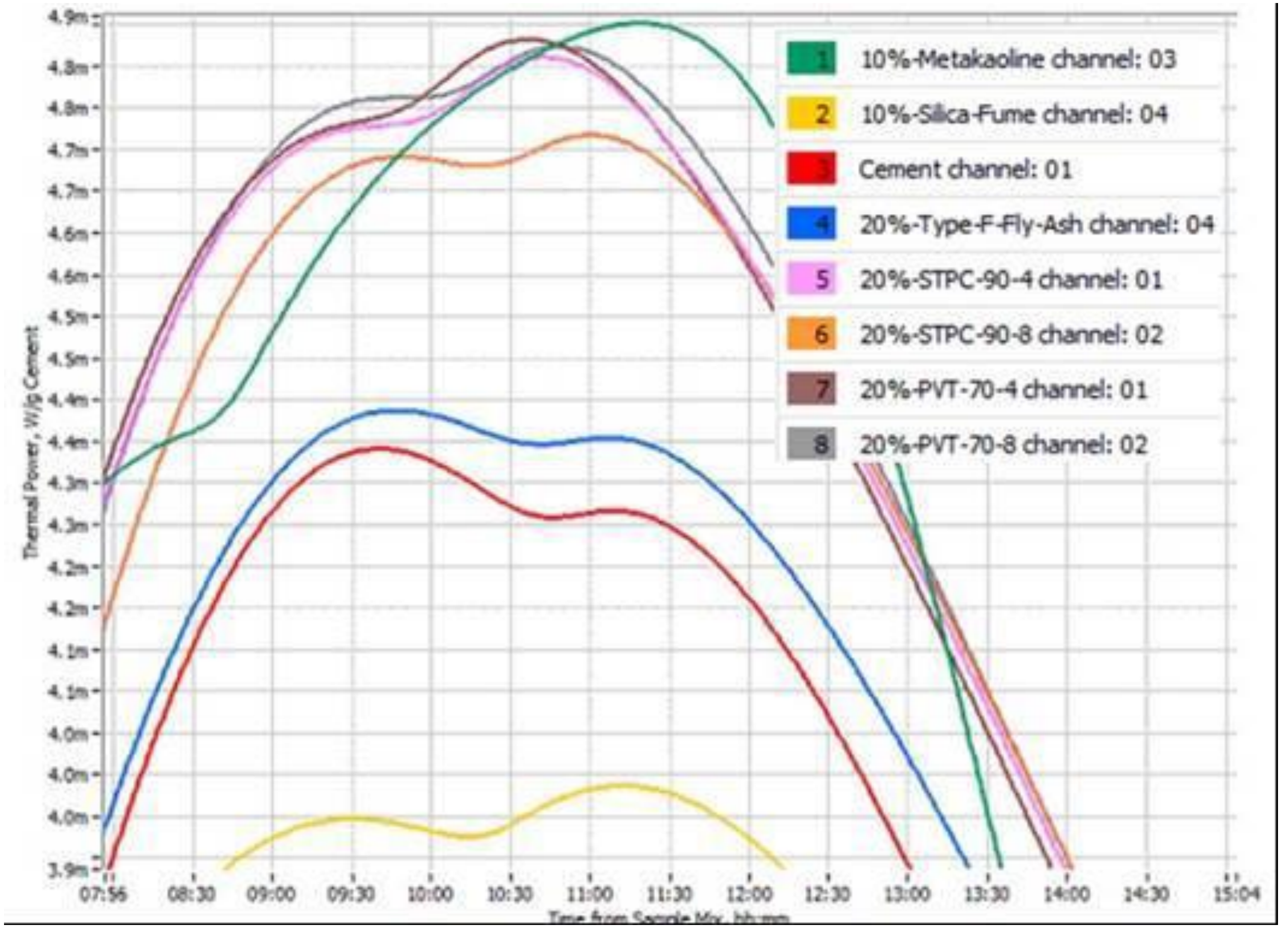
PVT 70-4

Isothermal Calorimetry Results

Mix	Peak	Peak	Peak Time	Total	Total
	watts	mw/g cement	H:min	J	J/g cement
Cement	0.44	4.4	9:45	33700	337
20%Fly Ash	0.35	4.4	9:40	29040	363
20%PVT-70-4	0.38	4.8	10:35	30160	377
20%PVT-70-8	0.38	4.8	10:50	30400	380
10%Metakaolin	0.44	4.9	11:15	36360	404
10%SF	0.36	4.0	11:15	31770	353

- Improves cement efficiency but lowers overall heat output
- In contrast to metakaolin which will increase heat produced

Isothermal Calorimetry Curves



• Increase clinker replacement RATIO to decrease overall CO_2 footprint
• Unconsolidated mineral deposit ZERO CO_2 footprint associated with the natural deposit.
• Total CO2 footprint dependent on the distance to market, type of electricity and mining

Estimated less than 100kg/ton compared to 700-800 kg/ton for OPC

Neal S. Berke, Ph.D., FACI, FASTM, FAMPP

Dr. Neal S. Berke, FACI, is the Vice President, Research at Tourney Consulting Group, in Kalamazoo, MI. He has over 35 years of experience, at Bethlehem Steel and Grace Construction Products in the corrosion and durability of infrastructure materials and the properties of concrete as well as service life modeling. He has conducted extensive research on silica fume, fly ash, slag, metakaolin and other pozzolanic materials with an emphasis on improving both the durability and sustainability of concrete. He is the October 2012 recipient of the J.C. Roumain Innovation in Concrete Award.

He has written and presented over one hundred papers on his research activities, has 45 U. S. patents, and is a frequent reviewer for several technical organizations and journals.

Neal serves on several ACI, NACE, ASTM, and TRB committees, and is a Past Chairman of ASTM Committee G01 On the Corrosion of Metals, and chairman of ASTM Section C.09.03.08 on Durability Enhancing Admixtures.

Dr. Berke has a bachelor's degree in Physics from the University of Chicago and a Ph.D. in Metallurgical Engineering from the University of Illinois at Urbana-Champaign.

Romeo Ciuperca is an inventor and entrepreneur.

He is the founder of Greencraft, an Atlanta-based company. Ciuperca founded Greencraft in 2006 to develop sustainable construction methods and new construction materials with which owners can create highly energy efficient, high performance resilient building envelopes and structures while reducing the carbon footprint.

Under Ciuperca's direction, Greencraft launched several initiatives focused on improving a construction project's carbon footprint by improving hardened concrete properties that yield more durable structures cost competitive with conventional construction systems. To accomplish this, Greencraft has partnered with leading research laboratories and research centers on topics such as the development and testing of ternary concrete mix designs, new curing methods, concrete maturity measurement systems, carbon footprint reduction and alternative cementitious materials.

Greencraft's research initiatives have resulted in the awarding of 65 United States patents and several in other countries such as EU, Canada and Australia.

Thank You

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