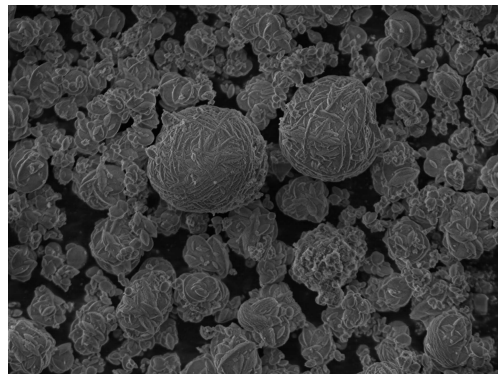




ReAct® Blend

3RD PARTY REPORT INTRODUCTION

Fortera is in the process of commercially manufacturing a cementitious and proprietary form of calcium carbonate, ReAct Blend. ReAct Blend's unique properties optimize blended cements. ReAct Blend's spherical shape enhances cements' workability and increases flow, while its ample surface area nucleates the growth of calcium silicate hydrate, thereby accelerating cement hydration and early property development and increasing the cement paste pore tortuosity. ReAct Blend's main mineral, vaterite, reacts to form monocarboaluminate, a stiff and stable AFm mineral that helps to stabilize ettringite.



This report is a compilation of testing reports detailing the properties of blended cements produced with ReAct Blend and provides comparisons to portland cement and portland-limestone cement made from the same clinker. Cements from two different plants were utilized. From plant #1, a Type I portland cement was tested as a control and used to make a portland-limestone cement and a ternary blended cement. From plant #2, a Type IL(10) portland-limestone cement was tested as a control, and a Type II/V portland cement was tested as a control and used to make two portland-limestone cements and a ternary blended cement. The table below summarizes the composition of the cements tested.

Sample Name	Type II/V	Type IL(10)	Type I	Fortera ReAct*	Calcined Clay	Calcined Shale	Calcium Carbonate Total**
Type I - Control	-	-	100%	-	-	-	3.2%
Type I - IL(15)	-	-	87.7%	12.3%	-	-	15.0%
Type I - IT(L15)(P15)	-	-	72.1%	12.9%	15.0%	-	15.0%
Type II/V - Control	100%	-	-	-	-	-	4.3%
Type IL(10) - Control	-	100%	-	-	-	-	7.5%
Type II/V - IL(10)	96.6%	-	-	3.4%	-	-	7.5%
Type II/V - IL(15)	88.6%	-	-	11.4%	-	-	15.0%
Type II/V - IT(L15)(P15)	72.9%	-	-	12.1%	-	15.0%	15.0%
*Fortera ReAct contains 98.4% calcium carbonate							
**Calcium carbonate content determined by TGA							

Prepared by:

Craig Hargis
Vice President, Products
Fortera Corporation
100 Great Oaks Blvd, Suite 120



April 12, 2022

Mr. Craig W. Hargis
Fortera
251 E. Hacienda Ave, Suite B.
Campbell, CA 95008

Phone: (669) 267-6407
Email: chargis@forterausa.com

Subject: **Report of Results of ASTM C595 Testing
Cement: Type I Control
TEC Laboratory ID: 22-291-1**

Dear Mr. Hargis:

SGS TEC Services is an AASHTO R18, ANSI/ISO/IEC 17025:2017, and Army Corps of Engineers accredited laboratory. SGS TEC Services is pleased to present this report on the testing performed on the submitted sample of cement identified as Type I Control.

One sample of cement was received on February 15, 2022. Testing was performed in accordance with ASTM C595-21 *Standard Specification for Blended Hydraulic Cements*. Results of the chemical and physical testing of the cement samples are reported in the attached Table 1. These test results pertain only to the sample tested.

We appreciate the opportunity to provide our services to you on this project. Should you have any questions or comments regarding this report, please feel free to contact us.

Sincerely,

SGS TEC SERVICES

Dean T. Roosa
Project Manager

Shawn P. McCormick
Laboratory Principal

Attachment: Table 1 – Cement Test Results



SGS TEC SERVICES
235 Buford Drive | Lawrenceville GA 30046
770-995-8000 | www.tecservices.com



Table 1– ASTM C595 Test Results for Type I Control

Chemical Analysis**		Results	ASTM C595 Type IL Specifications
Silicon Dioxide (SiO ₂)		20.5	----
Aluminum Oxide (Al ₂ O ₃)		5.3	----
Iron Oxide (Fe ₂ O ₃)		2.14	----
Calcium Oxide (CaO)		64.0	----
Magnesium Oxide (MgO)		1.1	----
Sodium Oxide (Na ₂ O)		0.14	----
Potassium Oxide (K ₂ O)		1.02	----
Equivalent Alkalies (Na ₂ O+0.658 K ₂ O)		0.81	----
Titanium Dioxide (TiO ₂)		0.25	----
Manganic Oxide (Mn ₂ O ₃)		0.033	----
Sulfur Trioxide (SO ₃)		2.84	3.0 % max
Loss on Ignition		2.3	10.0 % max
Insoluble Residue		1.56	----
Physical Analysis		Results	ASTM C595 Type IL Specifications
ASTM C1437 - Flow		129	----
ASTM C109 - Compressive Strength, psi (MPa)			
1 Day: 2/23/22	Test Average	2,380	
3 Days: 2/25/22	Test Average	4,010	1890 (13.0) min
7 Days: 3/10/22	Test Average	4,840	2900 (20.0) min
28 Days: 3/22/22	Test Average	5,730	3620 (25.0) min
ASTM C191 - Time of setting (Vicat test), min	Initial set	108	45 min -420 max
	Final set	215	----
ASTM C187 - Normal Consistency (%)		25.5	----
ASTM C188 – Density (g/cm ³)		3.09	----
ASTM C151 - Autoclave Expansion (%)		0.05	0.80 max
ASTM C185 - Air content of mortar (%)		8	12 % max
ASTM C204 - Fineness (Air permeability test) m ² /kg		332	----
ASTM C430 - Fineness (Wash #325 Sieve) %		14.94	----

*Indicates items not meeting ASTM C595-21

** No adjustment has been made for possible use of limestone or inorganic processing additions.



April 12, 2022

Mr. Craig W. Hargis
Fortera
251 E. Hacienda Ave, Suite B.
Campbell, CA 95008

Phone: (669) 267-6407
Email: chargis@forterausa.com

Subject: **Report of Results of ASTM C595 Testing
Cement: Type I - IL (15)
TEC Laboratory ID: 22-291-2**

Dear Mr. Hargis:

SGS TEC Services is an AASHTO R18, ANSI/ISO/IEC 17025:2017, and Army Corps of Engineers accredited laboratory. SGS TEC Services is pleased to present this report on the testing performed on the submitted sample of cement identified as Type I - IL (15).

One sample of cement was received on February 15, 2022. Testing was performed in accordance with ASTM C595-21 *Standard Specification for Blended Hydraulic Cements*. Results of the chemical and physical testing of the cement samples are reported in the attached Table 1. These test results pertain only to the sample tested.

We appreciate the opportunity to provide our services to you on this project. Should you have any questions or comments regarding this report, please feel free to contact us.

Sincerely,

SGS TEC SERVICES

Dean T. Roosa
Project Manager

Shawn P. McCormick
Laboratory Principal

Attachment: Table 1 – Cement Test Results



SGS TEC SERVICES
235 Buford Drive | Lawrenceville GA 30046
770-995-8000 | www.tecservices.com



Table 1– ASTM C595 Test Results for Type I - IL (15)

Chemical Analysis**		Results	ASTM C595 Type IL Specifications
Silicon Dioxide (SiO ₂)		17.6	----
Aluminum Oxide (Al ₂ O ₃)		4.6	----
Iron Oxide (Fe ₂ O ₃)		1.81	----
Calcium Oxide (CaO)		62.6	----
Magnesium Oxide (MgO)		1.0	----
Sodium Oxide (Na ₂ O)		0.13	----
Potassium Oxide (K ₂ O)		0.93	----
Equivalent Alkalies (Na ₂ O+0.658 K ₂ O)		0.75	----
Titanium Dioxide (TiO ₂)		0.22	----
Manganic Oxide (Mn ₂ O ₃)		0.029	----
Sulfur Trioxide (SO ₃)		2.75	3.0 % max
Loss on Ignition		7.8	10.0 % max
Insoluble Residue		1.22	----
Physical Analysis		Results	ASTM C595 Type IL Specifications
ASTM C1437 - Flow		129	----
ASTM C109 - Compressive Strength, psi (MPa)			
1 Day: 2/23/22	Test Average	2,590	
3 Days: 2/25/22	Test Average	3,940	1890 (13.0) min
7 Days: 3/10/22	Test Average	4,870	2900 (20.0) min
28 Days: 3/22/22	Test Average	5,780	3620 (25.0) min
ASTM C191 - Time of setting (Vicat test), min	Initial set	78	45 min -420 max
	Final set	185	----
ASTM C187 - Normal Consistency (%)		26.8	----
ASTM C188 – Density (g/cm ³)		3.02	----
ASTM C151 - Autoclave Expansion (%)		0.06	0.80 max
ASTM C185 - Air content of mortar (%)		7	12 % max
ASTM C204 - Fineness (Air permeability test) m ² /kg		479	----
ASTM C430 - Fineness (Wash #325 Sieve) %		11.18	----

*Indicates items not meeting ASTM C595-21

** No adjustment has been made for possible use of limestone or inorganic processing additions.



April 12, 2022

Mr. Craig W. Hargis
Fortera
251 E. Hacienda Ave, Suite B.
Campbell, CA 95008

Phone: (669) 267-6407
Email: chargis@forterausa.com

Subject: **Report of Results of ASTM C595 Testing
Cement: Type I – IT (L15) (P15)
TEC Laboratory ID: 22-291-3**

Dear Mr. Hargis:

SGS TEC Services is an AASHTO R18, ANSI/ISO/IEC 17025:2017, and Army Corps of Engineers accredited laboratory. SGS TEC Services is pleased to present this report on the testing performed on the submitted sample of cement identified as Type I – IT (L15) (P15).

One sample of cement was received on February 15, 2022. Testing was performed in accordance with ASTM C595-21 *Standard Specification for Blended Hydraulic Cements*. Results of the chemical and physical testing of the cement samples are reported in the attached Table 1. These test results pertain only to the sample tested.

We appreciate the opportunity to provide our services to you on this project. Should you have any questions or comments regarding this report, please feel free to contact us.

Sincerely,

SGS TEC SERVICES

Dean T. Roosa
Project Manager

Shawn P. McCormick
Laboratory Principal

Attachment: Table 1 – Cement Test Results



SGS TEC SERVICES
235 Buford Drive | Lawrenceville GA 30046
770-995-8000 | www.tecservices.com



Table 1– ASTM C595 Test Results for Type I – IT (L15) (P15)

Chemical Analysis**		Results	ASTM C595 Type IT Specifications
Silicon Dioxide (SiO ₂)		22.0	----
Aluminum Oxide (Al ₂ O ₃)		10.2	----
Iron Oxide (Fe ₂ O ₃)		1.58	----
Calcium Oxide (CaO)		53.8	----
Magnesium Oxide (MgO)		0.8	6.0 % max
Sodium Oxide (Na ₂ O)		0.16	----
Potassium Oxide (K ₂ O)		0.81	----
Equivalent Alkalies (Na ₂ O+0.658 K ₂ O)		0.69	----
Titanium Dioxide (TiO ₂)		0.40	----
Manganic Oxide (Mn ₂ O ₃)		0.025	----
Sulfur Trioxide (SO ₃)		2.16	3.0 % max
Loss on Ignition		8.0	10.0 % max
Insoluble Residue		14.10	----
Physical Analysis		Results	ASTM C595 Type IT Specifications
ASTM C1437 - Flow		123	----
ASTM C109 - Compressive Strength, psi (MPa)			
1 Day: 2/23/22	Test Average	2,140	
3 Days: 2/25/22	Test Average	5,120	1890 (13.0) min
7 Days: 3/10/22	Test Average	6,210	2900 (20.0) min
28 Days: 3/22/22	Test Average	7,310	3620 (25.0) min
ASTM C191 - Time of setting (Vicat test), min	Initial set	117	45 min -420 max
	Final set	205	----
ASTM C187 - Normal Consistency (%)		34.3	----
ASTM C188 – Density (g/cm ³)		2.86	----
ASTM C151 - Autoclave Expansion (%)		-0.04	0.80 max
ASTM C185 - Air content of mortar (%)		8	12 % max
ASTM C204 - Fineness (Air permeability test) m ² /kg		692	----
ASTM C430 - Fineness (Wash #325 Sieve) %		10.94	----

*Indicates items not meeting ASTM C595-21

** No adjustment has been made for possible use of limestone or inorganic processing additions.



September 7, 2022

Mr. Craig W. Hargis
Fortera
251 E. Hacienda Ave, Suite B.
Campbell, CA 95008

Phone: (669) 267-6407
Email: chargis@forterausa.com

Subject: **Report of Results of ASTM C595 Testing
Cement: Type II/V Control
TEC Laboratory ID: 22-291-5**

Dear Mr. Hargis:

SGS TEC Services is an AASHTO R18, ANSI/ISO/IEC 17025:2017, and Army Corps of Engineers accredited laboratory. SGS TEC Services is pleased to present this report on the testing performed on the submitted sample of cement identified as Type II/V Control.

One sample of cement was received on February 15, 2022. Testing was performed in accordance with ASTM C595-21 *Standard Specification for Blended Hydraulic Cements*. Results of the chemical and physical testing of the cement samples are reported in the attached Table 1. These test results pertain only to the sample tested.

We appreciate the opportunity to provide our services to you on this project. Should you have any questions or comments regarding this report, please feel free to contact us.

Sincerely,

SGS TEC SERVICES

Dean T. Roosa
Project Manager

Shawn P. McCormick
Laboratory Principal

Attachment: Table 1 – Cement Test Results



SGS TEC SERVICES
235 Buford Drive | Lawrenceville GA 30046
770-995-8000 | www.tecservices.com



Table 1– ASTM C595 Test Results for Type II/V Control

Chemical Analysis**		Results	ASTM C595 Type II Specifications
Silicon Dioxide (SiO ₂)		19.9	----
Aluminum Oxide (Al ₂ O ₃)		4.1	----
Iron Oxide (Fe ₂ O ₃)		3.56	----
Calcium Oxide (CaO)		63.3	----
Magnesium Oxide (MgO)		2.3	----
Sodium Oxide (Na ₂ O)		0.18	----
Potassium Oxide (K ₂ O)		0.57	----
Equivalent Alkalies (Na ₂ O+0.658 K ₂ O)		0.56	----
Titanium Dioxide (TiO ₂)		0.21	----
Manganic Oxide (Mn ₂ O ₃)		0.052	----
Sulfur Trioxide (SO ₃)		2.77	3.0 % max
Loss on Ignition		3.2	10.0 % max
Insoluble Residue		1.15	----
Physical Analysis		Results	ASTM C595 Type II Specifications
ASTM C1437 - Flow		128	----
ASTM C109 - Compressive Strength, psi (MPa)			
1 Day: 2/23/22	Test Average	2,490	
3 Days: 2/25/22	Test Average	4,310	1890 (13.0) min
7 Days: 3/10/22	Test Average	4,890	2900 (20.0) min
28 Days: 3/22/22	Test Average	6,560	3620 (25.0) min
ASTM C191 - Time of setting (Vicat test), min	Initial set	147	45 min -420 max
	Final set	265	----
ASTM C187 - Normal Consistency (%)		26.6	----
ASTM C188 – Density (g/cm ³)		3.11	----
ASTM C151 - Autoclave Expansion (%)		0.02	0.80 max
ASTM C185 - Air content of mortar (%)		7	12 % max
ASTM C204 - Fineness (Air permeability test) m ² /kg		433	----
ASTM C430 - Fineness (Wash #325 Sieve) %		0.93	----
ASTM C1702 – Heat of hydrations (kJ/kg)			
3 Days		291	----
7 Days		320	----
ASTM C1012 – Sulfate expansion (%) 6 months		0.06	----

*Indicates items not meeting ASTM C595-21

** No adjustment has been made for possible use of limestone or inorganic processing additions.

September 7, 2022

Mr. Craig W. Hargis
Forterra
251 E. Hacienda Ave, Suite B.
Campbell, CA 95008

Phone: (669) 267-6407
Email: chargis@forterausa.com

Subject: **Report of Result for ASTM C 1012 Testing**
Client ID: Type II/V
TEC Lab ID: 22-291-5

Dear Mr. Hargis:

SGS TEC Services is an AASHTO R18, ANS/ISO/IEC 17025:2017, and Army Corps of Engineers accredited laboratory. SGS TEC Services is pleased to present this report on the testing performed on the submitted sample identified as "Type II/V".

The cement was tested in accordance with the following test method:

- ASTM C1012-18b *Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.*

ASTM C1012 Sulfate Expansion Testing

The specimens were prepared in accordance with the procedures described in ASTM C1012. Six mortar bars were prepared for the test mix. A control mixture is not mandatory since performance measured is based on maximum expansion of the test mixture. Mix proportions are reported in Table 1.

The specimens were cured according to C1012 until the strength of the cubes reached a minimum of 2,850 psi. The specimens were then stored in sulfate solution at 73°F (± 3.5°F) for nine months. Results of the testing are reported in Table 2.

Table 1 – C1012 Mix Proportions

	Test Mix
Type II/V Cement, g	740
Standard Graded Sand, g	2,035
Water, ml	359
Flow %	134
24 hr break (psi)	3,630

Table 2 – Sulfate Expansion Test Results

Sample ID	1	2	3	4	5	6	Average	Standard Deviation	Coefficient Variance
Age	Length Change (%)								
Initial	---	---	---	---	---		---	---	---
1 Week	0.004	0.003	0.005	0.005	0.003	0.004	0.00	0.001	22.361
2 Weeks	0.005	0.003	0.005	0.005	0.003	0.005	0.00	0.001	23.834
3 Weeks	0.004	0.004	0.005	0.005	0.004	0.004	0.00	0.001	11.917
4 Weeks	0.005	0.006	0.006	0.006	0.005	0.005	0.01	0.001	9.959
8 Weeks	0.016	0.016	0.019	0.017	0.014	0.014	0.02	0.002	11.859
13 Weeks	0.023	0.023	0.022	0.023	0.019	0.018	0.02	0.002	10.551
15 Weeks	0.024	0.031	0.025	0.026	0.024	0.023	0.03	0.003	11.298
4 Months	0.029	0.030	0.039	0.030	0.025	0.027	0.03	0.005	16.055
6 Months	0.060	0.059	0.067	0.061	0.046	0.055	0.06	0.007	12.143

We appreciate the opportunity to provide our services to you on this project. Should you have any questions or comments regarding this report, please feel free to contact us.

Sincerely,

SGS TEC SERVICES



Dean T. Roosa
Project Manager



Shawn P. McCormick
Laboratory Principal



September 7, 2022

Mr. Craig W. Hargis
Fortera
251 E. Hacienda Ave, Suite B.
Campbell, CA 95008

Phone: (669) 267-6407
Email: chargis@forterausa.com

Subject: **Report of Results of ASTM C595 Testing
Cement: Type IL (10) Control
TEC Laboratory ID: 22-291-4**

Dear Mr. Hargis:

SGS TEC Services is an AASHTO R18, ANSI/ISO/IEC 17025:2017, and Army Corps of Engineers accredited laboratory. SGS TEC Services is pleased to present this report on the testing performed on the submitted sample of cement identified as Type IL (10) Control.

One sample of cement was received on February 15, 2022. Testing was performed in accordance with ASTM C595-21 *Standard Specification for Blended Hydraulic Cements*. Results of the chemical and physical testing of the cement samples are reported in the attached Table 1. These test results pertain only to the sample tested.

We appreciate the opportunity to provide our services to you on this project. Should you have any questions or comments regarding this report, please feel free to contact us.

Sincerely,

SGS TEC SERVICES

Dean T. Roosa
Project Manager

Shawn P. McCormick
Laboratory Principal

Attachment: Table 1 – Cement Test Results



SGS TEC SERVICES
235 Buford Drive | Lawrenceville GA 30046
770-995-8000 | www.tecservices.com



Table 1– ASTM C595 Test Results for Type IL (10) Control

Chemical Analysis**		Results	ASTM C595 Type IL Specifications
Silicon Dioxide (SiO ₂)		19.3	----
Aluminum Oxide (Al ₂ O ₃)		3.9	----
Iron Oxide (Fe ₂ O ₃)		4.04	----
Calcium Oxide (CaO)		63.0	----
Magnesium Oxide (MgO)		1.7	----
Sodium Oxide (Na ₂ O)		0.37	----
Potassium Oxide (K ₂ O)		0.35	----
Equivalent Alkalies (Na ₂ O+0.658 K ₂ O)		0.59	----
Titanium Dioxide (TiO ₂)		0.23	----
Manganic Oxide (Mn ₂ O ₃)		0.148	----
Sulfur Trioxide (SO ₃)		3.11*	3.0 % max
Loss on Ignition		4.2	10.0 % max
Insoluble Residue		1.55	----
Physical Analysis		Results	ASTM C595 Type IL Specifications
ASTM C1437 - Flow		130	----
ASTM C109 - Compressive Strength, psi (MPa)			
1 Day: 2/23/22	Test Average	2,320	
3 Days: 2/25/22	Test Average	4,150	1890 (13.0) min
7 Days: 3/10/22	Test Average	4,340	2900 (20.0) min
28 Days: 3/22/22	Test Average	5,780	3620 (25.0) min
ASTM C191 - Time of setting (Vicat test), min	Initial set	133	45 min -420 max
	Final set	250	----
ASTM C187 - Normal Consistency (%)		27.7	----
ASTM C188 – Density (g/cm ³)		3.13	----
ASTM C151 - Autoclave Expansion (%)		-0.02	0.80 max
ASTM C185 - Air content of mortar (%)		8	12 % max
ASTM C204 - Fineness (Air permeability test) m ² /kg		491	----
ASTM C430 - Fineness (Wash #325 Sieve) %		0.71	----
ASTM C1702 – Heat of hydrations (kJ/kg)			
3 Days		269	----
7 Days		299	----
ASTM C1012 – Sulfate expansion (%) 6 months		0.05	----

*Indicates items not meeting ASTM C595-21

** No adjustment has been made for possible use of limestone or inorganic processing additions.

September 7, 2022

Mr. Craig W. Hargis
Forterra
251 E. Hacienda Ave, Suite B.
Campbell, CA 95008

Phone: (669) 267-6407
Email: chargis@forterausa.com

Subject: **Report of Result for ASTM C 1012 Testing**
Client ID: Type IL (10) Control
TEC Lab ID: 22-291-4

Dear Mr. Hargis:

SGS TEC Services is an AASHTO R18, ANS/ISO/IEC 17025:2017, and Army Corps of Engineers accredited laboratory. SGS TEC Services is pleased to present this report on the testing performed on the submitted sample identified as "Type IL (10) Control".

The cement was tested in accordance with the following test method:

- ASTM C1012-18b *Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.*

ASTM C1012 Sulfate Expansion Testing

The specimens were prepared in accordance with the procedures described in ASTM C1012. Six mortar bars were prepared for the test mix. A control mixture is not mandatory since performance measured is based on maximum expansion of the test mixture. Mix proportions are reported in Table 1.

The specimens were cured according to C1012 until the strength of the cubes reached a minimum of 2,850 psi. The specimens were then stored in sulfate solution at 73°F (± 3.5°F) for nine months. Results of the testing are reported in Table 2.

Table 1 – C1012 Mix Proportions

	Test Mix
Type IL (10) Control Cement, g	740
Standard Graded Sand, g	2,035
Water, ml	359
Flow %	126
24 hr break (psi)	3,350

Table 2 – Sulfate Expansion Test Results

Sample ID	1	2	3	4	5	6	Average	Standard Deviation	Coefficient Variance
Age	Length Change (%)								
Initial	---	---	---	---	---		---	---	---
1 Week	0.001	0.001	0.001	0.001	0.003	0.001	0.00	0.001	61.237
2 Weeks	0.002	0.003	0.003	0.004	0.005	0.002	0.00	0.001	36.917
3 Weeks	0.003	0.005	0.004	0.005	0.006	0.003	0.00	0.001	27.948
4 Weeks	0.004	0.005	0.007	0.006	0.008	0.005	0.01	0.001	25.234
8 Weeks	0.015	0.014	0.015	0.017	0.017	0.011	0.01	0.002	15.024
13 Weeks	0.016	0.018	0.019	0.018	0.020	0.019	0.02	0.001	7.452
15 Weeks	0.024	0.023	0.022	0.023	0.024	0.021	0.02	0.001	5.120
4 Months	0.024	0.023	0.023	0.025	0.025	0.021	0.02	0.002	6.454
6 Months	0.048	0.054	0.054	0.054	0.054	0.053	0.05	0.002	4.545

We appreciate the opportunity to provide our services to you on this project. Should you have any questions or comments regarding this report, please feel free to contact us.

Sincerely,
SGS TEC SERVICES



Dean T. Roosa
 Project Manager



Shawn P. McCormick
 Laboratory Principal



September 7, 2022

Mr. Craig W. Hargis
Fortera
251 E. Hacienda Ave, Suite B.
Campbell, CA 95008

Phone: (669) 267-6407
Email: chargis@forterausa.com

Subject: **Report of Results of ASTM C595 Testing
Cement: Type II/V IL (10)
TEC Laboratory ID: 22-291-6**

Dear Mr. Hargis:

SGS TEC Services is an AASHTO R18, ANSI/ISO/IEC 17025:2017, and Army Corps of Engineers accredited laboratory. SGS TEC Services is pleased to present this report on the testing performed on the submitted sample of cement identified as Type II/V IL (10).

One sample of cement was received on February 15, 2022. Testing was performed in accordance with ASTM C595-21 *Standard Specification for Blended Hydraulic Cements*. Results of the chemical and physical testing of the cement samples are reported in the attached Table 1. These test results pertain only to the sample tested.

We appreciate the opportunity to provide our services to you on this project. Should you have any questions or comments regarding this report, please feel free to contact us.

Sincerely,

SGS TEC SERVICES

Dean T. Roosa
Project Manager

Shawn P. McCormick
Laboratory Principal

Attachment: Table 1 – Cement Test Results



SGS TEC SERVICES
235 Buford Drive | Lawrenceville GA 30046
770-995-8000 | www.tecservices.com



Table 1– ASTM C595 Test Results for Type II/V IL (10)

Chemical Analysis**		Results	ASTM C595 Type IL Specifications
Silicon Dioxide (SiO ₂)		19.3	----
Aluminum Oxide (Al ₂ O ₃)		4.0	----
Iron Oxide (Fe ₂ O ₃)		3.45	----
Calcium Oxide (CaO)		63.0	----
Magnesium Oxide (MgO)		2.2	----
Sodium Oxide (Na ₂ O)		0.18	----
Potassium Oxide (K ₂ O)		0.56	----
Equivalent Alkalies (Na ₂ O+0.658 K ₂ O)		0.55	----
Titanium Dioxide (TiO ₂)		0.21	----
Manganic Oxide (Mn ₂ O ₃)		0.053	----
Sulfur Trioxide (SO ₃)		2.69	3.0 % max
Loss on Ignition		4.6	10.0 % max
Insoluble Residue		1.06	----
Physical Analysis		Results	ASTM C595 Type IL Specifications
ASTM C1437 - Flow		132	----
ASTM C109 - Compressive Strength, psi (MPa)			
1 Day: 2/23/22	Test Average	2,300	
3 Days: 2/25/22	Test Average	4,350	1890 (13.0) min
7 Days: 3/10/22	Test Average	4,890	2900 (20.0) min
28 Days: 3/22/22	Test Average	6,470	3620 (25.0) min
ASTM C191 - Time of setting (Vicat test), min	Initial set	136	45 min -420 max
	Final set	245	----
ASTM C187 - Normal Consistency (%)		26.9	----
ASTM C188 – Density (g/cm ³)		3.11	----
ASTM C151 - Autoclave Expansion (%)		0.03	0.80 max
ASTM C185 - Air content of mortar (%)		7	12 % max
ASTM C204 - Fineness (Air permeability test) m ² /kg		442	----
ASTM C430 - Fineness (Wash #325 Sieve) %		0.83	----
ASTM C1702 – Heat of hydrations (kJ/kg)			
3 Days		285	----
7 Days		314	----
ASTM C1012 – Sulfate expansion (%) 6 months		0.06	----

*Indicates items not meeting ASTM C595-21

** No adjustment has been made for possible use of limestone or inorganic processing additions.

September 7, 2022

Mr. Craig W. Hargis
Forterra
251 E. Hacienda Ave, Suite B.
Campbell, CA 95008

Phone: (669) 267-6407
Email: chargis@forterausa.com

Subject: **Report of Result for ASTM C 1012 Testing**
Client ID: Type II/V – IL(10)
TEC Lab ID: 22-291-6

Dear Mr. Hargis:

SGS TEC Services is an AASHTO R18, ANS/ISO/IEC 17025:2017, and Army Corps of Engineers accredited laboratory. SGS TEC Services is pleased to present this report on the testing performed on the submitted sample identified as “Type II/V – IL(10)”.

The cement was tested in accordance with the following test method:

- ASTM C1012-18b *Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.*

ASTM C1012 Sulfate Expansion Testing

The specimens were prepared in accordance with the procedures described in ASTM C1012. Six mortar bars were prepared for the test mix. A control mixture is not mandatory since performance measured is based on maximum expansion of the test mixture. Mix proportions are reported in Table 1.

The specimens were cured according to C1012 until the strength of the cubes reached a minimum of 2,850 psi. The specimens were then stored in sulfate solution at 73°F (± 3.5°F) for nine months. Results of the testing are reported in Table 2.

Table 1 – C1012 Mix Proportions

	Test Mix
Type II/V – IL(10) Cement, g	740
Standard Graded Sand, g	2,035
Water, ml	359
Flow %	137
24 hr break (psi)	3,320

Table 2 – Sulfate Expansion Test Results

Sample ID	1	2	3	4	5	6	Average	Standard Deviation	Coefficient Variance
Age	Length Change (%)								
Initial	---	---	---	---	---		---	---	---
1 Week	0.005	0.005	0.004	0.005	0.003	0.005	0.00	0.001	18.592
2 Weeks	0.007	0.007	0.007	0.006	0.004	0.008	0.01	0.001	21.206
3 Weeks	0.009	0.008	0.008	0.007	0.004	0.008	0.01	0.002	23.880
4 Weeks	0.011	0.009	0.010	0.009	0.006	0.010	0.01	0.002	18.790
8 Weeks	0.028	0.022	0.026	0.016	0.012	0.016	0.02	0.006	31.623
13 Weeks	0.029	0.027	0.027	0.024	0.021	0.024	0.03	0.003	11.349
15 Weeks	0.031	0.030	0.029	0.027	0.024	0.027	0.03	0.003	9.035
4 Months	0.033	0.032	0.040	0.031	0.025	0.028	0.03	0.005	16.156
6 Months	0.059	0.056	0.066	0.065	0.049	0.058	0.06	0.006	10.610

We appreciate the opportunity to provide our services to you on this project. Should you have any questions or comments regarding this report, please feel free to contact us.

Sincerely,

SGS TEC SERVICES



Dean T. Roosa
Project Manager



Shawn P. McCormick
Laboratory Principal



September 7, 2022

Mr. Craig W. Hargis
Fortera
251 E. Hacienda Ave, Suite B.
Campbell, CA 95008

Phone: (669) 267-6407
Email: chargis@forterausa.com

Subject: **Report of Results of ASTM C595 Testing
Cement: Type II/V IL (15)
TEC Laboratory ID: 22-291-7**

Dear Mr. Hargis:

SGS TEC Services is an AASHTO R18, ANSI/ISO/IEC 17025:2017, and Army Corps of Engineers accredited laboratory. SGS TEC Services is pleased to present this report on the testing performed on the submitted sample of cement identified as Type II/V IL (15).

One sample of cement was received on February 15, 2022. Testing was performed in accordance with ASTM C595-21 *Standard Specification for Blended Hydraulic Cements*. Results of the chemical and physical testing of the cement samples are reported in the attached Table 1. These test results pertain only to the sample tested.

We appreciate the opportunity to provide our services to you on this project. Should you have any questions or comments regarding this report, please feel free to contact us.

Sincerely,

SGS TEC SERVICES

Dean T. Roosa
Project Manager

Shawn P. McCormick
Laboratory Principal

Attachment: Table 1 – Cement Test Results



SGS TEC SERVICES
235 Buford Drive | Lawrenceville GA 30046
770-995-8000 | www.tecservices.com



Table 1– ASTM C595 Test Results for Type II/V IL (15)

Chemical Analysis**		Results	ASTM C595 Type IL Specifications
Silicon Dioxide (SiO ₂)		17.7	----
Aluminum Oxide (Al ₂ O ₃)		3.7	----
Iron Oxide (Fe ₂ O ₃)		3.13	----
Calcium Oxide (CaO)		62.4	----
Magnesium Oxide (MgO)		2.1	----
Sodium Oxide (Na ₂ O)		0.16	----
Potassium Oxide (K ₂ O)		0.51	----
Equivalent Alkalies (Na ₂ O+0.658 K ₂ O)		0.49	----
Titanium Dioxide (TiO ₂)		0.19	----
Manganic Oxide (Mn ₂ O ₃)		0.049	----
Sulfur Trioxide (SO ₃)		2.47	3.0 % max
Loss on Ignition		7.9	10.0 % max
Insoluble Residue		0.62	----
Physical Analysis		Results	ASTM C595 Type IL Specifications
ASTM C1437 - Flow		131	----
ASTM C109 - Compressive Strength, psi (MPa)			
1 Day: 2/23/22	Test Average	2,360	
3 Days: 2/25/22	Test Average	3,660	1890 (13.0) min
7 Days: 3/10/22	Test Average	4,760	2900 (20.0) min
28 Days: 3/22/22	Test Average	6,060	3620 (25.0) min
ASTM C191 - Time of setting (Vicat test), min	Initial set	142	45 min -420 max
	Final set	275	----
ASTM C187 - Normal Consistency (%)		28.6	----
ASTM C188 – Density (g/cm ³)		3.03	----
ASTM C151 - Autoclave Expansion (%)		0.04	0.80 max
ASTM C185 - Air content of mortar (%)		6	12 % max
ASTM C204 - Fineness (Air permeability test) m ² /kg		479	----
ASTM C430 - Fineness (Wash #325 Sieve) %		0.70	----
ASTM C1702 – Heat of hydrations (kJ/kg)			
3 Days		272	----
7 Days		302	----
ASTM C1012 – Sulfate expansion (%) 6 months		0.06	----

*Indicates items not meeting ASTM C595-21

** No adjustment has been made for possible use of limestone or inorganic processing additions.

September 7, 2022

Mr. Craig W. Hargis
Forterra
251 E. Hacienda Ave, Suite B.
Campbell, CA 95008

Phone: (669) 267-6407
Email: chargis@forterausa.com

Subject: **Report of Result for ASTM C 1012 Testing**
Client ID: Type II/V – IL(15)
TEC Lab ID: 22-291-7

Dear Mr. Hargis:

SGS TEC Services is an AASHTO R18, ANS/ISO/IEC 17025:2017, and Army Corps of Engineers accredited laboratory. SGS TEC Services is pleased to present this report on the testing performed on the submitted sample identified as “Type II/V – IL(15)”.

The cement was tested in accordance with the following test method:

- ASTM C1012-18b *Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.*

ASTM C1012 Sulfate Expansion Testing

The specimens were prepared in accordance with the procedures described in ASTM C1012. Six mortar bars were prepared for the test mix. A control mixture is not mandatory since performance measured is based on maximum expansion of the test mixture. Mix proportions are reported in Table 1.

The specimens were cured according to C1012 until the strength of the cubes reached a minimum of 2,850 psi. The specimens were then stored in sulfate solution at 73°F (± 3.5°F) for nine months. Results of the testing are reported in Table 2.

Table 1 – C1012 Mix Proportions

	Test Mix
Type II/V – IL(15) Cement, g	740
Standard Graded Sand, g	2,035
Water, ml	359
Flow %	132
24 hr break (psi)	3,040

Table 2 – Sulfate Expansion Test Results

Sample ID	1	2	3	4	5	6	Average	Standard Deviation	Coefficient Variance
Age	Length Change (%)								
Initial	---	---	---	---	---		---	---	---
1 Week	0.004	0.004	0.004	0.003	0.003	0.002	0.00	0.001	24.495
2 Weeks	0.006	0.007	0.006	0.003	0.004	0.002	0.00	0.002	42.137
3 Weeks	0.006	0.001	0.006	0.003	0.005	0.005	0.00	0.002	49.312
4 Weeks	0.011	0.012	0.010	0.007	0.007	0.008	0.01	0.002	23.312
8 Weeks	0.018	0.017	0.017	0.016	0.017	0.015	0.02	0.001	6.197
13 Weeks	0.026	0.028	0.025	0.023	0.025	0.024	0.03	0.002	6.844
15 Weeks	0.032	0.028	0.032	0.027	0.028	0.028	0.03	0.002	7.641
4 Months	0.034	0.031	0.032	0.029	0.032	0.028	0.03	0.002	7.067
6 Months	0.071	0.062	0.060	0.058	0.071	0.067	0.06	0.006	8.693

We appreciate the opportunity to provide our services to you on this project. Should you have any questions or comments regarding this report, please feel free to contact us.

Sincerely,

SGS TEC SERVICES



Dean T. Roosa
Project Manager



Shawn P. McCormick
Laboratory Principal



September 7, 2022

Mr. Craig W. Hargis
Fortera
251 E. Hacienda Ave, Suite B.
Campbell, CA 95008

Phone: (669) 267-6407
Email: chargis@forterausa.com

Subject: **Report of Results of ASTM C595 Testing
Cement: Type II/V – IT (L15) (P15)
TEC Laboratory ID: 22-291-8**

Dear Mr. Hargis:

SGS TEC Services is an AASHTO R18, ANSI/ISO/IEC 17025:2017, and Army Corps of Engineers accredited laboratory. SGS TEC Services is pleased to present this report on the testing performed on the submitted sample of cement identified as Type II/V – IT (L15) (P15).

One sample of cement was received on February 15, 2022. Testing was performed in accordance with ASTM C595-21 *Standard Specification for Blended Hydraulic Cements*. Results of the chemical and physical testing of the cement samples are reported in the attached Table 1. These test results pertain only to the sample tested.

We appreciate the opportunity to provide our services to you on this project. Should you have any questions or comments regarding this report, please feel free to contact us.

Sincerely,

SGS TEC SERVICES

Dean T. Roosa
Project Manager

Shawn P. McCormick
Laboratory Principal

Attachment: Table 1 – Cement Test Results



SGS TEC SERVICES
235 Buford Drive | Lawrenceville GA 30046
770-995-8000 | www.tecservices.com



Table 1– ASTM C595 Test Results for Type II/V – IT (L15) (P15)

Chemical Analysis**		Results	ASTM C595 Type IT Specifications
Silicon Dioxide (SiO ₂)		22.0	----
Aluminum Oxide (Al ₂ O ₃)		6.4	----
Iron Oxide (Fe ₂ O ₃)		5.44	----
Calcium Oxide (CaO)		53.5	----
Magnesium Oxide (MgO)		1.8	6.0 % max
Sodium Oxide (Na ₂ O)		0.14	----
Potassium Oxide (K ₂ O)		0.53	----
Equivalent Alkalies (Na ₂ O+0.658 K ₂ O)		0.49	----
Titanium Dioxide (TiO ₂)		0.39	----
Manganic Oxide (Mn ₂ O ₃)		0.050	----
Sulfur Trioxide (SO ₃)		1.97	3.0 % max
Loss on Ignition		8.0	10.0 % max
Insoluble Residue		19.65	----
Physical Analysis		Results	ASTM C595 Type IT Specifications
ASTM C1437 - Flow		114	----
ASTM C109 - Compressive Strength, psi (MPa)			
1 Day: 2/23/22	Test Average	1,670	
3 Days: 2/25/22	Test Average	3,370	1890 (13.0) min
7 Days: 3/10/22	Test Average	4,980	2900 (20.0) min
28 Days: 3/22/22	Test Average	6,320	3620 (25.0) min
ASTM C191 - Time of setting (Vicat test), min	Initial set	136	45 min -420 max
	Final set	270	----
ASTM C187 - Normal Consistency (%)		32.3	----
ASTM C188 – Density (g/cm ³)		2.98	----
ASTM C151 - Autoclave Expansion (%)		0.00	0.80 max
ASTM C185 - Air content of mortar (%)		7	12 % max
ASTM C204 - Fineness (Air permeability test) m ² /kg		592	----
ASTM C430 - Fineness (Wash #325 Sieve) %		5.60	----
ASTM C1702 – Heat of hydrations (kJ/kg)			
3 Days		236	----
7 Days		283	----
ASTM C1012 – Sulfate expansion (%) 6 months		0.03	----

*Indicates items not meeting ASTM C595-21

** No adjustment has been made for possible use of limestone or inorganic processing additions.

September 7, 2022

Mr. Craig W. Hargis
Forterra
251 E. Hacienda Ave, Suite B.
Campbell, CA 95008

Phone: (669) 267-6407
Email: chargis@forterausa.com

Subject: **Report of Result for ASTM C 1012 Testing**
Client ID: Type II/V – IT(L15)(P15)
TEC Lab ID: 22-291-8

Dear Mr. Hargis:

SGS TEC Services is an AASHTO R18, ANS/ISO/IEC 17025:2017, and Army Corps of Engineers accredited laboratory. SGS TEC Services is pleased to present this report on the testing performed on the submitted sample identified as “Type II/V – IT(L15)(P15)”.

The cement was tested in accordance with the following test method:

- ASTM C1012-18b *Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.*

ASTM C1012 Sulfate Expansion Testing

The specimens were prepared in accordance with the procedures described in ASTM C1012. Six mortar bars were prepared for the test mix. A control mixture is not mandatory since performance measured is based on maximum expansion of the test mixture. Mix proportions are reported in Table 1.

The specimens were cured according to C1012 until the strength of the cubes reached a minimum of 2,850 psi. The specimens were then stored in sulfate solution at 73°F (± 3.5°F) for nine months. Results of the testing are reported in Table 2.

Table 1 – C1012 Mix Proportions

	Test Mix
Type II/V – IT(L15)(P15) Cement, g	740
Standard Graded Sand, g	2,035
Water, ml	359
Flow %	119
24 hr break (psi)	2,640
40 hr break (psi)	2,940

Table 2 – Sulfate Expansion Test Results

Sample ID	1	2	3	4	5	6	Average	Standard Deviation	Coefficient Variance
Age	Length Change (%)								
Initial	---	---	---	---	---		---	---	---
1 Week	0.005	0.003	0.005	0.003	0.003	0.004	0.00	0.001	25.648
2 Weeks	0.006	0.004	0.006	0.004	0.005	0.005	0.01	0.001	17.889
3 Weeks	0.007	0.006	0.007	0.007	0.007	0.007	0.01	0.000	5.974
4 Weeks	0.007	0.010	0.008	0.008	0.010	0.007	0.01	0.001	16.395
8 Weeks	0.011	0.013	0.012	0.012	0.014	0.011	0.01	0.001	9.609
13 Weeks	0.016	0.015	0.016	0.019	0.018	0.017	0.02	0.001	8.744
15 Weeks	0.019	0.018	0.019	0.018	0.018	0.020	0.02	0.001	4.374
4 Months	0.021	0.019	0.023	0.023	0.022	0.023	0.02	0.002	7.338
6 Months	0.026	0.023	0.026	0.027	0.028	0.028	0.03	0.002	7.071

We appreciate the opportunity to provide our services to you on this project. Should you have any questions or comments regarding this report, please feel free to contact us.

Sincerely,
SGS TEC SERVICES



Dean T. Roosa
 Project Manager



Shawn P. McCormick
 Laboratory Principal