



December 7, 2020

Mrs. Katheryn L. Malusky
AASHTO
444 N. Capitol St. N.W., Suite 249
Washington D.C. 20001

Phone: (202) 624-5815
Email: Kmalusky@ashto.org

Subject: **Final Report Fritz-Pak Air Plus, Air-Entraining Admixture – Compliance Verification AASHTO M154-12 Specification for Chemical Admixtures for Concrete and ASTM C260-10 Specification for Air-Entraining Admixtures for Concrete**
TEC Services Laboratory No: 20-500
CADD-2020-01-003

Dear Mrs. Malusky:

SGS TEC Services, Inc. (TEC Services) is an AASHTO R18, ANS/ISO/IEC 17025:2005 and Army Corps of Engineers accredited laboratory. TEC Services is pleased to present this report of our compliance verification testing of Fritz-Pak Air Plus, an ASTM C260-10a *Standard Specification for Air-Entraining Admixtures for Concrete* admixture. Our services were performed in accordance with our service agreement date August 30, 2013.

Sample preparation and testing was performed in accordance with applicable sections of AASHTO M154-12 and ASTM C260, *Standard Specification for Air Entraining Admixtures for Concrete*, and documents referenced therein. Material and procedures outlined in AASHTO M154 were used. Based on our results, Fritz-Pak Air Plus complies with the requirements in AASHTO M154 and Table 1 of ASTM C260. These test results pertain only to the samples tested.

The compliance verification was performed by TEC Services in Lawrenceville, Georgia. Concrete batching was performed on three different days in May and June of 2020. One control mixture and one test mixture containing Fritz-Pak Air Plus, both meeting the requirements of AASHTO M154 and ASTM C260 for fresh concrete properties, were produced each day. One 1-gallon sample of Fritz-Pak Air Plus was supplied to TEC Services by Fritz-Pak Corporation.

Testing of the concrete's plastic properties, time of setting, bleed, compressive strengths, flexural strengths, length change, and freeze thaw resistance were performed by TEC Services. Mixture proportions and results of our testing are given in Tables 1 to 3. Information and test data on fine and coarse aggregates are listed in Tables 4 to 6. Table 7 contains information on Fritz-Pak Air Plus. Product information and test data on the Type I cement is included in Table 8. Test results for each of the six batches prepared for this report are included in Tables 9 thru 12.



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



Table 1: Fritz-Pak Air Plus performance and ASTM C260 requirements for an air entraining admixture

Test Results	Fritz-Pak Air Plus	Specification Requirements
Time of setting, deviation of control		
Initial (hr:min)	-0:03	-1:15 to +1:15
Final (hr:min)	-0:23	-1:15 to +1:15
Compressive strength (percent of control)		
3 days	91	90 (min)
7 days	92	90 (min)
28 days	94	90 (min)
56 days	102	90 (min)
Flexural strength (percent of control)		
3 days	100	90 (min)
7 days	94	90 (min)
28 days	92	90 (min)
56 days	101	90 (min)
Length change (increase over control)	0.000	0.006 (max)
Relative durability factor	101	80 (min)
Bleeding of the net amount of mixing water (%) (percent over control)	-0.01	+2% (max over control)

Table 2: Mixture proportions, fresh concrete properties, and ASTM C260 requirements for air entraining admixture

Average of Three Separate Tests	Control Mixture	Fritz-Pak Air Plus	Specification Requirements
Cement factor (lb/yd ³)	515	516	517 ± 5
Water (lb/yd ³)	279	274	
Water-cement ratio	0.540	0.532	
Coarse aggregate	1845	1846	
Fine aggregate	1171	1183	
Fine aggregate-total aggregate ratio	0.39	0.39	
Fritz-Pak Air Plus (% of cement)	0.00	0.037	
Vinsol Resin (oz/cwt)	0.75	0.00	
Slump (in.)	4.00	3.75	3 ½ ± ½
Air content (%)	5.8	5.7	5-7 (± 0.5 of control)
Density (lb/ft ³)	141.1	141.4	
Time of setting			
Initial (hr:min)	5:20	5:17	
dev. of control (hr:min)		-0:03	-1:15 to +1:15
Final (hr:min)	7:05	6:42	
dev. of control (hr:min)		-0:23	-1:15 to +1:15

Table 3: Properties of hardened concrete

	Control Mixture	Fritz-Pak Air Plus
Compressive strength (psi)		
3 days	2910	2640
7 days	3340	3070
28 days	4060	3810
56 days	3990	4070
Flexural strength (psi)		
3 days	560	560
7 days	615	580
28 days	670	615
56 days	670	675
Length change (%)	-0.016	-0.016
Durability factor (%)	90	91

Table 4: Properties of fine and coarse aggregates

	Fine aggregate	Coarse aggregate
Manufacturer	Lambert Materials, Shorter	Vulcan, Grayson
Aggregate type	Natural sand	Crushed Granite
Specific gravity _{SSD}	2.64	2.62
Absorption (%)	0.58	0.60

Table 5: Gradation of fine aggregate and ASTM C260 requirements

Percent passing		
Sieve	Fine aggregate	Specifications Requirements
No. 4 (4.75 mm)	100	100
No. 16 (2.36 mm)	73	65 to 75
No. 50 (300 μm)	17	12 to 20
No. 100 (150 μm)	4	2 to 5

Table 6: Gradation of coarse aggregate and ASTM C260 requirements

Percent passing		
Sieve	Coarse aggregate	Specifications Requirements
1.5 in. (37.5 mm)	100	100
1.0 in. (25.4 mm)	97	95 to 100
0.5 in. (12.5 mm)	31	25 to 60
No. 4 (4.75 mm)	6	0 to 10
No. 8 (2.36 mm)	4	0 to 5

Table 7: Admixture information

Information	Air Entraining Admixture
Brand Name	Fritz-Pak Air Plus
Manufacturer	Fritz-Pak Corporation
Lot Size	2000 lbs
Solids content (%)	98.940
pH	10.02
Chloride Content (% per BS EN 480-10:2009)	0.013

Table 8: Cement information and test data

ASTM C 150 Type I/II cement			
Brand name		Portland Type I/II	
Manufacturer		Coosa Cement	
Chemical Analyses by Mass (%)			
Silicon dioxide (SiO ₂)	20.6	Sulfur trioxide (SO ₃)	2.8
Aluminum oxide (Al ₂ O ₃)	4.7	Loss on ignition (950°C)	2.8
Iron oxide (Fe ₂ O ₃)	3.11	Insoluble residue	n/a
Calcium oxide (CaO)	62.0	Alkalies as Na ₂ O	0.59
Magnesium oxide (MgO)	2.75		
Calculated Potential Compounds as per ASTM C 150-05 (%)			
Tricalcium silicate (C ₃ S)	52	Tricalcium aluminate (C ₃ A)	7
Dicalcium silicate (C ₂ S)	20	Tetracalcium aluminoferrite (C ₄ AF)	9
Physical Testing and Results			
Fineness Specific Surface (Blaine)	436 m ² /Kg	Air Content (%)	7
Setting Times (Vicat) Initial	147 minutes	Autoclave Expansion (%)	0.00
Compressive 3 Day Strength (psi)	3410	Compressive 7 Day Strength (psi)	4080
C1038 Expansion @ 3.3% SO ₃ (%)	0.014	False Set (%)	53

Table 9: Yield adjusted mixture proportions, fresh concrete properties, time of set, and bleeding % for three control batches

	Control 1	Control 2	Control 3	Average
Cement factor (lb/yd ³)	516	514	516	515
Water (lb/yd ³)	279	278	279	279
Water-cement ratio	0.54	0.54	0.54	0.54
Coarse aggregate (lb/yd ³)	1847	1840	1847	1845
Fine aggregate (lb/yd ³)	1173	1168	1173	1171
Fine aggregate-total aggregate ratio	0.39	0.39	0.39	0.39
Fritz-Pak Air Plus (% of cement)	0.00	0.00	0.00	0.00
Vinsol Resin (oz/cwt)	0.75	0.75	0.75	0.75
Slump (in.)	4.00	3.75	4.00	4.00
Air content (%)	5.6	6.1	5.6	5.8
Density (lb/ft ³)	141.3	140.7	141.3	141.1
Time of setting				
Initial (hr:min)	5:23	5:21	5:17	5:20
Final (hr:min)	7:09	7:00	7:05	7:05
Bleed Water (%)	1.61	1.64	1.54	1.60

Table 10: Yield adjusted mixture proportions, fresh concrete properties, time of set, and bleeding % for three test batches containing Fritz-Pak Air Plus

	Test 1	Test 2	Test 3	Average
Cement factor (lb/yd ³)	516	516	515	516
Water (lb/yd ³)	275	274	274	274
Water-cement ratio	0.53	0.53	0.53	0.53
Coarse aggregate (lb/yd ³)	1847	1846	1844	1846
Fine aggregate (lb/yd ³)	1182	1184	1183	1183
Fine aggregate-total aggregate ratio	0.39	0.39	0.39	0.39
Fritz-Pak Air Plus (% of cement)	0.037	0.037	0.037	0.037
Vinsol Resin (oz/cwt)	0.00	0.00	0.00	0.00
Slump (in.)	3.75	4.00	3.50	3.75
Air content (%)	5.6	5.7	5.9	5.7
Density (lb/ft ³)	141.5	141.5	141.3	141.4
Time of setting				
Initial (hr:min)	5:16	5:19	5:15	5:17
Final (hr:min)	6:45	6:51	6:31	6:42
Bleed Water (%)	1.44	1.76	1.56	1.59

Table 11: Properties of hardened concrete from three control batches

	Control 1	Control 2	Control 3	Average			
Compressive strength (psi)							
3 days	2870	2970	2900	2910			
7 days	3550	3240	3230	3340			
28 days	4220	3960	4010	4060			
56 days	3520	4420	4020	3990			
Flexural strength (psi)							
3 days	550	570	555	560			
7 days	635	610	600	615			
28 days	660	670	675	670			
56 days	685	660	665	670			
Length change (%)	-0.011	-0.017	-0.019	-0.016			
Durability Factor (%)	89	90	90	90			
Approximate Total Cycles Completed	Fundamental Transverse Frequency, kHz			Relative Dynamic Modulus, (%) Average of 2 Beams per Mix			Average
	Control 1	Control 2	Control 3	Control 1	Control 2	Control 3	
0 cycles	1.992	1.953	1.855	NA	NA	NA	NA
32 cycles	1.875	1.855	1.755	89	90	90	90
66 cycles	1.875	1.855	1.755	89	90	90	90
96 cycles	1.875	1.855	1.755	89	90	90	90
128 cycles	1.875	1.855	1.755	89	90	90	90
162 cycles	1.875	1.855	1.755	89	90	90	90
192 cycles	1.875	1.855	1.755	89	90	90	90
220 cycles	1.875	1.855	1.755	89	90	90	90
253 cycles	1.875	1.855	1.755	89	90	90	90
287 cycles	1.875	1.855	1.755	89	90	90	90
300 cycles	1.875	1.855	1.755	89	90	90	90

Table 12: Properties of hardened concrete from three batches containing Fritz-Pak Air Plus

	Test 1	Test 2	Test 3	Average			
Compressive strength (psi)							
3 days	2450	2810	2670	2640			
7 days	3110	3170	2930	3070			
28 days	3780	3880	3760	3810			
56 days	4030	4020	4170	4070			
Flexural strength (psi)							
3 days	545	565	570	560			
7 days	595	575	575	580			
28 days	625	630	590	615			
56 days	655	710	660	675			
Length change (%)	-0.012	-0.017	-0.018	-0.016			
Durability Factor (%)	87	87	99	91			
Approximate Total Cycles Completed	Fundamental Transverse Frequency, kHz			Relative Dynamic Modulus, (%) Average of 2 Beams per Mix			Average
	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3	
0 cycles	1.983	1.963	1.856	NA	NA	NA	NA
32 cycles	1.846	1.836	1.856	87	87	100	91
66 cycles	1.846	1.836	1.856	87	87	100	91
96 cycles	1.846	1.836	1.856	87	87	100	91
128 cycles	1.846	1.836	1.856	87	87	100	91
162 cycles	1.846	1.836	1.856	87	87	100	91
192 cycles	1.846	1.836	1.846	87	87	99	91
220 cycles	1.846	1.836	1.846	87	87	99	91
253 cycles	1.846	1.836	1.846	87	87	99	91
287 cycles	1.846	1.836	1.846	87	87	99	91
300 cycles	1.846	1.836	1.846	87	87	99	91

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 at your convenience.

Sincerely,

Testing, Engineering, & Consulting Services, Inc.

Kimberly Pleasant
 Administrator

Shawn P. McCormick
 Laboratory Principal