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September 6, 2016

Ms. Katheryn Malusky
NTPEP
444 N Capitol Street NW
Suite 249
Washington DC, 20001

CADD-2015-01-058

Final Compliance Report: Fritz-Pak Corporation, Delayed Set, Standard & Mini, Type D

ASTM C494/C494M – 13, “Standard Specification for Chemical Admixtures for Concrete”
AASHTO M194/M194 – 12, “Standard Specification for Chemical Admixtures for Concrete”
AET Project No. 29-01922

Dear Ms. Malusky:

American Engineering Testing, Inc. (AET) is pleased to present this report of our compliance verification testing of Fritz-Pak Delayed Set, Standard & Mini. The attached report presents the final test results of the referenced admixture. Three 2-lb. bags of the admixture were received on August 20, 2015 and the NTPEP notification to proceed was received on August 7, 2015.

All sample preparation and testing was performed in accordance with the applicable sections of AASHTO M194M/M194M, ASTM C494/C494M – 13, “Standard Specification for Chemical Admixtures for Concrete” and all referenced documents. Based on our results through one year, Fritz-Pak Delayed Set, Standard & Mini complies with the requirements in AASHTO M194/M194 and Table 1 of ASTM C494 for a Type D, water reducing and retarding admixture.

Concrete batching and test specimen fabrication was conducted on three consecutive days. One control mixture and one test mixture containing Fritz-Pak Delayed Set, Standard & Mini, both meeting the requirements of AASHTO M194 and ASTM C494 for fresh concrete properties, were produced each day. A quart sample of commercially available vinsol resin based air-entraining agent was used for this testing. Holcim Type I/II portland cement from the St. Genevieve plant was used for all concrete mixtures.

Product information and cement chemical and physical properties are presented in Table 1 and 2. Aggregate properties and gradations are presented in Tables 3 and 4. Mixture proportions and results of testing are given in Tables 5 and 6.

If there are any questions with regard to this report, please contact me.

Sincerely,
American Engineering Testing, Inc.

A handwritten signature in black ink that reads 'Willy Morrison'.

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Table 1 Admixture Information

	Reference Admixture	Test Admixture
Manufacturer	Commercial Source	Fritz-Pak Corporation
Brand Name	Vinsol Resin	Delayed Set, Standard & Mini
NTPEP CADD Number	--	CADD-2015-01-058
Lot Number	E093014	01150617
Quantity Supplied	One Quart	Three 2-lb. Bags
Total Solids, %	15.01	93.98
Specific Gravity	1.044	Not Required for Powder Admixtures
pH	10.7	4.4
Chloride, %	0.009	0.013

Table 2 Portland Cement Analysis – Chemical and Physical

ASTM C150 Type I/II Cement			
Brand Name	St. Genevieve		
Manufacturer	Holcim (US) Inc.		
<i>Chemical Analysis, %</i>			
Silicon dioxide (SiO ₂)	19.8	Tricalcium silicate (C ₃ S) (%)	61
Aluminum oxide (Al ₂ O ₃)	4.5	Dicalcium silicate (C ₂ S) (%)	8
Iron oxide (Fe ₂ O ₃)	3.2	Tricalcium aluminate (C ₃ A) (%)	6
Magnesium oxide (MgO)	2.7	Tetracalcium aluminoferrite (C ₄ AF) (%)	9
Sulfur trioxide (SO ₃)	3.4	C ₃ S + 4.75C ₃ A (%)	90.7
Calcium oxide (CaO)	64.2		
Insoluble Residue (%)	0.47	Loss on Ignition (%)	2.6
Alkalies as Na ₂ O (%)	0.54		
<i>Physical Analysis</i>			
Fineness, Blaine (m ² /kg)	379	Air Content (%)	7
Vicat Time of Set (Initial), minutes	90	Autoclave Expansion (%)	0.04
Compressive Strength			
3 Day (psi)	4330	7 Day (psi)	5360
Mortar Bar Expansion (%) (C 1038)	0.013		

Table 3 - Properties of Fine and Coarse Aggregates

	Fine Aggregate	Coarse Aggregate
Manufacturer	Aggregate Industries	Aggregate Industries
Aggregate type, ID	Natural Sand, Elk River	River Gravel, Lakeville #57
Specific gravity, SSD	2.675	2.740
Absorption %	0.6	1.1

Table 4 – Gradations of Fine and Coarse Aggregates

ASTM C136, Gradation of fine aggregate

	Percent passing	
	Fine Aggregate	ASTM C494/AASHTO M194 Requirements
No. 4 [4.75 mm]	100	100
No. 16 [1.18 mm]	72	65 to 75
No. 50 [300 µm]	13	12 to 20
No. 100 [150 µm]	2	2 to 5

ASTM C136, Gradation of coarse aggregate

	Percent passing	
	Coarse Aggregate	ASTM C494 Requirements
1.5 in. [37.5 mm]	100	100
1.0 in. [25.0 mm]	100	95 to 100
0.5 in. [12.5 mm]	58	25 to 60
No. 4 [4.75 mm]	9	0 to 10
No. 8 [2.36 mm]	1	0 to 5

TABLE 5 Laboratory Data	Concrete Mixtures and Testing Results									Delayed Set, Standard & Mini added at a rate of 1.7 oz/cwt
	Delayed Set, Standard & Mini					Delayed Set, Standard & Mini				
	Batch No. Cast Date	Vinsol Resin			AVER.	Test #1	Test #2	Test #3	AVER.	
	Control #1	Control #2	Control #3	(Test Value)	8/31/2015	9/1/2015	9/2/2015	(Test Value)		
Cement, pcy	517	519	519	518	514	514	513	514	517 ± 5	
Sand, pcy	1,300	1,303	1,303	1,302	1,305	1,305	1,301	1,304		
Gravel, pcy	1,789	1,794	1,794	1,792	1,803	1,803	1,798	1,801		
Water, pcy	282	283	283	283	266	266	266	266		
Water Content (Percent of Control)	---	---	---	---	94	94	94	94	95%	
AEAName	Vinsol Resin				Vinsol Resin					
AEA Dosage, oz/cwt	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4		
Admixture Name	Delayed Set, Standard & Mini									
Admixture Dosage, oz/cwt	---	---	---	---	1.7	1.7	1.7	1.7		
WATER CEMENT RATIO	0.55	0.55	0.55	0.55	0.52	0.52	0.52	0.52		
Slump, inches	4.00	4.00	4.00	4.00	4.00	4.00	3.50	3.75	3.5 ± 0.5	
Air Content, %	6.0	5.5	5.9	5.8	6.5	6.0	5.5	6.0	± 0.5	
Density, pcf	144.0	144.4	144.4	144.3	144.0	144.0	143.6	143.9		
SETTING TIME										
Initial, hr:mn	4:00	4:19	3:58	4:05	6:09	5:30	5:24	5:41		
Final, hr:mn	5:22	5:46	5:17	5:28	7:44	7:40	7:18	7:34		
TIME of SETTING (deviation from reference)										
Initial, hr:mn	---	---	---	---	2:09	1:11	1:26	1:36	At least 1:00 later but not more than 3:30 later	
Final, hr:mn	---	---	---	---	2:22	1:54	2:01	2:06	Not more than 3:30 later	
COMPRESSIVE STRENGTH										
3 Days, psi	2,550	2,250	2,180	2,330	2,820	3,570	4,830	3,740		
7 Days, psi	3,150	2,430	3,150	2,910	3,620	4,050	5,600	4,420		
28 Days, psi	4,160	3,100	3,650	3,640	4,970	4,910	6,220	5,370		
90 Days, psi	4,460	3,350	4,480	4,100	5,340	5,320	6,850	5,840		
6 Months, psi	4,660	3,650	4,900	4,400	5,600	5,450	7,320	6,120		
1 Year, psi	4,170	2,560	3,800	3,510	5,300	5,250	7,470	6,010		
3 Days, % reference	---	---	---	---	111	159	222	161	≥110%	
7 Days, % reference	---	---	---	---	115	167	178	152	≥110%	
28 Days, % reference	---	---	---	---	119	158	170	148	≥110% (≥120%)^B	
90 Days, % reference	---	---	---	---	120	159	153	142	(≥117%)^B	
6 Months, % reference	---	---	---	---	120	149	149	139	≥100% (≥113%)^B	
1 Year, % reference	---	---	---	---	127	205	197	171	≥100%	
FLEXURAL STRENGTH										
3 Days, psi	515	515	485	505	540	535	695	590		
7 Days, psi	615	490	505	535	620	555	650	610		
28 Days, psi	700	760	630	695	830	745	795	790		
3 Days, % reference	---	---	---	---	105	104	143	117	≥100%	
7 Days, % reference	---	---	---	---	101	113	129	114	≥100%	
28 Days, % reference	---	---	---	---	119	98	126	114	≥100%	
LENGTH CHANGE, %										
Increase over control	-0.022	-0.010	-0.017	-0.016	-0.015	-0.023	-0.018	-0.019		
	---	---	---	---	-0.007	0.013	0.001	0.003	≤0.010^A	
RESISTANCE TO FREEZING AND THAWING										
Relative Dynamic Modulus, %										
0	cycles	100/100	100/100	100/100	100	100/100	100/100	100/100	100	
36	cycles	97/97	97/99	96/97	97	99/98	100/98	98/99	99	
72	cycles	97/96	96/97	97/97	97	99/98	100/98	98/98	99	
108	cycles	97/96	96/97	97/96	97	99/99	99/98	98/95	98	
144	cycles	97/95	96/97	97/97	97	99/99	99/98	99/98	99	
180	cycles	97/95	96/99	99/97	97	100/99	99/96	99/98	99	
216	cycles	97/95	96/97	97/97	97	99/99	100/96	99/98	99	
252	cycles	96/94	96/97	97/96	96	99/99	99/95	98/98	98	
288	cycles	96/92	96/99	97/96	96	99/99	99/95	99/97	98	
324	cycles	96/91	96/97	97/95	95	98/99	100/95	98/97	98	
RELATIVE DURABILITY FACTOR									103	min 80

A. Increased shrinkage over control.

B. Alternative requirement. If any of the measured relative strengths are greater than the requirement in parentheses, the admixture shall be considered provisionally qualified until the 1-year strength test results are obtained.

TABLE 6
TESTS OF CHEMICAL ADMIXTURES FOR CONCRETE
DELAYED SET, STANDARD & MINI
ASTM SPECIFICATION C494 / AASHTO M194
TYPE D, WATER REDUCING AND RETARDING

MIXTURE DESIGNATION	<u>CONTROL</u>	<u>DELAYED SET STANDARD & MINI</u>	<u>CHANGE vs. CONTROL</u>	<u>SPECIFICATION REQUIREMENT</u>
MIXTURE PROPORTIONS				
CEMENT, pcy	518	514	-4	517 ± 5
SAND, pcy	1,302	1,304		
GRAVEL, pcy	1,792	1,801		
NET WATER, pcy	283	266	94%	95%
AEA (Vinsol Resin), oz/cwt	0.5	0.4		
ADMIXTURE DOSAGE, oz/cwt	---	1.7		
RATIO OF FINE TO TOTAL AGG., %	42	42		
WATER/CEMENT RATIO, lb./lb.	0.55	0.52		
SLUMP, inches	4.00	3.75	-0.25	3.5 ± 0.5
ENTRAINED AIR, %	5.8	6.0	0.2	± 0.5
UNIT WEIGHT, pcf	144.3	143.9		
SET TIME, hr:min				
INITIAL	4:05	5:41	1:36	At least 1:00 later but not more than 3:30 later
FINAL	5:28	7:34	2:06	Not more than 3:30 later
COMPRESSIVE STRENGTH, psi				
3 DAYS	2,330	3,740	161%	≥110%
7 DAYS	2,910	4,420	152%	≥110%
28 DAYS	3,640	5,370	148%	≥110% (≥120%)^B
90 DAYS	4,100	5,840	142%	(≥117%)^B
180 DAYS	4,400	6,120	139%	≥100% (≥113%)^B
365 DAYS	3,510	6,010	171%	≥100%
FLEXURAL STRENGTH, psi				
3 DAYS	505	590	117%	≥100%
7 DAYS	535	610	114%	≥100%
28 DAYS	695	790	114%	≥100%
LENGTH CHANGE				
Increase over control	-0.016	-0.019	0.003	≤0.010^A
RELATIVE DURABILITY FACTOR, %			103	≥80%

A. Increased shrinkage over control.

B. Alternative requirement. If any of the measured relative strengths are greater than the requirement in parentheses, the admixture shall be considered provisionally qualified until the 1-year strength test results are obtained.