TEC Services
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Subject: **Final Report: PLASTIMENT ES, Type B & D– Compliance Verification**
AASHTO M 194-06 ***Standard Specification for Chemical Admixtures for Concrete***
TEC Services Project No.: TEC 07-0629
TEC Services Laboratory No.: 09-160

Dear Mr. Mašek:

Testing, Engineering and Consulting Services, Inc. (TEC Services) is pleased to present this report of our compliance verification testing of PLASTIMENT ES, an ASTM C 494-08a Type B & D *(Water Reducing and Retarding)* admixture. All sample preparation and testing was performed in accordance with applicable sections of AASHTO M 194-06, ASTM C 494 and documents referenced therein. Material and procedures outlined in AASHTO M 194 were used. Based on our results, PLASTIMENT ES complies with the requirements in AASHTO M 194 and Table 1 of ASTM C 494. These test results pertain only to the sample tested.

The compliance verification was performed in TEC Service's laboratory in Lawrenceville, Georgia. Concrete batching was carried out on three different days in April, 2009. One control mixture and one test mixture containing PLASTIMENT ES, both meeting the requirements of AASHTO M 194 and ASTM C 494 for fresh concrete properties, were produced each day. A 1-gallon sample of PLASTIMENT ES was manufactured and supplied to TEC Service by Sika Corporation (Sika). The air-entraining agent used in this testing was a commercially available vinsol resin admixture, meeting the requirements of AASHTO M 154-05.

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 supplied by the producers of the PLASTIMENT ES. 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 through 12.

Table 1. Admixture performance and AASHTO M 194 requirements for a Type B & D admixture

	Plastiment ES	**Type B Admixture Requirements**	**Type D Admixture Requirements**
Water content (percent of control)	94	NA	95 (max)
Time of setting, deviation of control			
Initial (hr:min)	2:48	+1:00 to +3:30	+1:00 to +3:30
Final (hr:min)	2:37	+3:30 (Max)	+3:30 (Max)
Compressive strength (percent of control)			
3 days	124	90 (min)	110 (min)
7 days	122	90 (min)	110 (min)
28 days	121	90 (min)	110, 120* (min)
56 days	112	90* (min)	120* (min)
90 days	112	NA (min)	117* (min)
6 months	113	90 (min)	100, 113* (min)
1 year	116	90 (min)	100 (min)
Flexural strength (percent of control)			
3 days	110	90 (min)	100 (min)
7 days	114	90 (min)	100 (min)
28 days	107	90 (min)	100 (min)
56 days	102	90* (min)	100* (min)
Length change (increase over control)	-0.011	0.010 (max)	0.010 (max)
Relative durability factor	99	80 (min)	80 (min)

Table 2. Mixture proportions, fresh concrete properties, and AASHTO M 194 requirements for a Type B & D admixture

Average of Three Separate Tests	**Control Mixture**	**Plastiment ES**	**Specification Requirements**
Cement factor (lb/yd^3)	516	515	517 ± 5
Water (lb/yd^3)	282	266	
Water-cement ratio	0.546	0.515	
Coarse aggregate	1845	1845	
Fine aggregate	1143	1185	
Fine aggregate-total aggregate ratio	0.38	0.39	
Plastiment ES (oz/cwt)	0.00	2.85	
Vinsol Resin (oz/cwt)	0.62	0.72	
Slump (in.)	3.75	3.25	3 ½ ± ½
Air content (%)	6.1	6.2	5 - 7 (± 0.5 of control)
Density (lb/ft^3)	140.2	141.1	
Time of setting			
Initial (hr:min)	7:00	9:48	
dev. of control (hr:min)		2:48	+1:00 to +3:30
Final (hr:min)	9:03	11:41	
dev. of control (hr:min)		2:37	+3:30

Table 3. Properties of hardened concrete

	Control Mixture	**Plastiment ES**
Compressive strength (psi)		
3 days	2760	3420
7 days	3520	4300
28 days	4480	5420
56 days	5090	5700
90 days	5180	5810
6 months	5360	6060
1 year	5360	6210
Flexural strength (psi)		
3 days	455	500
7 days	500	570
28 days	610	650
56 days	645	655
Length change (%)	-0.018	-0.007
Durability factor (%)	86	86

Table 4 Properties of fine and coarse aggregates

	Fine aggregate	**Coarse aggregate**
Manufacturer	Martin Marietta, Shorter	Vulcan, Lithonia
Aggregate type	Natural sand	Crushed Granite
Specific gravity$_{SSD}$	2.63	2.61
Absorption (%)	0.56	0.76

Table 5 Gradation of fine aggregate and AASHTO T 157 requirements

Percent passing		
Sieve	**Fine aggregate**	**Specifications Requirements**
No. 4 (4.75 mm)	**100**	100
No. 16 (2.36 mm)	**72**	65 to 75
No. 50 (300 µm)	**17**	12 to 20
No. 100 (150 µm)	**3**	2 to 5

Table 6 Gradation of coarse aggregate and AASHTO T 157 requirements

Percent passing		
Sieve	**Coarse aggregate**	**Specifications Requirements**
1.5 in. (37.5 mm)	**100**	100
1.0 in. (25.4 mm)	**96**	95 to 100
0.5 in. (12.5 mm)	**41**	25 to 60
No. 4 (4.75 mm)	**2**	0 to 10
No. 8 (2.36 mm)	**1**	0 to 5

Table 7. Admixture information as supplied by the manufacturers

	Type B & D, Water Reducing and Retarding Admixture
Brand name	PLASTIMENT ES
Manufacturer	Sika Corporation
Lot ID	SikaPlastimentES-040909
Lot Size	1,000 gallons
Solids Content %	37.0
Specific Gravity	1.18

Table 8. Cement information and test data

ASTM C 150 Type I cement			
Brand name		Cemex Portland Type I	
Manufacturer		Cemex Cement Company	
Chemical analyses by mass (%)			
Silicon dioxide (SiO_2)	19.9	Titanium dioxide (TiO_2)	0.36
Aluminum oxide (Al_2O_3)	5.3	Phosphorus pentoxide (P_2O_5)	0.10
Iron oxide (Fe_2O_3)	3.7	Manganic oxide (Mn_2O_3)	0.07
Calcium oxide (CaO)	63.9	Strontium oxide (SrO)	0.08
Magnesium oxide (MgO)	1.04	Barium oxide (BaO)	0.00
Sodium oxide (Na_2O)	0.04	Loss on ignition (950ºC)	1.59
Potassium oxide (K_2O)	0.39	Insoluble residue	0.30
Sulfur trioxide (SO_3)	3.56	Alkalies as Na_2O	0.30
Calculated potential compounds as per ASTM C 150-05 (%)			
Tricalcium silicate (C_3S)	58	Tricalcium aluminate (C_3A)	8
Dicalcium silicate (C_2S)	13	Tetracalcium aluminoferrite (C_4AF)	11
Physical Testing and Results			
Fineness Specific Surface (Blaine)	372 m^2/Kg	Air Content (%)	8.89
Setting Times (Vicat) Initial	113 minutes	Autoclave Expansion (%)	0.01
Setting Times (Vicat) Final	187 minutes		
Compressive 3 Day Strength (psi)	3770	Compressive 7 Day Strength (psi)	4700
% Expansion @ 4.34 SO_3 (C1038)	0.011		

Table 9. Mixture proportions, fresh concrete properties, and time of set for three control batches

	Control 1	**Control 2**	**Control 3**	**Average**
Cement factor (lb/yd^3)	517	515	515	516
Water (lb/yd^3)	282	282	282	282
Water-cement ratio	0.545	0.547	0.547	0.546
Coarse aggregate (lb/yd^3)	1849	1843	1844	1845
Fine aggregate (lb/yd^3)	1146	1141	1141	1143
Fine aggregate-total aggregate ratio	0.38	0.38	0.38	0.38
Plastiment ES (oz/cwt)	0.00	0.00	0.00	0.00
Vinsol Resin (oz/cwt)	0.62	0.61	0.62	0.62
Slump (in.)	3.50	4.00	3.50	3.75
Air content (%)	6.0	6.2	6.0	6.1
Density (lb/ft^3)	140.5	140.0	140.1	140.2
Time of setting				
Initial (hr:min)	7:14	6:53	6:55	7:00
Final (hr:min)	9:12	9:09	8:50	9:03

Table 10. Properties of hardened concrete from three control test batches

	Control 1	**Control 2**	**Control 3**	**Average**
Compressive strength (psi)				
3 days	3470	1980	2830	2760
7 days	4120	3110	3320	3520
28 days	5150	3690	4610	4480
56 days	5680	4460	5130	5090
90 days	5800	4320	5430	5180
6 months	6070	4620	5390	5360
1 year	5850	4670	5550	5360
Flexural strength (psi)				
3 days	515	425	425	455
7 days	535	490	475	500
28 days	610	560	650	610
56 days	650	635	650	645
Length change (%)	-0.025	-0.008	-0.02	-0.018
Durability Factor (%)	85	87	87	86

Approximate Total Cycles Completed	Fundamental Transverse Frequency, kHz			Relative Dynamic Modulus, percent			**Average**
	Control 1	Control 2	Control 3	Control 1	Control 2	Control 3	
0 cycles	2.07	2.012	1.992	NA	NA	NA	NA
36 cycles	1.953	1.914	1.914	89	90	92	91
69 cycles	1.934	1.914	1.895	87	90	90	89
105 cycles	1.934	1.895	1.895	87	89	90	89
135 cycles	1.934	1.895	1.895	87	89	90	89
165 cycles	1.934	1.895	1.875	87	89	89	88
206 cycles	1.914	1.895	1.875	85	89	89	88
251 cycles	1.914	1.895	1.855	85	89	87	87
300 cycles	1.914	1.875	1.855	85	87	87	86

Table 11. Mixture proportions, fresh concrete properties, and time of set for three test batches containing PLASTIMENT ES

	Test 1	**Test 2**	**Test 3**	**Average**
Cement factor (lb/yd^3)	515	517	514	515
Water (lb/yd^3)	265	266	265	266
Water-cement ratio	0.515	0.515	0.515	0.515
Coarse aggregate (lb/yd^3)	1844	1850	1839	1845
Fine aggregate (lb/yd^3)	1184	1188	1181	1185
Fine aggregate-total aggregate ratio	0.39	0.39	0.39	0.39
Plastiment ES (oz/cwt)	2.9	2.9	2.9	2.9
Vinsol Resin (oz/cwt)	0.72	0.72	0.72	0.72
Slump (in.)	3.25	3.00	3.25	3.25
Air content (%)	6.3	6.0	6.4	6.2
Density (lb/ft^3)	141.1	141.5	140.7	141.1
Time of setting				
Initial (hr:min)	9:43	9:45	9:58	9:48
Final (hr:min)	11:33	11:52	11:38	11:41

Table 12. Properties of hardened concrete from three batches containing PLASTIMENT ES

	Test 1	**Test 2**	**Test 3**	**Average**
Compressive strength (psi)				
3 days	3960	3010	3280	3420
7 days	4590	4480	3820	4300
28 days	5940	5230	5090	5420
56 days	6070	5540	5490	5700
90 days	6210	5750	5480	5810
6 months	6510	5780	5900	6060
1 year	6680	5890	6050	6210
Flexural strength (psi)				
3 days	560	480	455	500
7 days	595	575	545	570
28 days	665	645	635	650
56 days	655	690	615	655
Length change (%)	-0.011	-0.012	0.001	-0.007
Durability Factor (%)	85	85	87	86

Approximate Total Cycles Completed	Fundamental Transverse Frequency, kHz			Relative Dynamic Modulus, percent			**Average**
	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3	
0 cycles	2.051	2.031	2.012	NA	NA	NA	NA
36 cycles	1.953	1.934	1.914	91	91	90	91
69 cycles	1.934	1.914	1.914	89	89	90	89
105 cycles	1.934	1.914	1.914	89	89	90	89
135 cycles	1.934	1.914	1.895	89	89	89	89
165 cycles	1.934	1.914	1.895	89	89	89	89
206 cycles	1.934	1.895	1.895	89	87	89	88
251 cycles	1.934	1.895	1.875	89	87	87	88
300 cycles	1.895	1.875	1.875	85	85	87	86

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.

Anne Miller
Chemical Engineer

Shawn P. McCormick
Laboratory Manager