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Mr. Paul Falco
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Subject: **Final Report Stable Air, Air-Entraining Admixture – Compliance Verification**
AASHTO M 154-06 Standard Specification for Chemical Admixtures for Concrete
TEC Services Project No: TEC 09-0774
TEC Services Laboratory No: 11-172

Dear Mr. Falco:

Testing, Engineering and Consulting Services, Inc. (TEC Services) is pleased to present this report of our compliance verification testing of Cellular Concrete Technologies' STABLE AIR, an ASTM C 260-06 (*Air-Entraining*) admixture. The sample preparation and testing was performed in accordance with applicable sections of AASHTO M 154-06, ASTM C 260 and documents referenced therein. Material and procedures outlined in AASHTO T 157-06 were used. Our test results indicate that STABLE AIR complies with the requirements in AASHTO M 154 and Table 1 of ASTM C 260. These test results pertain only to the sample tested.

The compliance verification was performed by TEC Services in Lawrenceville, Georgia. Concrete batching was performed on three different days in April, 2011. One control mixture and one test mixture containing STABLE AIR were produced each day. All six mixes met the requirements of AASHTO M 154 and ASTM C 260 for fresh concrete properties. A 1-gallon sample of STABLE AIR was supplied to TEC Services by Cellular Concrete Technologies. The control air-entraining agent used was a commercially available vinsol resin admixture, meeting the requirements of AASHTO M 154.

Mixture proportions and our test results 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 STABLE AIR. 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 to 12.

Table 1: Average admixture performance and specification requirements for an Air-Entraining admixture

	STABLE AIR	Specification Requirements
Time of setting, deviation of control		
Initial (hr:min)	-0:18	-1:15 to +1:15
Final (hr:min)	-0:23	-1:15 to +1:15
Compressive strength (percent of control)		
3 days	129	90 (min)
7 days	115	90 (min)
28 days	104	90 (min)
56 days	105	90 (min)
Flexural strength (percent of control)		
3 days	101	90 (min)
7 days	113	90 (min)
28 days	104	90 (min)
56 days	108	90 (min)
Length change (increase over control)	-0.005	0.006 (max)
Relative durability factor	99	80 (min)
Bleeding of the net amount of mixing water (%) (percent over control)	0.32	+2% (max of control)

Table 2: Average mixture proportions, fresh concrete properties, and specification requirements for an Air-Entraining admixture

Average of Three Separate Tests	Control Mixture	STABLE AIR	Specification Requirements
Cement factor (lb/yd ³)	517	519	517 ± 5
Water (lb/yd ³)	281	274	
Water-cement ratio	0.543	0.528	
Coarse aggregate	1851	1858	
Fine aggregate	1173	1197	
Fine aggregate-total aggregate ratio	0.39	0.39	
STABLE AIR (oz/cwt)	0.00	8.87	
Vinsol Resin (oz/cwt)	0.59	0.00	
Slump (in.)	4.00	3.25	3 ½ ± ½
Air content (%)	5.4	5.2	± 0.5 of control
Density (lb/ft ³)	141.6	142.5	
Time of setting			
Initial (hr:min)	5:23	5:05	
dev. of control (hr:min)		-0:18	-1:15 to +1:15
Final (hr:min)	7:08	6:45	
dev. of control (hr:min)		-0:23	-1:15 to +1:15
Bleeding of the net amount of mixing water (%)	3.47	3.79	+2% (max of control)

Table 3: Properties of hardened concrete

	Control Mixture	STABLE AIR
Compressive strength (psi)		
3 days	1850	2380
7 days	2830	3250
28 days	4590	4770
56 days	5010	5250
Flexural strength (psi)		
3 days	455	460
7 days	485	550
28 days	590	615
56 days	610	660
Length change (%)	-0.022	-0.017
Durability factor (%)	85	84

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}	2.61	2.61
Absorption (%)	0.45	0.60

Table 5: Gradation of fine aggregate and ASTM C 494 requirements

Percent passing		
Sieve	Fine aggregate	Specifications Requirements
No. 4 (4.75 mm)	100	100
No. 16 (2.36 mm)	75	65 to 75
No. 50 (300 μm)	15	12 to 20
No. 100 (150 μm)	2	2 to 5

Table 6: Gradation of coarse aggregate and ASTM C 494 requirements

Percent passing		
Sieve	Coarse aggregate	Specifications Requirements
1.5 in. (37.5 mm)	100	100
1.0 in. (25.4 mm)	99	95 to 100
0.5 in. (12.5 mm)	38	25 to 60
No. 4 (4.75 mm)	3	0 to 10
No. 8 (2.36 mm)	1	0 to 5

Table 7: Admixture information as supplied by the manufacturer

	Air-entraining admixture
Brand name	STABLE AIR
Manufacturer	Cellular Concrete Technologies
Lot Number	041211StableAir
Lot Size	1 gallon
Specific Gravity	1.000
Solids content (%)	0.143
pH	7.16

Table 8: Cement information and test data

ASTM C 150 Type I cement			
Brand name		Cemex Portland Type I	
Manufacturer		Cemex Cement Company	
<i>Chemical analyses by mass (%)</i>			
Silicon dioxide (SiO ₂)	20.3	Titanium dioxide (TiO ₂)	0.34
Aluminum oxide (Al ₂ O ₃)	5.2	Phosphorus pentoxide (P ₂ O ₅)	0.06
Iron oxide (Fe ₂ O ₃)	4.0	Manganic oxide (Mn ₂ O ₃)	0.07
Calcium oxide (CaO)	64.4	Strontium oxide (SrO)	0.08
Magnesium oxide (MgO)	0.9	Barium oxide (BaO)	0.00
Sodium oxide (Na ₂ O)	0.32	Loss on ignition (950°C)	1.0
Potassium oxide (K ₂ O)	0.34	Insoluble residue	0.18
Sulfur trioxide (SO ₃)	2.9	Alkalies as Na ₂ O	0.28
<i>Calculated potential compounds as per ASTM C 150-05 (%)</i>			
Tricalcium silicate (C ₃ S)	59	Tricalcium aluminate (C ₃ A)	7
Dicalcium silicate (C ₂ S)	14	Tetracalcium aluminoferrite (C ₄ AF)	12
<i>Physical Testing and Results</i>			
Fineness Specific Surface (Blaine)	384 m ² /Kg	Air Content (%)	6.2
Setting Times (Vicat)	Initial	Autoclave Expansion (%)	-0.023
	Final		
	105 minutes		
	200 minutes		
Compressive 3 Day Strength (psi)	3490	Compressive 7 Day Strength (psi)	4710
% Expansion @ 3.55% SO ₃ (C1038)	0.005		

Table 9: Yield adjusted 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	518	517	517
Water (lb/yd ³)	281	281	281	281
Water-cement ratio	0.543	0.543	0.543	0.543
Coarse aggregate (lb/yd ³)	1850	1854	1849	1851
Fine aggregate (lb/yd ³)	1172	1175	1171	1173
Fine aggregate-total aggregate ratio	0.39	0.39	0.39	0.39
STABLE AIR (oz/cwt)	0.00	0.00	0.00	0.00
Vinsol Resin (oz/cwt)	0.58	0.58	0.61	0.59
Slump (in.)	4.00	4.00	4.00	4.00
Air content (%)	5.5	5.3	5.5	5.4
Density (lb/ft ³)	141.5	141.8	141.4	141.6
Time of setting				
Initial (hr:min)	5:31	5:21	5:17	5:23
Final (hr:min)	7:19	7:14	6:53	7:08
Bleed Water (%)	4.41	1.92	4.09	3.47

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

	Control 1	Control 2	Control 3	Average			
Compressive strength (psi)							
3 days	1750	1830	1960	1850			
7 days	2690	2780	3010	2830			
28 days	4030	4840	4900	4590			
56 days	4750	4920	5350	5010			
Flexural strength (psi)							
3 days	460	495	410	455			
7 days	490	510	460	485			
28 days	590	565	610	590			
56 days	615	595	615	610			
Length change (%)	-.028	-0.020	-0.018	-0.022			
Durability Factor (%)	87	85	83	85			
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	1.992	1.992	2.031	NA	NA	NA	NA
48 cycles	1.875	1.836	1.895	89	85	87	87
91 cycles	1.875	1.836	1.895	89	85	87	87
143 cycles	1.875	1.836	1.875	89	85	85	86
187 cycles	1.875	1.836	1.855	89	85	83	86
245 cycles	1.875	1.836	1.855	89	85	83	86
283 cycles	1.855	1.836	1.855	87	85	83	85
313 cycles	1.855	1.836	1.855	87	85	83	85

Table 11: Yield adjusted mixture proportions, fresh concrete properties, and time of set for three test batches containing STABLE AIR

	Test 1	Test 2	Test 3	Average
Cement factor (lb/yd ³)	517	521	520	519
Water (lb/yd ³)	273	275	274	274
Water-cement ratio	0.528	0.528	0.528	0.528
Coarse aggregate (lb/yd ³)	1850	1863	1860	1858
Fine aggregate (lb/yd ³)	1192	1200	1199	1197
Fine aggregate-total aggregate ratio	0.39	0.39	0.39	0.39
STABLE AIR (oz/cwt)	8.80	8.90	8.90	8.87
Vinsol Resin (oz/cwt)	0.00	0.00	0.00	0.00
Slump (in.)	3.00	3.50	3.50	3.25
Air content (%)	5.3	5.0	5.2	5.2
Density (lb/ft ³)	141.9	142.9	142.7	142.5
Time of setting				
Initial (hr:min)	5:18	4:58	5:00	5:05
Final (hr:min)	6:59	6:36	6:41	6:45
Bleed Water (%)	4.58	3.05	3.74	3.79

Table 12: Properties of hardened concrete from three batches containing STABLE AIR

	Test 1	Test 2	Test 3	Average			
Compressive strength (psi)							
3 days	2500	2440	2200	2380			
7 days	3370	3170	3200	3250			
28 days	4770	4980	4560	4770			
56 days	5600	4890	5250	5250			
Flexural strength (psi)							
3 days	430	475	470	460			
7 days	560	550	545	550			
28 days	610	590	645	615			
56 days	650	650	675	660			
Length change (%)	-0.021	-0.023	-0.008	-0.017			
Durability Factor (%)	82	85	85	84			
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	2.012	2.031	NA	NA	NA	NA
48 cycles	1.895	1.875	1.934	85	87	91	88
91 cycles	1.895	1.875	1.934	85	87	91	88
143 cycles	1.895	1.875	1.9114	85	87	89	87
187 cycles	1.895	1.875	1.914	85	87	89	87
245 cycles	1.875	1.875	1.895	84	87	87	86
283 cycles	1.855	1.855	1.895	82	85	87	85
313 cycles	1.855	1.855	1.875	82	85	85	84


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
Project Manager



Shawn P. McCormick
Laboratory Manager