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ASTM C 494 testing for MCI-2007 P by AET

Purpose: For all construction chemicals, there is certain minimal testing that must be completed before customers will be interested in buying the product. Physical properties testing for MCI-2007 P, Cortec's only Type F admixture, must be done by an independent lab for engineers to use in specifications. This testing is done for all admixtures before sales are made.

Materials: MCI-2007 P
(MCI-2008 L and MCI-2008 P will not be tested at this time)

Method: ASTM C494

Conclusion: MCI-2007 P meets the ASTM C 494 for type F water reducing high range admixtures after 6 months of testing for use as an admixture in concrete. There will be one more value given after 12 months (~1-15-08) and an updated report will be sent out at that time.

Project #: 06-172-1425

Attachments: AET Job no: 05-02912





CONSULTANTS
• ENVIRONMENTAL
• GEOTECHNICAL
• MATERIALS
• FORENSICS

March 19, 2007

Ms. Andrea Hansen
Cortec Corporation
4119 White Bear Parkway
St. Paul MN 55110

Subj: MCI-2007 Powder Corr
AET Job No. 05-02912

Dear Ms. Hansen:

The attached report presents the results of our testing of Cortec's MCI-2007 Powder Corr. Our work consisted of testing the product for conformance to ASTM:C494 and AASHTO M194 Type F requirements.

"The sample meets the requirements of ASTM:C494 and AASHTO M194 for a Type F Water Reducing, High Range Admixtures" for the tests completed.

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

Sincerely,
American Engineering Testing, Inc.

Daniel M. Vruno, P.E.
Senior Concrete Engineer
Phone: 651-659-1334
Fax: 651-647-2744
dvruno@amengtest.com

DMV/jw

enc.

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of Minnesota.

Daniel M. Vruno, P.E.

Date MARCH 19, 2007 Lic. No. 42037



AMERICAN
ENGINEERING
TESTING, INC.

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• ENVIRONMENTAL
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REPORT OF ADMIXTURE TESTING

PROJECT:

MCI-2007 POWDER CORR

REPORTED TO:

CORTEC CORPORATION
4119 WHITE BEAR PARKWAY
ST. PAUL MN 55110

ATTN: ANDREA HANSEN

AET JOB NO: 05-02912

DATE: MARCH 19, 2007

INTRODUCTION

This report presents the results of our testing of Cortec's MCI-2007 Powder Corr. Andrea Hansen requested we test the product for conformance to ASTM:C494 and AASHTO M194 Type F requirements. The scope of our work consisted of batching concrete and testing for plastic properties, compressive strength, flexural strength, set time, shrinkage, and freeze-thaw durability.

TESTING METHODS AND RESULTS

Between January 4 and January 25, 2007, concrete was batched in our laboratory. The following mix design was used:

Lehigh=s Type I Portland Cement, ASTM:C150	517 pcy
Aggregate Industries= Glacial Gravel, ASTM:C33	1803 pcy
Aggregate Industries= Glacial Sand, ASTM:C33	1372 pcy
MCI-2007 Powder Corr	18.1 ocy
Water	As needed

The coarse aggregate was batched to contain equal portions of 3/4, 1/2, 3/8, and #4 sizes conforming to AASHTO:M194. The fine aggregate was sieved to conform to AASHTO:M194.

The plastic concrete was tested for the following properties:

Slump	ASTM:C143
Air Content	ASTM:C231
Unit Weight	ASTM:C138
Temperature	ASTM:C1064
Set Time	ASTM:C403

The control and test concrete were maintained within the following limits:

Cement factor	517 ± 5 pcy
Slump	3½" ± ½"
Air content	5.5 ± 0.5% (for air series)

The concrete was tested for set time using a Proctor needle as described in ASTM:C403. Samples for strength, shrinkage, and freeze-thaw durability were cast, cured and tested using the following methods:

Compressive strength	ASTM:C192, ASTM:C39
Flexural strength	ASTM:C192, ASTM:C78
Length change	ASTM:C157
Freeze-thaw	ASTM:C192, ASTM:C666, Method A

The test data are contained in the attached tables.

REMARKS

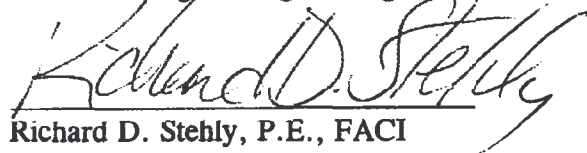
The chemical admixture was consumed during the testing.

Report Prepared By:
American Engineering Testing, Inc.



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TABLE 1 - ADMIXTURES

ASTM:C494 Type F, AASHTO M194 Type F

Type of Admixture	High Range Water Reducing
Company Name	Cortec Corporation
Brand Name	MCI-2007 P Super Corr
Lot Number	91436
Lot Size	
Quantity Supplied	1 liter container
Total Solids, %	99
Specific Gravity	0.68 (5.67 pounds per gallon)
pH	11.98 at 1% in water

**TABLE 2 - CEMENT
PROPERTIES OF CEMENT
ASTM:C150 and AASHTO M85**

<u>CHEMICAL ANALYSIS</u>	
<u>CONSTITUENT</u>	<u>WEIGHT, %</u>
Silicon dioxide	20.5
Aluminum oxide	5.2
Ferric oxide	2.4
Calcium oxide	64.4
Magnesium oxide	2.2
Sulfur trioxide	2.9
Sodium oxide	0.23
Potassium oxide	0.54
Tricalcium aluminate (C ₃ A)	10.0
INSOLUBLE RESIDUE	0.29

<u>PHYSICAL ANALYSIS</u>	
<u>PROPERTY</u>	<u>RESULT</u>
COMPRESSIVE STRENGTH 3 day, psi 7 day, psi	3,680 4,970
SETTING TIME (Gillmore) Initial, (minutes) Final, (minutes)	129 235
AIR CONTENT, %	7.0
LOSS ON IGNITION	1.4
SPECIFIC GRAVITY	3.15
AUTOCLAVE EXPANSION, %	0.30
FINENESS (BLAINE)	381 m ² /Kg

This cement is a Type I, manufactured by Lehigh Cement Company at the Mason City production plant.

TABLE 3 - AGGREGATES
ASTM:C33 and AASHTO M6 & M80

PROPERTIES OF AGGREGATES

	FINE AGGREGATE		COARSE AGGREGATE	
<u>GRADATION</u> ASTM:C136	<u>SIEVE</u>	<u>CUMMULATIVE BY WEIGHT</u>	<u>SIEVE</u>	<u>CUMMULATIVE BY WEIGHT</u>
	#4	0%	1	0%
	8	6	3/4	25
	16	25	1/2	50
	30	48	3/8	75
	50	82	#4	100
	100	97	#8	100
	F.M	2.58	F.M.	7.00
<u>ORGANIC</u> ASTM:C40	COLOR	0%	COLOR	0%
<u>SPEC. GRAVITY</u> ASTM:C128		2.65		2.70
<u>ABSORPTION</u> ASTM:C128 and C127		.9%		.9%
<u>UNIT WEIGHT</u> ASTM:C29	DRY LOOSE DRY RODDED	102.6 pcf 106.1 pcf	DRY LOOSE DRY RODDED	97.0 pcf 103.5 pcf

The aggregates comprise a mixture of processed gravel aggregates available in the Eagan, MN market area.

The sand gradation is as received; the coarse aggregate represents separated and blended sizes as required by ASTM:C494 and AASHTO T194.

ADMIXTURE TESTING

Table 4A Concrete Mixtures and Testing Results – Air Entrained Series

AET Job No. 05-02912

Laboratory Data

	Control Mixtures				Average (Test Value)	Mixtures			Average (Test Value)	ASTM:C494 AASHTO M194 Type F
	Batch: Date:	C1 1-5-07	C2 1-9-07	C3 1-25-07		A1 1-5-07	A2 1-9-07	A3 1-25-07		
Cement, pcy		521	519	517	519	520	515	521	519	517 ∇ 5
Sand, pcy		1345	1339	1335	1340	1342	1328	1344	1338	
Rock, pcy		1822	1818	1815	1818	1820	1809	1826	1818	
Water, pcy		281	280	280	280	242	240	239	240	
Admixture name		-	-	-	-	MCI-2007	MCI-2007	MCI-2007	MCI-2007	
oz/cu.yd		-	-	-	-	18.1	18.0	18.2	18.1	
AEA name		VR	VR	VR	VR	VR	VR	VR	VR	
oz/cu.yd		2.9	2.9	2.9	2.9	1.6	1.5	1.6	1.6	
Ratio of fine to total agg., %		42	42	42	42	42	42	42	42	
W/C lb./lb.		.54	.54	.54	.54	.47	.47	.46	.47	
Relative water content, %		-	-	-	-	86	86	85	86	88 max.
Slump, in.		3.0	3.2	3.4	3.2	3.3	3.2	3.2	3.2	3-4
Air Content, %		5.5	6.0	6.2	5.9	6.0	6.4	6.0	6.1	5-7
Unit wt., pcf		146.8	146.5	146.4	146.6	146.5	146.2	146.5	146.4	
Concrete Temp, °F		68	68	68	68	68	68	68	68	
Ambient Temp, °F		70	70	70	70	70	70	70	70	
SETTING TIME										
Initial, hrs:min.		4:39	4:50	4:10	4:33	4:30	4:40	4:03	4:24	
Final, hrs:min.		6:07	6:10	5:52	6:03	5:59	6:03	5:47	5:56	
Setting (deviation from ref.)										
Initial, hrs: min.						-.09	-.10	-.07	-.09	-1:00 to 1:30
Final, hrs:min.						-.08	-.07	-.05	-.07	-1:00 to +1:30
COMPRESSIVE STRENGTH										
1 day, psi		1,510	1,210	1,540	1,420	2,160	1,890	2,290	2,110	
3 day, psi		3,200	3,190	2,910	3,100	4,260	3,990	4,330	4,140	
7 day, psi		4,100	4,380	4,070	4,180	4,820	5,170	5,370	5,120	
28 day, psi		5,130	5,340	5,290	5,250	5,990	6,300	6,670	6,320	
6 month, psi										
1 year, psi										
1 day, % reference						143	156	149	149	140% min.
3 day, % reference						133	125	149	135	125% min.
7 day, % reference						118	118	132	122	115% min.
28 day, % reference						117	718	126	120	110% min.
6 month, % reference										100% min.
1 year, % reference										100% min.
FLEXURAL STRENGTH										
3 day, psi		500	560	520	530	560	620	630	600	
7 day, psi		610	660	640	640	680	700	710	700	
28 day, psi		750	790	770	770	810	850	840	830	
3 day, % reference						112	111	121	112	110% min.
7 day, % reference						112	107	111	109	100% min.
28 day, % reference						108	108	109	108	100% min.
LENGTH CHANGE, %										
Increase Over Reference		-0.026	-0.023	-0.030	-0.026	-0.026	-0.027	-0.031	-0.028	Max. increase over control 0.01
						0.000	+0.004	+0.001	+0.002	
RESISTANCE TO FREEZING AND THAWING										
Relative Dynamic Modulus, %		C1/2	C3/4	C5/6		T1/2	T3/4	T5/6		
0 cycles										
cycles										
cycles										
cycles										
cycles										
Durability factor										
RELATIVE DURABILITY FACTOR										80 min.

ADMIXTURE TESTING

Table 4B Concrete Mixtures and Testing Results – Non-Air Entrained Series
Laboratory Data

AET Job No. 05-02912

	Batch: Date:	Control Mixtures			Average (Test Value)	Mixtures			Average (Test Value)	ASTM:C494 AASHTO M194 Type F
		C1 1-4-07	C2 1-10-07	C3 1-12-07		A1 1-04-07	A2 1-10-07	A3 1-12-07		
Cement, pcy		515	514	520	516	513	512	519	515	517 ∇ 5
Sand, pcy		1369	1368	1376	1371	1367	1365	1374	1369	
Rock, pcy		1800	1798	1810	1802	1798	1796	1808	1801	
Water, pcy		295	290	291	292	252	252	254	253	
Admixture name		-	-	-	-	MCI-2007	MCI-2007	MCI-2007	MCI-2007	
oz/cu.yd		-	-	-	-	18.1	17.9	18.1	18.1	
Ratio of fine to total agg., %		43	43	43	43	43	43	43	43	88 max.
W/C lb./lb.		.57	.56	.56	.56	.49	.49	.49	.49	
Relative water content, %		-	-	-	-	85	87	87	87	
Slump, in.		3.0	3.2	3.3	3.3	3.0	4.0	3.2	3.2	3-4
Air Content, %		2.0	2.2	2.3	2.2	2.2	2.4	2.4	2.4	
Unit wt., pcf		148.4	148.2	148.1	148.2	148.2	148.0	148.0	148.1	
Concrete Temp, °F		68	68	69	68	68	68	68	68	
Ambient Temp, °F		69	69	70	69	69	69	70	69	
SETTING TIME										
Initial, hrs:min.		4:52	4:20	4:17	4:30	4:49	4:22	4:33	4:38	
Final, hrs:min.		7:20	7:11	7:00	7:10	7:31	7:17	7:20	7:23	
Setting (deviation from ref.)										
Initial, hrs: min.						+07	+02	+16	+08	-1:00 to 1:30
Final, hrs:min.						+11	+06	+20	+13	-1:00 to +1:30
COMPRESSIVE STRENGTH										
1 day, psi		1,500	1,620	1,710	1,610	2,150	2,500	2,410	2,350	
3 day, psi		3,500	2,790	2,690	2,990	4,730	4,010	3,930	4,220	
7 day, psi		5,060	4,600	4,440	4,700	6,360	5,620	5,590	5,860	
28 day, psi		6,250	5,820	5,760	5,940	7,660	7,310	7,200	7,390	
6 month, psi										
1 year, psi										
1 day, % reference						143	159	141	146	140% min.
3 day, % reference						135	143	146	141	125% min.
7 day, % reference						125	122	126	125	115% min.
28 day, % reference						122	126	125	124	110% min.
6 month, % reference										100% min.
1 year, % reference										100% min.
FLEXURAL STRENGTH										
3 day, psi		570	510	550	540	670	650	650	660	
7 day, psi		660	590	600	620	710	700	690	700	
28 day, psi		790	680	710	730	820	790	770	790	
3 day, % reference						118	128	118	122	110% min.
7 day, % reference						108	119	115	113	100% min.
28 day, % reference						104	116	108	109	100% min.
LENGTH CHANGE, %										
Increase Over Reference		-0.030	-0.026	-0.030	-0.029	-0.033 +0.003	-0.029 +0.003	-0.032 +0.002	-0.031 +0.003	Max. increase over control 0.01

**TABLE 5B - NON-AIR ENTRAINED SERIES
TESTS OF HIGH RANGE WATER REDUCING
ADMIXTURE FOR CONCRETE
ASTM SPECIFICATIONS C494; TYPE F
AASHTO SPECIFICATIONS CM 494; TYPE F**

MIXTURE DESIGNATION	CONTROL	MCI-2007 Powder Corr	CHANGE vs. CONTROL	SPECIFICATION REQUIREMENT
Mixture Proportions				
Cement, lb./cu. yd.	516	515	-	517 ± 5
Sand, lb./cu. yd.	1371	1369	-	-
Gravel, lb./cu. yd.	1802	1801	-	-
Water, lb./cu. yd.	292	253	87	88% max.
Admix. Name	-	MCI-2007 Powder Corr	-	-
Addition, oz./cu. yd.	-	18.1	-	-
Ratio of Fine to Total Aggregate	43	43	-	-
Water/Cement Ratio, lb/lb.	.56	.49	-	-
Slump, inches	3.25	3.5	.25	3" to 4"
Entrained Air, %	2.2	2.4	.2	-
Unit Wt., pcf	148.2	148.1	-	-
Set Time, hr:mn				
Initial	4:30	4:38	+:08	-1:00 to +1:30
Final	7:10	7:23	+:13	-1:00 to + 1:30
Compressive Strength, psi				
1 day	1,610	2,350	146	140% min.
3 days	2,990	4,220	141	125% min.
7 days	4,700	5,860	125	115% min.
28 days	5,940	7,390	124	110% min.
6 months				
1 year				
Flexural Strength, psi				
3 day	540	660	122	110% min.
7 day	620	700	113	100% min.
28 day				100% min.
Length Change, %	-0.029	-0.031	+0.003	Max. increase over control 0.01