AMERICAN ENGINEERING TESTING, INC.

CONSULTANTS
• GEOTECHNICAL
• MATERIALS
• ENVIRONMENTAL

REPORT OF CONCRETE CORROSION INHIBITOR TESTING

PROJECT:

MCI 2005 NS

REPORTED TO:

CORTEC CORPORATION
4119 WHITE BEAR PARKWAY
ST. PAUL MN 55110

ATTN: JESSI JACKSON MEYER

AET JOB NO: 05-01171

DATE: JUNE 4, 2003

INTRODUCTION

This report presents the results of our testing of Cortec's MCI 2005, NS, and competing products. We understand the admixture was developed to provide corrosion protection to steel embedded in concrete. We understand Illinois DOT is considering using MCI 2005 NS. Ms. Jessi Jackson Meyer of Cortec Corporation requested we evaluate the material's effectiveness. The scope of our work consists of batching concrete; testing plastic concrete for properties; casting, curing and testing cylinders and beams for strength; and casting beams containing steel and testing for corrosion.

CONCLUSIONS

Base on the results of our work and experience, it is our opinion the following conclusions are appropriate:

1. The cracked beams in the control and concretes with corrosion inhibitors showed corrosion currents greater than 10 μA by the second cycle.

2. MC 2005NS reduced the corrosion currents about 50% and the total corrosion about two thirds through 12 cycles.

3. DCI at 4 gpy reduced corrosion currents about 22% and total corrosion about 25% through 12 cycles.

4. Rheocrete 222+ reduced corrosion currents about 10% and total corrosion about 25% through 12 cycles.

TESTING METHODS AND RESULTS

Between January 7 and 15, 2003, four test batches of concrete were made at our laboratory. The batches were 1¾ cubic feet and proportioned to the following mix designs:

	Mix 1	Mix 2	Mix 3	Mix 4
Portland Cement, Type I, pcy	600	600	600	600
3/4" Glacial Gravel, pcy	1225	1225	1225	1225
3/8" Glacial Gravel, pcy	410	410	410	410
Sand, pcy	1370	1370	1370	1370
MCI 2005 NS, pints/yd (liquid)	-	1.5	-	-
DCI, gal/yd	-	-	4	-
Rheocrete, gal/yd	-	-	-	1
Neutralized Vinsol Resin, ocy	6.0	3.0	3.0	3.0
Water, pcy	238	238	238	238
Water/Cement Ratio	0.40	0.40	0.40	0.40

The plastic concrete was tested for slump, and air content, immediately after discharge into a wheelbarrow. Specimens were cast, cured and tested for compressive strength and flexural strength. The following data was obtained:

	Control Mix #1	MCI 2005 NS Mix #2	DCI 4 gcy Mix #3	Rheocrete 222 Mix #4
Slump, in	6	6	6	6
Air, %	10.5	6.1	5.8	7.8
Compressive Strength, psi				
1 day	1620	2670	2640	1750
	1540	2570	2590	1950
28 days	5530	6990	7350	5650
	5200	6900	7190	5230
Flexural Strength, psi				
1 day	370	510	610	340
	420	540	490	400
28 days	710	810	770	720
	740	700	680	780

Four beams were cast from each concrete batch for corrosion testing. Three 18" long #3 bars were sandblasted to near white metal. The ends were coated with epoxy leaving a 15-inch section of bar exposed to the concrete. The bars were cleaned with acetone and set in a triangular array with one bar 1" from the concrete beam top surface. The concrete was moist cured 7 days, then air dried 14 days. The beams were cut 0.75" deep across the width at mid-length. The beams were loaded in flexure using center point loading with the notched surface in tension. Load was applied until a crack developed just beyond the single top bar. A plexiglass container was sealed onto the beam's top surface and allows ponding of saline solution over the middle 4". Epoxy was applied to the concrete beam sides and unponded top surface. The top bar was connected to the bottom bars with a shielded copper wire and a 10 ohm resistor.

A 6% solution of sodium chloride was poured into the plexiglass container. A weekly test schedule was initiated consisting of 96-hour salt water ponding, testing half cell potential of bars, testing macrocell corrosion top bar to bottom bars, vacuum removal, fresh water rinse, vacuum removal, and 72 hours air drying. The test data is contained in Tables 1-4.

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TABLE #1 - CONTROL

	CORROSION POTENTIAL (Mv)			CORROSION CURRENT (µA)				TOTAL CORROSION, COULOMBS
Test Cycle	BEAM A Top/Left/Right	BEAM B Top/Left/Right	BEAM C Top/Left/Right	BEAM A	BEAM B	BEAM C	AVERAGE	
1	486/485/485	366/366/366	476/475/475	11.0	3.8	6.9	7.2	2
2	OL/OL/OL	346/346/346	OL/OL/OL	83.0	26.0	65.6	58.2	22
3	488/487/487	380/380/380	474/473/477	72.0	0.0	32.0	34.7	50
4	482/480/480	377/377/377	482/481/482	88.0	34.6	142.8	88.5	87
5	495/493/493	381/381/381	476/475/475	94.5	32.9	56.6	61.3	132
6	489/488/489	377/377/377	472/471/476	93.2	31.0	55.4	59.9	169
7	484/483/483	385/384/384	467/466/465	103.2	39.2	63.2	68.5	208
8	490/489/489	375/375/375	469/468/469	102.7	34.5	62.0	66.4	249
9	491/490/490	368/368/368	480/480/482	102.6	33.1	64.3	66.7	289
10	490/489/489	367/367/367	482/482/472	95.0	32.1	54.4	60.5	327
11	489/481/485	368/368/368	480/473/470	93.3	28.2	59.6	60.4	364
12	479/478/478	369/369/369	468/467/467	92.4	17.6	64.4	58.1	400

TABLE #2 - MCI 2005 NS

	CORROSION POTENTIAL (Mv)				CORROSION CURRENT (µA)					TOTAL CORROSION, COULOMBS
Test Cycle	BEAM A Top/Left/Right	BEAM B Top/Left/Right	BEAM C Top/Left/Right	BEAM D Top/Left/Right	BEAM A	BEAM B	BEAM C	BEAM D	AVERAGE	
1	540/538/538	442/440/430	288/288/288	442/425/435	26.6	5.1	34.5	1.5	16.9	5
2	OL/OL/OL	358/358/358	262/262/261	OL/OL/OL	17.6	7.0	10.4	19.8	13.7	14
3	544/542/542	469/426/463	298/298/298	450/450/450	19.2	0.0	8.5	2.4	7.5	20
4	538/535/535	514/463/463	332/330/330	433/427/429	48.9	45.9	45.0	27.3	41.8	35
5	540/538/537	439/439/439	389/383/389	451/451/451	19.5	13.1	26.8	6.9	16.6	53
6	532/530/530	436/436/436	394/393/392	444/444/444	16.9	0.6	7.4	3.4	7.1	60
7	527/525/525	432/433/433	404/399/397	428/426/426	21.2	53.0	7.3	2.3	21.0	68
8	539/537/537	442/442/444	409/395/394	436/437/437	58.8	0.6	50.1	9.9	29.9	83
9	538/536/536	433/453/461	392/388/388	426/426/426	64.0	0.5	3.7	5.3	18.4	98
10	527/527/527	478/469/474	415/385/383	436/435/435	70.6	0.2	56.0	13.5	35.1	114
11	529/528/528	463/450/446	423/384/380	432/430/430	80.4	0.2	5.3	12.8	24.7	132
12	531/529/529	450/449/449	432/382/379	430/425/425	98.2	0.2	4.9	9.3	28.2	148

TABLE #3 - DCI

	CORROSION POTENTIAL (Mv)				CORROSION CURRENT (μA)					TOTAL CORROSION, COULOMBS
Test Cycle	BEAM A Top/Left/Right	BEAM B Top/Left/Right	BEAM C Top/Left/Right	BEAM D Top/Left/Right	BEAM A	BEAM B	BEAM C	BEAM D	AVERAGE	
1	328/326/326	412/411/411	331/333/333	428/427/427	17.6	6.3	5.2	7.6	9.2	3
2	340/339/339	269/269/269	212/212/212	OL/OL/OL	26.5	9.0	9.4	74.4	29.8	15
3	361/358/357	420/419/419	373/376/377	421/420/420	76.2	48.0	42.3	0.0	41.6	37
4	382/381/381	422/422/422	366/364/361	412/411/411	74.7	75.0	46.9	47.9	61.1	68
5	377/379/379	422/421/421	351/352/353	418/417/417	48.3	38.8	35.6	48.7	42.9	99
6	374/373/373	406/404/404	347/347/347	428/427/427	47.9	83.3	35.2	59.0	56.4	129
7	366/367/367	416/412/411	323/324/325	432/430/430	35.1	55.8	23.2	62.5	44.2	159
8	383/382/382	424/424/424	310/312/313	436/435/435	55.6	50.0	25.3	51.0	45.5	186
9	395/394/394	413/406/405	345/349/349	414/414/414	74.4	49.3	36.7	46.0	51.6	215
10	394/393/393	417/411/417	338/340/341	407/407/407	67.0	41.4	36.7	38.2	45.8	244
11	364/356/390	415/411/415	332/333/340	403/405/405	75.3	46.2	37.3	24.6	45.9	272
12	349/348/348	411/411/411	327/328/324	402/402/402	78.8	45.0	37.8	19.8	45.4	300

TABLE #4 - RHEOCRETE 222+

	CORROSION POTENTIAL (Mv)				CORROSION CURRENT (µA)					TOTAL CORROSION, COULOMBS
Test Cycle	BEAM A Top/Left/Right	BEAM B Top/Left/Right	BEAM C Top/Left/Right	BEAM D Top/Left/Right	BEAM A	BEAM B	BEAM C	BEAM D	AVERAGE	
1	538/537/537	437/436/436	412/412/411	390/390/390	5.6	8.5	5.0	5.5	6.2	2
2	OL/OL/OL	OL/OL/OL	402/401/401	357/357/357	37.0	-	32.9	28.9	31.3	13
3	543/542/542	483/185/185	420/415/414	373/373/373	35.0	134.0	21.0	29.0	54.8	39
4	541/540/540	489/176/176	441/441/441	395/394/394	38.6	86.0	40.7	42.9	52.1	71
5	549/548/548	434/433/433	448/447/447	402/401/401	54.1	54.3	33.9	43.9	46.6	101
6	544/544/544	438/437/437	444/444/444	403/402/402	34.9	58.6	29.9	44.6	42.0	128
7	527/526/526	441/441/441	450/450/450	404/404/404	68.6	56.5	30.0	47.2	50.6	156
8	540/539/539	446/445/445	454/453/453	403/402/402	48.4	33.8	29.0	46.8	39.5	183
9	540/539/539	443/442/442	444/444/444	406/405/405	50.4	50.0	21.2	50.0	42.9	208
10	530/529/529	454/454/454	448/447/447	409/408/408	64.4	55.4	27.0	49.4	49.1	236
11	532/529/529	450/450/450	447/447/447	400/400/402	67.8	59.2	23.0	50.2	50.1	266
12	530/529/529	449/448/448	446/446/446	399/396/398	73.8	60.1	23.7	51.4	52.3	297

SODIUM NITRITE, 5.1, UN1500, PGIII, OXIDIZER/TOXIC

98%-120 MESH Lot No: **NANI-03-171**

RQ: 100(45.4) Net Wt. **50 LBS.**

CAS#: 7632-00-0 RTECS#: RA 1225000

FW: 69.00 MERK INDEX: 9,8407

Emergency Contact: CHEMTREC:1-800-424-9300

CHEMTREC INTERNATIONAL: (703) 527-3887

HEALTH HAZARADS & FIRST AID:
MATERIAL IS DANGEROUS IF INHALED! IMMEDIATELY FLUSH EYES OR SKIN WITH COPIOUS AMOUNT OF WATER, FOR AT LEAST 15 MINUTES IN CASE OF CONTACT EXPOSURE. MATERIAL IS IRRITATING TO THE MUCOUS MEMBRANES AND UPPER RESPIRATORY TRACT. EXPOSURE
SYMPTOMS MAY INCLUDE - BURNING SENSATION, COUGHING, WHEEZING, SHORTNESS OF BREATH, HEADACHES, LARYNGITIS, NAUSEA AND VOMITING, DIURESIS, ANEMIA, METHEMOGLOBINEMIA, NEPHRITIS, GASTROENTERITIS AND VASODILATION. IF MATERIAL HAS BEEN INHALED, REMOVE SUBJECT TO FRESH AIR. IF SUBJECT IS NOT BREATHING GIVE ARTIFICIAL RESPIRATION - PREFERABLY MOUTH-TO-MOUTH. IF BREATHING IS DIFFICULT OXYGEN SHOULD BE SUPPLIED. CONTAMINATED CLOTHING SHOULD BE REMOVED AND THOROUGHLY CLEANED BEFORE REUSE. CALL A PHYSICIAN! WASH THOROUGHLY AFTER HANDLING.

INCOMPATIBILITIES: ACIDS, ACID ANHYDRIDES, FUELS, (REDUCING AGENTS). EXPLOSIVE MIXTURES MAY RESULT FROM IMPROPER HANDLING!

PRODUCTS OF DECOMPOSITION: OXIDES OF SODIUM AND NITROGEN.

HANDLING & STORAGE: APPROPRIATE OSHA/MSHA APPROVED RESPIRATOR, CHEMICALLY RESISTANT GLOVES, CHEMICAL GOGGLES AND OTHER APPROPRIATE PROTECTIVE CLOTHING (RUBBER APRON OR OVERWEAR)SHOULD BE WORN. MECHANICAL EXHAUST IS REQUIRED. AVOID CONTACT WITH EYES, SKIN AND CLOTHING. DO NOT BREATHE DUST. AVOID PROLONGED AND REPEATED EXPOSURE. HYGROSCOPIC. KEEP CONTAINERS SEALED. STORE IN COOL DRY PLACE. OBSERVE PROPER PERSONAL HYGIENE. SAFETY SHOWER SHOULD BE AVAILABLE. THE PREFERRED FIRE EXTINGUISHING MEDIA IS WATER, DRY CHEMICAL POWDER, CARBON DIOXIDE OR POLYMER FOAM. MATERIAL IS NONCOMBUSTIBLE. PROTECTADJACENT AREA!

***** INDUSTRIAL OR MANUFACTURING USE ONLY *****