ANTI-GRAFFITI COATING SYSTEMS TEST

by

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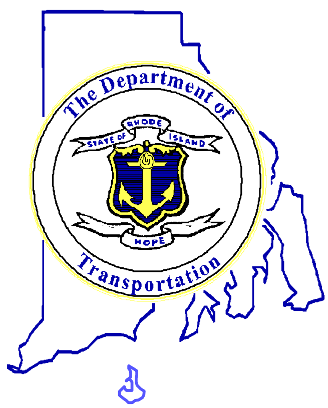

RESEARCH
TECHNOLOGY
DEVELOPMENT

RHODE ISLAND DEPARTMENT OF TRANSPORTATION

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Notice

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EXECUTIVE SUMMARY

Graffiti has become an unwelcome and unsightly intrusion on public structures such as buildings, bridges, and other concrete structures such as headwalls median barriers, retaining walls, etc. The public tolerance for the same has diminished, and as a result, public officials have been forced to seek ways to remedy the problem. Common remedial methods currently in use are blast cleaning with a soft blast media, overcoating, and solvent cleaning. These methods, while effective, are time consuming, labor intensive, and often times detrimental to the aesthetics and durability of the structure. However there is an alternative: anti-graffiti coating systems that are applied shortly after the structure is complete. These systems allow for easy removal of graffiti paint with water soluble nontoxic solvents that require a minimal amount of "brush off".

To investigate the effectiveness of these systems, and their effect on the durabilitv of the structure the RIDOT R&TD section performed a study on the same. The study comprised both laboratory and field testing of three anti-graffiti coating systems, with the laboratory testing phase comprising testing of concrete prisms coated with the anti-graffiti systems for a) freeze thaw durability and b) effectiveness of graffiti paint removal.

The three anti-graffiti coating systems used were a) Ni-Dura Hydro-Glaze-A, b) Armaglaze and c) Protecta-poxy. All were provided by the local suppliers. All three systems use a base coat applied to the concrete, usually an epoxy with an over coat of polyurethane that provides the barrier to the graffiti. The cleaners used were nontoxic water soluble and organic in composition.

The results of the laboratory and field testing showed that all three systems performed adequately in removing most of the commonly available graffiti paints. However paints containing a lead base were difficult to remove and required a high-pressure water blast. The durability of the concrete was not adversely impacted with no significant distresses noted. Strength test results after freeze thaw cycling were comparable to the uncoated control with no appreciable loss of strength.

Footnote: Of late there has been some reluctance from the highway community to utilize these systems as these are expensive, if not cost prohibitive, for routine use. We would recommend use of these systems in areas prone to accute graffiti vandalism, in conjunction with an aggressive deterrence plan, requiring the use of law enforcement.

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ABSTRACT

Three anti-graffiti coating systems (Armaglaze, Protecta-Poxy and Ni-Dura) were tested against the concrete sealer Crete-Shield[1] and uncoated concrete. All the coating systems exhibited some localized failures by the end of the test. Except in the case of Crete-Shield, no significant distresses in the concrete or the coatings were noted. The Crete-Shield coatings had became soft after thirty-six cycles in the freeze/thaw machine and were removed from the test[2]. The Ni-Dura product remained mostly intact, but the Crete-Shield that it used as a base coat had also softened. All systems seemed to be fairly effective at removing recently applied spray paint, but had more difficulty with one brand of paint that had been applied earlier. Field trials conducted by the manufacturers of two of the coating systems (Ni-Dura, Protecta-Poxy) showed good performance, with Ni-Dura being noticably more effective.

[1] Currently, the only approved concrete protective sealer.
[2] This is suspect, as Crete-Shield's performance history has shown no such problems.

INTRODUCTION

The problem of graffiti markings on concrete and masonry structures is an unpleasant reality in contemporary society. Structures are often the subject of this vandalism before they are even completed. Many entrepreneurial companies have formulated coating systems that allow graffiti paint to be removed with minimal labor, when special cleaners are used. One characteristic common to these systems is impermeability of the top coat. In order to prevent graffiti from penetrating, the coating must resist absorption of commonly available spray paints.

This high level of impermeability was considered a source of potential physical failure for the coatings. Concrete coatings have to “breathe”, that is, allow water vapor that is created in the concrete from accumulated moisture to pass through the coating. A system that cannot meet this requirement will fail by blistering, cracking and peeling from the concrete substrate. A coating with an exceptionally good bond may contribute to the premature failure of the concrete by causing moisture to be retained in the concrete and increasing the potential for freeze/thaw deterioration.

A coating must also be able to resist damage occurring due to exposure to the elements (wind, rain, sun, etc.). The test conducted here did not incorporate these factors, however.

Three systems and their respective cleaners were submitted for testing:

1] Ni-Dura Hydro-Glaze-A
This product is a solvent-based polyurethane produced by Northern Industries and is marketed by Princeton Chemicals. This system uses Crete-Shield as a base coat (Crete-Shield is a water-based epoxy and is currently the only product approved for use as protective concrete sealer on Rhode Island Department of Transportation construction projects). Two coats of Crete-Shield are applied to the concrete, prior to application of the Ni-Dura top coat. The cleaner provided by the manufacturer was Ni-Dura Graffiti Remover.

2] Armaglaze

This product is also a solvent-based polyurethane and is produced by Aquarius Coatings of Canada. It is marketed in the U.S. by Sherwin-Williams. Two coats of the material are used; the base coat uses a gray pigment. The cleaner provided by the distributor was Armakleen.

3] Protecta-poxy

This product is a water-based epoxy/polyurethane hybrid produced by AGP Surface Control Systems and marketed by Eco-Safe. This system uses a water-based epoxy called Prima-Coat as a base coat. The cleaner provided by the distributor was Wipe-Away Graffiti Cleaner.

Two types of tests were performed. In the first, paint was applied to the coating and removal was attempted using the supplied cleaner. The second test was RIDOT's standard freeze/thaw test.

SAMPLE FABRICATION AND PREPARATION

Fourteen 7.5 × 7.5 × 35 centimeter specimens were fabricated using a standard air-entrained bridge deck mix (see Appendix A for the mix test results). The specimens were stripped from the molds after twenty hours and cured in a bath of hydrated lime water for fourteen days. After removal from the bath, the specimens were dried to constant weight. Prior to application of the coating, the specimens were scrubbed with a stiff brush, washed and allowed to dry.

Each of the three test groups were coated per manufacturer's recommendations, using a short nap roller brush. The specimens were designated as follows: A1 through A3 for the Armaglaze system, C1 through C3 for the Crete-Shield controls, E1 through E3 for the Protecta-poxy system, N1 through N3 for the Ni-Dura system and U1 and U2 for the uncoated controls. One end of each specimen was marked with a circle as a reference. The specimens that were intended to have only Crete-Shield were inadvertently top coated with the Ni-Dura Hydro-Glaze-A. The coating was stripped with a sandblaster, removing all of the Ni-Dura and most of the Crete-Shield. The specimens were then recoated with two coats of Crete-Shield. The Crete-Shield remained tacky for several days after coating.

All of the coatings exhibited some odor. The Protecta-poxy's odor was quite noticeable. The odors from the Armaglaze coatings and the Ni-Dura Hydro-Glaze-A required additional ventilation and even then were uncomfortably strong. The Armaglaze system and the Protecta-poxy system did not seem to provide good coverage (the concrete was visible through the coating). Except for the Ni-Dura Hydro-Glaze-A, all coatings were two component systems and required thorough mixing of each component and the mixture.

Coat Number	Armaglaze	Crete-Shield [1] (no anti-graffiti coat)	Ni-Dura	Protecta-poxy
1	pigmented Armaglaze - two component, solvent-based polyurethane	two component, water-based epoxy	two component, water-based epoxy (Crete-Shield)	two component, water-based epoxy (Prima-coat)
2	non-pigmented Armaglaze - two component, solvent-based polyurethane	two component, water-based epoxy	two component, water-based epoxy (Crete-Shield)	two component, water-based epoxy/polyurethane hybrid (Protecta-poxy)
3			single component solvent-based polyurethane (Ni-Dura Hydro-Glaze-A)	

1] Two additional coats of Crete-Shield were applied to the Crete-Shield only specimens after a mistakenly applied coat of Ni-Dura was stripped off. Most of the two initial coats of Crete-Shield was removed as well.

Table 1 - Coating Systems

TEST PROCEDURE

I. Paint Removal

One specimen was selected from each of the groups coated with an anti-graffiti system. Four commonly available spray paints were applied to the specimens, one to each long face. The paints were: Krylon Orange Red and True Blue, Rustoleum Silver-Gray and Red Devil Stove and Barbecue Black, Heat Resistant Finish. The Rustoleum paint was applied four weeks before the attempted cleaning; the others were applied four days before. The cleaners were applied to the graffiti paint at three sites on the specimens [3]for each specimen, for each paint. After intervals of two, five and ten minutes, removal of the paints was attempted by scrubbing with a terry cloth towel. After each site was cleaned, the area was rinsed with water to remove the cleaner, the area was examined and the effectiveness of the cleaners were noted

II. Freeze/Thaw

After the paint removal test, initial weight measurements and visual inspections were performed on each specimen. The specimens were then subjected to freeze/thaw cycling according to ASTM C666, method A in a modified Soiltest CT-110 machine, which orients the specimens long dimension vertically. The specimens were set circle end up and then down at alternate inspections and were placed in the machine according to a random number chart. At 36, 72, 108, 131, 167, 203, 239, 264 and 300 cycles, the weighings and visuals were repeated. In examining the coated specimens, the coatings were checked for dulling, blistering, cracking and peeling. The uncoated controls were checked for loss of paste, exposure and loss of aggregate and cracking of the concrete.

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[3] Each site was cleaned after a different length of time

RESULTS

The results of the graffiti removal test are summarized in Table 2.

Paint	Time Before Cleaning (minutes)	Results for Each Specimen Amount Removed/Difficulty		
		A1	E1	N1
Black	2.0	ALL/HARD	ALL/EASY	ALL/EASY
	5.0	ALL/EASY	ALL/EASY	ALL/HARD
	10.0	ALL/EASY [1]	ALL/HARD [2]	ALL/HARD [2]
Blue	2.0	ALL/EASY	ALL/EASY	ALL/EASY
	5.0	ALL/EASY	ALL/EASY	ALL/EASY [2}
	10.0	ALL/EASY [1]	ALL/EASY [2]	ALL/EASY
Red	2.0	MOST/HARD	ALL/VERY EASY	ALL/EASY
	5.0	ALL/HARD	ALL/VERY EASY	ALL/EASY
	10.0	ALL/EASY [1]	ALL/VERY EASY [2]	ALL/EASY [2]
Gray	2.0	PART/HARD	NONE	NONE
	5.0	MOST/HARD	NONE	NONE
	10.0	MOST/EASY [1]	NONE [2] (ON PAINT)	SOME/HARD [2]

Specimens: A1 - Armaglaze, E1 - Protecta-poxy, N1 - Ni-Dura

[1] Coating slightly tacky after cleaning and water wash

[2] Coating very tacky after cleaning and water wash

Table 2 - Effectiveness of Graffiti Removers

The effectiveness of the cleaners generally increased for longer standing times. Note that the gray paint had been on seven times as long as the others and was also a different brand. The tackiness referenced lasted only a few minutes. Some field trials were also conducted, with the results given in Appendix B.

The anti-graffiti coatings maintained much of their integrity throughout the test, with only minor losses. There was some cracking, blistering and peeling, but in each case, this represented only a small portion of the total surface area. With the exception of the Ni-Dura coating, the distresses in the coatings appeared to be localized and showed no sign of significantly increasing in scope. On one of the Protecta-poxy specimens, a piece of coating that had peeled off was still firmly adhered to the mortar which had separated with it.

The Crete-Shield coated specimens and by consequence, the Ni-Dura coated specimens, had severe difficulties. After only 36 freeze/thaw cycles, the Crete-Shield coating had softened to the point where it could be deformed by finger pressure, which was sufficient to force through the coating to the concrete beneath. The Crete-Shield specimens were considered to have failed and were removed from the test. At 131 cycles, on one of the Ni-Dura specimens, some of the top coat peeled off.[4] The Crete-Shield underneath was soft. At 300 cycles, a blister appeared on another Ni-Dura specimen. When the blister was opened, the Crete-Shield underneath was found to have softened, causing the blister.

The uncoated controls lost paste and U1 lost a significant amount (see figure 1). This is unusual for air-entrained concrete using the particular mix and aggregate. The pattern of loss indicates that the specimen would have continued to gradually lose material until it failed. Previous test control specimens have survived 300 cycles with negligible loss. The air content of the mixes used to make the specimens was 5.3%, which is at the low end of what is normally specified.

All the specimens gained weight during the test, although, as noted above, U1 lost weight in the second half of the test, making its overall gain lower. The weight gain is not unusual, as the specimens were dried before coating and were therefore substantially moisture-free when the test started. The Ni-Dura specimens showed small gains, the Armaglaze had moderate gains and the Protecta-poxy showed large gains, when referenced to the uncoated controls.

After the completion of the freeze/thaw test, cubes were cut from the end of eight of the specimens (two from each group, excluding the Crete-Shield) and failed under compressive loading. The results are in Table 3. The results can be compared to the initial results for the mixes as provided in Appendix A. Note that the compressive breaks for the mix tests were for cylinders and are therefore not *directly* comparable to the cube breaks.

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[4] Near an edge, where there was a slightly excessive thickness of the base coat.

Specimen Designation	Machine Load (kips)	Compressive Strength (psi)	Machine Load (KN)	Compressive Strength (MPa)
A2	55.8	6,200	248	42.7
A3	41.2	4,600	183	31.6
E2	59.5	6,600	265	45.6
E3	55.0	6,100	245	42.1
N2	36.5	4,100	162	27.9
N3	48.3	5,400	215	36.9
U1	44.5	4,900	198	34.1
U2	43.5	4,800	194	33.3

Table 3 - Compressive Strengths of Concrete Cubes After Freeze/thaw

Cubes with compressive strengths under 35 MPa fractured more easily. After removal from the machine, they could be broken apart easily by hand. They also had a greater degree of failures at the mortar interface, which is usually a sign of freeze/thaw deterioration. However, there were also failures with the same type of aggregate on the cubes with higher compressive strength. This may indicate that the aggregate was not clean or was otherwise not completely sound.

Note: During the test, leaks occurred in two of the specimen compartments, allowing the ethylene glycol solution used as a heat transfer medium to leak into the compartments. The amount was very small in both cases and was not considered to be significant.[5] The compartment was replaced in the first instance and the second instance occurred during the last series of cycles.

5 This was assumed because the water in the compartments continued to freeze

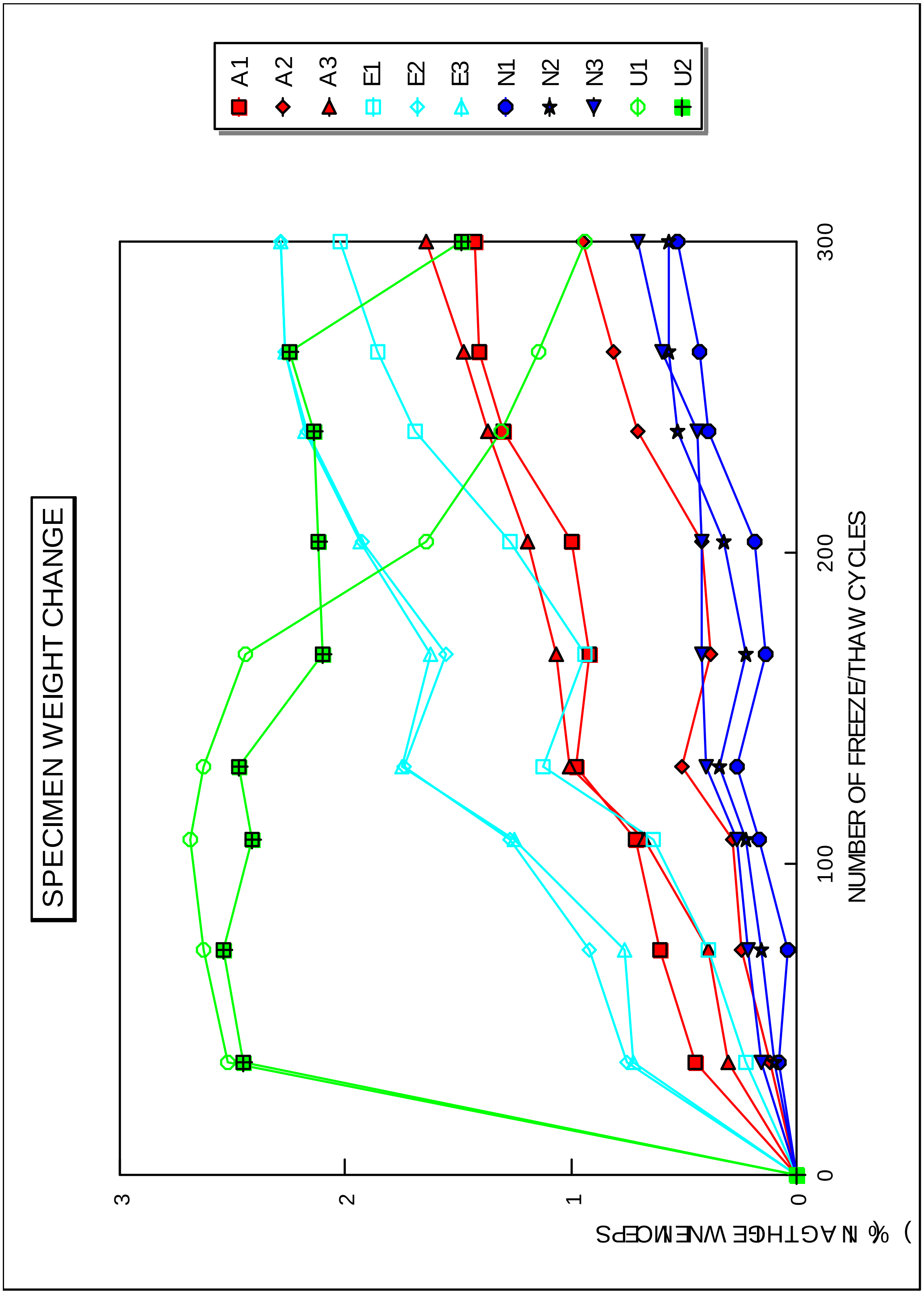

Figure 1 - Specimen Weight Change

CONCLUSIONS

The anti-graffiti systems did fairly well in removing the paint systems that were only allowed four days to cure. All of the cleaners had difficulty with the gray paint that was allowed to cure for four weeks. This may have been due to the length of time of the cure or properties of the specific paint.

The ease and effectiveness of the removal process seemed to be directly proportional to the length of time the cleaner was allowed to stand prior to the removal attempts. The Ni-Dura system required the least effort to clean, often with little or no setting time required. It was almost impossible to remove the gray paint from it, however. The Protecta-poxy system was slightly easier to clean than the Armaglaze, although the difference was small. The Armaglaze was the only system which allowed removal of most of the gray paint. *Note:* On all systems, some of the remaining paints came off during freeze/thaw cycling.

The tackiness exhibited by all the systems after cleaning may indicate that there is a solvent action taking place during the cleaning process.[6] However, the tackiness may also be caused by the remaining paint traces or a combination of the traces and a lesser solvent effect. There was some concern that use of the cleaners might affect the performance during freeze/thaw, but no effect was noted.

The Protecta-poxy and the Armaglaze systems performed adequately in the freeze/thaw test. The small amounts of the coating lost were mainly near edges where the concrete was difficult to clean. The loss may therefore have been caused by inadequate surface preparation. There was also some loss due to disintegration of the underlying paste. This may be related to the problem experienced by the uncoated controls and would not be an indication of a deficiency in the coating systems.

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[6] According to Eco-Safe, the Protecta-poxy's cleaner is capable of damaging the coating if left on too long.

The weight gain of the Protecta-poxy coated specimens may be cause for concern. It might indicate that the system is acting as a vapor barrier and this could cause premature failure of the coating or damage to the concrete. However, the effect appeared to be leveling off and the weight gain is not unusual for dry concrete. The top coat may be more permeable than those of the other systems.

The softening of the Crete-Shield coating is troubling. All previous testing has shown no indication of such a problem. Difficulties with field applications have shown problems with softness of the coating when the material was improperly mixed or proportioned. As noted previously however, the coating was mixed and applied per manufacturer's specifications. The coating took longer to cure tack-free than anticipated, but seemed to have hardened when the test was started.

RECOMMENDATIONS

The difficulty in removing the Rustoleum gray spray paint may reveal some limitations of the anti-graffiti systems. These limitations may be the result of the curing time of the paint or the type of paint. More testing should be performed with a broader range of paints, with varied curing times for each paint. However, the effectiveness of each system appears adequate for use in graffiti protection.

The Armaglaze and the Protecta-poxy systems did not seem to suffer any significant effects from freeze/thaw cycling. Nor does there seem to be any visible effect on the concrete. The coatings should therefore pose no problem when used as anti-graffiti systems. If their use also requires that they perform as a protective sealer, chloride intrusion testing would have to be performed.

The difficulties encountered with the Crete-Shield coating should be addressed. It is possible that the problems noted are the result of anomalous behavior, but this needs to be investigated to insure that there is no problem with the material that we are currently using (in discussions with the manufacturer, the possibility was raised that the components provided may not have been properly sampled). The problem may not be as immediately apparent in field use, as the freeze/thaw test involves extended submersion in water, as opposed to what occurs in actual field applications. It should be ***clearly understood***, however, *that Crete-shield has not exhibited behavior of this nature in the past when mixed and applied properly and this problem is not believed to be in any way typical of product performance.*

ACKNOWLEDGMENTS

Specimen mix design	J. Lima
Fabrication of specimens	J. Lima J. Fera S. Quintin C. Reynolds
Coating of specimens	S. Quintin
Testing of specimens	P. Petsching S. Quintin
Cutting and compression testing of freeze/thaw specimens	H. Bertsch
Compilation of Appendix C and general consultation on chemical issues	J. Walsh

I would also like to thank the Materials Section for the use of their facilities in making the mix and I. Frament and J. Arruda in particular for their assistance.

APPENDIX A

Concrete Mix Data

RHODE ISLAND DEPARTMENT OF TRANSPORTATION
DIVISION OF PUBLIC WORKS
MATERIALS SECTION

CONCRETE TESTING FORM

R.I. Cont. No: RTD F.A.P. No.: IR 1950 439 (01) Date Cast: 5-16-94
Concrete Producer: LAB Class of Mix / #: XX Nominal Aggregate Size: 3/4"
Project: Anti Graffiti Section Cast: Freeze Thaw Specimens

Set	Ticket No.	Air Content (%)	Slump (in)	Conc. Temp.	Air Temp.	Time Cast
A						
B	—	5.3	4 1/4	22°C	75	9:00AM
C						
D						

Number of cylinders: 8 #7 Diameter of cylinders: ☑ 4" ☐ 6" Number of beams: ____

Was curing accelerated? (e.g. steam curing, etc.) ☐ Yes ☑ No

Remarks and/or Special testing requirements: ____

Tested by: ____ Division ____

Lab use only: Date Received: 5-17 28 Day Strength Specification 4000 PSI

Set	Lab Tracking #	Test Date	Age (Days)	Machine Load (Lbs.)	Comp.Strength (psi)	Disposition
A	941231	5-17	1	21900	1743	☐ Acceptable
		5-17	1	20900	1663	☐ Unacceptable
		5-23	7	48750	3879	☐ Information Only
B		5-23	7	45000	3583	☐ Acceptable
		5-30	14	56250	4476	☐ Unacceptable
		5-30	14	57000	4536	☐ Information Only
C		6-13	28	68000	5411	☐ Acceptable
		6-13	28	65750	5232	☐ Unacceptable
						☐ Information Only
D						☐ Acceptable
						☐ Unacceptable
						☐ Information Only

Remarks ____

5/17, 5/23, 5/30 [illegible] Bentech 6/13
Tested By/Date

Materials Engineer/Date

RHODE ISLAND DEPARTMENT OF TRANSPORTATION
DIVISION OF PUBLIC WORKS
MATERIALS SECTION

CONCRETE TESTING FORM

R.I. Cont. No: RTD F.A.P. No.: IR 195 439(61) Date Cast: 5-16-94

Concrete Producer: Lab Class of Mix / #: XX Nominal Aggregate Size: 3/4"

Project: Anti Graffiti Section Cast: Freeze Thaw Specimens

Set	Ticket No.	Air Content (%)	Slump (in)	Conc. Temp.	Air Temp.	Time Cast
A	—	5.3	4 1/4	22°C	75	9:00AM
B						
C						
D						

Number of cylinders: 9 #1 Diameter of cylinders: ☑ 4" ☐ 6" Number of beams: ______

Was curing accelerated? (e.g. steam curing, etc.) ☐ Yes ☑ No

Remarks and/or Special testing requirements: ______

Tested by: ______ Division ______

Lab use only: Date Received: 5-17 28 Day Strength Specification 4000 PSI

Set	Lab Tracking #	Test Date	Age (Days)	Machine Load (Lbs.)	Comp. Strength (psi)	Disposition
A	941232	5-17	1	17900	1424	☐ Acceptable
		5-17	1	18000	1432	☐ Unacceptable
		5-23	7	46250	3682	☐ Information Only
B		5-23	7	43500	3463	☐ Acceptable
		5-30	14	52500	4178	☐ Unacceptable
		5-30	14	52750	4198	☐ Information Only
C		6-13	28	60000	4774	☐ Acceptable
		6-13	28	61250	4874	☐ Unacceptable
		6-13	28	58500	4655	☐ Information Only
D						☐ Acceptable
						☐ Unacceptable
						☐ Information Only

Remarks ______

[illegible] 5/17, 5/23, 5/30 [illegible] 6/13
Tested By/Date

______
Materials Engineer/Date

The mix design used for the test specimens was as follows:

Stone - Tilcon 3/4" blend (AASHTO M43, #67)	760 kg
Sand - Forte Concrete (AASHTO M6)	558 kg
Cement - Independent Type II (AASHTO M85)	229 kg
H_2O	132 kg
Air entrainment - Grace Daravair	267 mL/45 kg cement

Mix Test Results:	Mix #1	Mix #2
Slump (cm)	11	11
Air Content (%)	5.3	5.3
Concrete Temperature (°C)	22	22

The cylinder compression results for the mixes are on the preceding two pages.

APPENDIX B

Field Trials

Field tests were performed on the Protecta-poxy and Ni-Dura systems on a bridge pier on the Providence viaduct on Interstate 95. The test were performed over three different days.

First test:

Weather condition: 21-23ºC, fair, sunny

Graffiti Paint: Krylon bright red and olive green, allowed to cure for at least four days, perhaps as long as three weeks

System: Ni-Dura topcoat over Crete-Shield

Cleaners: Ni-Dura Graffiti Remover, applied by roller.

Results: Cleaning began almost immediately. The paint was mostly removed by the third or fourth pass of the roller and washed off almost completely with a sponge and water. No significant damage to the anti-graffiti coatings specular gloss was evident. At this time, the manufacturer claimed that the cleaner could be used on uncoated concrete, but pressure washing would be required to remove the loosened graffiti paint from the concrete pores.

Second test:

Weather condition: 13-15ºC, cloudy

Graffiti paint: Krylon bright red and olive green, black wrought iron enamel; allowed to cure for eight days. There was also some paint left by vandals.

System: Ni-Dura topcoat over Crete-Shield

Cleaner: Wipe-Away (Eco-Safe product) is allowed to stand for ten minutes; it's referred to as temperature sensitive by manufacturer and works faster at higher temperatures (this may be a problem as removal of graffiti may have to be performed at low temperatures - per a Maintanence worker). It's used with a 10 MPa power wash; water is claimed to neutralize the cleaner; otherwise the cleaner will damage the concrete coating, eventually. Note that there are two products: a **cleaner** (102GL) and a more powerful **remover** (106SL).

Results: Using the remover, the red and green were removed with a light scrubbing with a stiff brush and wash (using a fan tip for the power washer nozzle). Some black came off using the straight tip on the washer. Using the **cleaner** and scrubbing with a brass brush, the paints were cleaned fairly well. Some actual graffiti paint was taken off using the **remover**, from both uncoated concrete and painted structural steel. The remover may have been left on too long, as it began to act on the structural steel paint (probably lead-based).

Third test:

Weather condition: 13-15ºC, cloudy, windy (8-24 Km/h)

Graffiti paint: Krylon blue and red, allowed to cure for one week

System: Protecta-poxy, no Prima-coat primer

Cleaner: Wipe-Away Graffiti Cleaner, brush applied, allowed to stand for fifteen minutes

Results: Visibly starts to act on graffiti paint upon application, removes after standing and vigorous brushing. Rinsing with garden hose took off most paint, but letters were still visible. The letters were still clearly visible after 13.7 MPa power wash. Manufacturer stated that coating may not have been completely cured prior to application of spray paint and the paint may have blended in with the coating.

System: Ni-Dura topcoat over Crete-Shield

Cleaner: Ni-Dura Graffiti Remover, roller applied, allowed to stand for three to four minutes

Results: Visibly starts to act on graffiti paint upon application, scrubs off quickly with stiff brush. Letters no longer visible after ten minutes, cleaned with garden hose, but traces of paint remained. Second application of cleaner and 13.7 MPa power wash removed some of remaining, but traces still remained. A pressure wash of 34.3 MPa removed some of coating (to be expected, very high pressure). Manufacturer stated that this was the third time this particular site had been cleaned, putting the coating at a disadvantage.

IMPORTANT NOTE: These trials were conducted as demonstrations by the manufacturers, not as a controlled test. The data here is presented for the purpose of information only.

APPENDIX C

Graffiti Systems Chemicals & Hazards

System Number One - Northern Industries, Inc.

Ni-Dura Hydro-Glaze-A Anti-Graffiti System:

Primer - Crete Shield-(Polyamide / Polyamine / Epoxy Resin)

- No hazardous ingredients listed.

Topcoat - Ni-Dura Hydro-Glaze-A (Polyurethane Prepolymer Resin)

MSDS - Hazardous ingredients:

Xylene

Ethyl Benzene

Isophorone Diisocyanate

Ni-Dura Graffiti Remover:

MSDS - Hazardous ingredients:

Dipropylene Glycol Methyl Ether Acetate

N-Methyl-2-Pyrrolidione

Gamma-Butyrolacetone

Hydroxypropyl Cellulose

Ethoxylated Octyl Phenol

This mixture is hazardous as severe eye irritant, skin absorption, ingestion and inhalation irritants.

System Number Two - Aquarius Coatings (marketed in U.S. by Sherwin Williams)

Armaglaze Anti-Graffiti Coating:

Primer & Topcoat (Identical, except topcoat is pigmented)

Unable to secure the information after repeated calls to the manufacturer.

Armakleen 1-2-3 Graffiti Remover:

MSDS: Hazardous Ingredients:

1 -Methyl-2-Pyrrolidone
D'Limonene

Causes skin & eye irritation, inhalation causes irritation of respiratory tract. Ingestion will cause adverse health effects.

System Number Three - AGP Surface Control Systems, Eco-Safe

AGP-Protecta-Poxy Anti-Graffiti System:

Primer - Prima-Coat (emulsified water-based epoxy)

Two Components, Parts A & B

MSDS for Parts A & B combined:

Proprietary formulation - Non-hazardous, non-toxic, non-carcinogenic, non-mutagenic

Skin aborption - possible dermatitis and skin irritation. Eye irritation. Both hazards are acute hazards. Repeated exposure can lead to chronic skin hazard.

MSDS for Part A:

Same as for parts A & B combined.

MSDS for Part B:

Same as for parts A & B combined.

Topcoat - Protecta-Poxy

Two Component, Parts A & B.

MSDS for Parts A & B combined:

Hazardous ingredients:

Toluene

Zylene

N-Butyl Acetate

This mixture can cause skin & eye irritation and be absorbed through the skin.

MSDS for Part A:

Hazardous ingredients:

Toluene

Xylene

N-Butyl Acetate

MSDS for Part B:

No hazardous ingredients.

AGP-General Graffiti Cleaner:

MSDS:

Ingredients:

N -Methylpyrolidone

Dipropylene Glycol Methyl Ether Acetate

Propylene Carbamate

These ingredients were designated as non-toxic, non-carcinogenic and non-hazardous (note that the first manufacturer lists Dipropylene Glycol Methyl Ether Acetate as hazardous).