

Products for Concrete Corrosion Inhibition and Strength Improvement

Surtreat Solutions Inc. based on the formulation of TPS II and TPS XII developed for Structural Reinforcement Solutions LLC the following products **SRS-4000** and **SRS-4100**, these products meet the following performance criteria for TPS II and TPS XII and have been tested for over 30 years by multiple entities.

Properties: Reinforcing Steel (Rebar) Corrosion Inhibition

Problem: Concrete Rebar undergoing corrosion due to reduced pH and elevated chlorides causing delamination and spalling of concrete surface.

Products: **SRS-4000** & **SRS-4100**

Test Methods:

Modified ASTM-C876 – using silver - silver chloride half-cell
(Laboratory and Field)

Corrosion Current – Modified ASTM-G109-92 (Laboratory)

Polarization Resistance – NASA Laboratory

Test Results

Silver - Silver Chloride Half Cell

Test Location	Half-cell Potential – mV		% Change
	Before Application	After Application	
NASA Kennedy Space Center			
SRS-4000	350	200 (12 months)	43%
SRS-4100	390	170 (12 months)	56%
Korean Construction Materials Institute			
SRS-4000	545	200 (90 days)	63%
SRS-4100	557	200 (90 days)	64%
PA Turnpike Bridge			
SRS-4000	243	168 (30 days)	31%
Windjammer Condos, FL – Balconies			
SRS-4000	350	50 (5 years)	86%
Shipps Landing, FL – Balconies			
SRS-4000	250	75 (30 days)	70%
Suddath Parking Garage – Jacksonville, FL			
SRS-4000	316	+ 64 (180 days)	120%
Rand University – South Africa			
SRS-4000	340	160 (75 days)	50%

Corrosion Current

Test Location	Micro Amps		% Change
	Before Treatment	After Treatment	
NASA Kennedy Space Center			
SRS-4000	-90	+30 (12 months)	133%
SRS-4100	-50	+20 (12 months)	140%

Polarization Resistance

Test Location	ohm – cm2		% Change
	Untreated	Treated	
NASA Kennedy Space Center			
SRS-4000	4281	5365	25%
SRS-4100	4281	6612	55%

Corrosion Rate

Test Location	Micro Meters per year (µm/yr)		% Change
	Untreated	Treated	
Shea Stadium Ramp – NYC			
SRS-4000	43 (av)	14 (av)	67%
SRS-4100	99 (Hot Spot av)	15 (Hot Spot av)	85%
Parking Garage 420 E 51st – NYC			
SRS-4000 + SRS-4100	22 (av)	37 (av)	41%
SRS-4100 + SRS-4000	14 (Hot Spot av)	104 (Hot Spot av)	86%

Discussion:

Half-cell readings of –200 mV and lower indicate 90% probability of no corrosion.
Measurements of –300 mV and higher indicate a 90% probability that corrosion is occurring.

The shifts of the change of corrosion current and half-cell potential are interpreted as indicating the formation of a super-passive state on the rebar surface.

Polarization resistance can be converted into corrosion current. As polarization resistance goes up, corrosion current is going down.

Corrosion Rate determined from polarization resistance/corrosion current measurements using Galva Pulse instrument

Low Corrosion 10-30 µm/yr

Moderate Corrosion 30-300 µm/yr

Property: Concrete Strength

Problem: Weak concrete due to poor original quality or deterioration due to environmental exposure

Products: SRS 4000

Test Methods **CapoPull-out Force ASTM C-900**

Force in kN required to pull a 2 x 2 inch concrete plug from the surface

Core Compressive Strength ASTM C-42

Modified to use 3.0 inch long cores

Flexural Strength

Run by Korean Construction Materials Division using KSF-2407

TensionShear Strength

Run by NDT using 2" x 2" epoxy adhered steel plates

Test Results

Capo Pull-out Force

Test Location	Product	Before Treatment		After Treatment		% Change	
		kN	PSI	kN	PSI ¹	kN	PSI
Kunai Bridge, Korea	SRS 4000	33	5000	48	7500	45%	50%
PA Turnpike Bridge Structure	SRS 4000	22	3200	33	5050	50%	58%
Penn DOT Bridge	SRS 4000	24	3500	30	4500	25%	29%
Seymour Johnson AFB	SRS 4000	37	6000	42	6900	14%	15%
Canadian Pacific RR Bridge	SRS 4000	15	2100	24	3500	60%	67%
US DOE Fernald Ohio	SRS 4000	42	6800	44	7150	5%	5%
Storage Pad BOEING Long Beach CA	SRS 4000	31	4842	49	7875	58%	62%
NJ Turnpike Bridge Structure 68.4 (NJTA R 1358)	SRS 4000	20	2897	39	6370	95%	120%

Core Compression Tests

Test Location	Before Treatment PSI	After Treatment PSI	% Change
PSI Laboratory	1000	2000	100%
NY Thruway Bridge	3400	4300	26%
USS Coke Works	3000	4000	33%
Korean Construction Materials Lab Deteriorated Concrete	2700	3700	37%

Flexural Strength

Test Location	Before Treatment PSI	After Treatment PSI	% Change
Korean Construction Materials Lab New Concrete	418	475	14%
Korean Construction Materials Lab Deteriorated Concrete	270	449	66%

Tension Shear Strength

Test Location	Before Treatment PSI	After Treatment PSI	% Change
NDT Laboratory (Epoxy bond – concrete failure)	300	500	67%
Rand University - South Africa	354	468	32%

Property: Concrete Porosity

Problem: Micropores and cracks which allow air, water, salt and contaminants (acids) to penetrate concrete and cause deterioration of the cement and corrosion of reinforcing steel

Products: **SRS 4000**

Test Methods

Germann GWT: Measures concrete permeability as mm/sec at 0.5 to 2.5 BAR of pressure

Water Column Absorption – Measures rate of water absorption at atmospheric pressure as cc/hour

Rapid Chloride Permeability – ASTM C-1202 and AASHTO T-277 measure permeability in terms of conductivity of concrete in Coulombs

Chloride Ion Permeability – AASHTO-7259 measures the degree and depth of chloride ion penetration as sodium chloride

Test Results

Germann GWT – Flux Rate

Project/Location	BAR Pressure	Flux Rate Mm/sec x 10-3		% Change
		Before Application	After Application	
PA - Turnpike Bridge	1.5	1.08	0.02	98%
Korean Construction Materials	1.0	8.9	2.8	69%
Korean Construction Materials in Lab	1.0	3.9	0.5	87%
Seymour Johnson AFB	1.0	4.33	0.22	95%
New Jersey Turnpike Bridge	3.0	0.24	0.022	91%
Alcosan Sewage Plant	2.5	0.48	0.12	75%
Rand University - South Africa	0.5	3.5	0.5	85%

Water Column Absorption

Source	% Decrease Water Column		% Change
	Before Treatment	After Treatment	
Pittsburgh Test Lab	14 day - 10%	14 day - 0%	100%
	28 day - 13%	28 day - 3%	77%

Rapid Chloride Permeability

Source	Coulombs		% Change
	Before Treatment	After Treatment	
American Engineering Testing	350	300	14%
American Engineering Testing	320	290	9%
American Engineering Testing	1600	1200	25%

Chloride Ion Permeability

Source	Chloride Content Wt %		% Change
	Before Treatment	After Treatment	
Pittsburgh Testing Lab 0.5 - 1.0 inches	0.16	0.11	31%
Korean Construction Materials Lab 0.5 - 1.0 inches	0.003	0.002	33%
Rand University - South Africa 0.5 - 1.0 inches	0.124	0.059	52%

Properties: Modification of Concrete Cement Chemical Properties of: pH, Acid Reactivity and Water Soluble Chlorides and Chemical Contaminants

Products: **SRS 4000**

Problems: Attack of concrete by acids causing surface erosion, concrete chemical condition causing rebar corrosion, and contamination of concrete

Test Methods and Results

Concrete Acid Reactivity

Inorganic and organic acids will react with free calcium in cement. The amount of free calcium and level of reactivity can be measured by observing the reaction of concentrated hydrochloric acid on the concrete surface.

Location	Before Treatment	After Treatment
Field and Laboratory	Violent foaming reaction with surface etching	Little or no reaction on the surface

Concrete pH

The pH of fresh concrete is 12 to 13. Acids from the atmosphere (CO₂ and SO₂) penetrate and react with the free calcium to lower the pH. High pH inhibits rebar corrosion. Concrete pH is measured by exposing a fresh surface at a range of depths, and spraying a mixed indicator dye and observing the color change or measuring the pH of a water-extracted concrete sample using a pH meter.

Test Location	Before Application	After Application	% Change
Matco Associates Inc. 0 - 2.0 inches	Edges 5	Edges 9	+ 80%
	Center 9	Center 12	+ 33%

Reduction of Water-Soluble Chlorides

Water-soluble chlorides in the concrete cement phase catalyze rebar corrosion. Conversion to the water insoluble state will deactivate them. Concrete samples taken at various depths are extracted with water and the chloride content measured using the electrode method.

Test Location	ppm Water Soluble Cl ⁻		% Change
	Before Application	After Application	
Pittsburgh Testing Laboratory			
1.0 inch depth	6500	2700	-58%
2.0 inch depth	3300	1100	-67%
Korean Construction Materials Institute			
0.5 inch depth	580	360	-38%
1.0 inch depth	240	160	-33%

Contaminant Purging

Contaminants such as soil, chemicals, salt, etc. trapped in the micropores of the cement can be displaced and purged to the concrete surface.