SURTREAT®

PENNSYLVANIA TURNPIKE BRIDGE

CASE STUDY

PROBLEM

Restoration and protection of the concrete and steel components of the bridge

STRUCTURE

Pennsylvania Turnpike Bridge EB-526 Sandy Hill Road at Mile Marker 279.31

PROBLEM

Bridge EB-526 carries Sandy Hill Road over the Turnpike at Mile Marker 279.31. The bridge was constructed in 1952 using steel reinforced, air entrained concrete. The road surface is asphalt over concrete. The bridge is in relatively good condition, with some signs of surface deterioration and rebar corrosion.(Photo I)

The restoration and protection plan called for: cleaning the bridge surface to remove accumulated grime, removal of the asphalt pavement, application on SURTREAT TPS II to all concrete surfaces, placement of a poured in place hot rubber membrane on the bridge deck, replacement of the asphalt pavement, repair of cracks and application of REPEL-10, a high performance silicone water repellent.

OUR PROCESS

The bridge has about 12,000 sq. ft. of concrete surface, The bridge deck has 2,500 sq. ft of surface and the superstructure 9,500 sq. ft. The bridge superstructure was cleaned by first applying a water soluble nonhazardous cleaning compound, using pressure fed rollers (Photo 2), allowing it to sit on the surface and then washing away the released dirt with high pressure water. (Photo 3)

SURTREAT TPS II was applied to the clean surface in two application cycles using pressure fed rollers. (Photo 2,4,5)After allowing SURTREAT TPS II to penetrate and cure for one day REPEL-I0 was applied to the superstructure. (Photo 6) REPEL-I0 is a high performance, penetrating silicone water repellent, which is listed in Penn Dot Bulletin No. 15.

Cracks and open joints in the concrete were filled with a one part moisture curing urethane elastomer. Asphalt pavement was removed from the bridge deck using a milling head to expose the concrete bridge deck surface, SURTREAT TPS II was applied to the deck in two saturation level applications. (Photo 7) The SURTREAT TPS II was allowed to penetrate and dry for one day and the surface was then wetted with water to penetrate any residual Surtreat on the surface into the concrete. (Photo 8)

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The deck was allowed to dry for two days and 10 gallons of a cutback asphaltic tie coat were applied to the concrete surface. (Photo 9) Permaquik, a hot rubber liquid membrane was poured in place at an average thickness of 100 mils. Cracks and joints were reinforced with polyester tape. (Photo 10) The joints at the interface between the concrete deck and the road surface were filled with hot rubber and reinforced. The deck-curb interface was further scaled by bonding a sheet of rubber along the two surfaces. (Photo 11) The rubber membrane was covered with felt roofing boards to protect it from damage. (Photo 12) Several inches of Penn Dot Specification asphalt pavement was then placed over the rubber membrane. (Photo 13)

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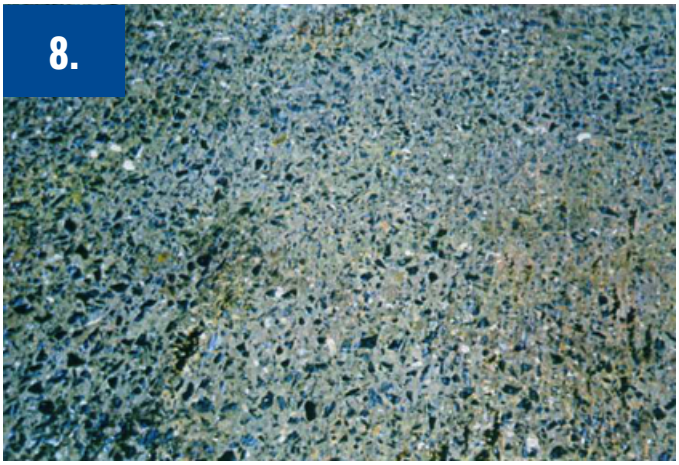

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PROJECT RESULTS AND MEASUREMENTS

Cleaning the concrete surface resulted in a significant improvement in appearance as can been seen by comparing Photos I and 2 with 4, 5 and 6, Besides improving appearance, surface cleaning removes acidic residue and mold which can cause concrete deterioration and opens the surface to allow SURTREAT TPS II and REPEL-10 to penetrate.

SURTREAT TPS II has the demonstrated ability to increase concrete strength, reduce porosity, increase pH (reverse carbonation), reduce chlorides, make concrete inert to reaction with acids and inhibit rebar corrosion. Tests were run before and after applications of SURTREAT TPS II to measure the change in these concrete and rebar properties. The following is a description of the results obtained and test methods used.

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(A) CONCRETE STRENGTH

Concrete strength was measured on the bridge deck curb using the CAPO Pull Out method. This measures the force required to pull out a 2 inch diameter, one inch thick plug from the concrete surface. The force is measured in kilo Newtons (kN) and has been correlated with cylinder compression strength in psi for reference purposes. The conversion table is in the Appendix Section.

CONDITION	PULL OUT FORCE (KN)	COMPARITIVE COMPRESSION – PSI
BEFORE APPLICATION	22.3	3,215
AFTER APPLICATION	32.8	5,038
CHANGE	10.5	1,823

This may seem like an unexpectedly high increase in strength. To put it in perspective the plug pulled out before the Surtreat application shattered, while the plug pulled out after treatment stayed in one piece as shown in Photo 14. Also, pull out strength increases of 2400 psi and 980 psi were recently measured on two Penn Dot bridge projects performed by Surtreat Pennsylvania. The difference in degree of increase is related primarily to the original concrete strength and condition. The weaker, more porous concrete exhibiting greater increase in strength.

(B) WATER PERMEABILITY

Water permeability was measured on the bridge deck curb using a Germann Instrument pressurized water permeability cell, The cell is fixed on the concrete surface using clamps and a glued in-place gasket. The cell is filled with water and pressurized to I atmosphere (15 psi), and the rate of water penetration measured in cc/minutes: The following results were obtained before and after application of SURTREAT TPS II.

CONDITION	SPECEFIC MEASUREMENT	RATE CC/MINUTE	
BEFORE APPLICATION	10.cc in 4 minutes	2.5 cc/minute	
AFTER APPLICATION	0.5 cc in 10 minutes	0.05 cc/minute	
CHANGE		2.45 cc/minute	98% CHANGE

This indicates that the permeability of the concrete was reduced by approximately 98% for a given pressure.

REPEL-10 is specifically designed to inhibit water permeation 100%.

(C) TOTAL CHLORIDES

Total chlorides in the concrete on the bridge deck were measured using a sample cut from the top one inch of a 1/2 inch diameter core taken from the curb. The sample was pulverized and dissolved in acid and weight percent chloride ion measured using a calibrated electrode measuring the solutions electrical potential. The sample contained 0.032 weight percent chloride ion or 320 PPM. This is a low chloride concentration, and is well below the 800 PPM level usually associated with rebar corrosion promotion. For this reason no further chloride measurements were made. Usually the application of Surtreat TPS II reduces the amount of water soluble chlorides by 50%, and water soluble chlorides typically account for about 50% of the total chlorides.

(D) DEPTH OF CARBONATION AND PH

The pH of 1/2 inch diameter cores taken from the bridge deck curb was measured using a multi range indicator dye mixture. The pH of the core taken before Surtreat application showed a depth of carbonation of 1/4 to 1/2 inch or a pH of 8 to 9 at this depth versus a pH of 12 below 1/2 inch. This is a modest degree of carbonation for a structure of this age. After application of SURTREAT TPS II the pH was increased in the carbonated area to 11.5 showing that this form of deterioration had been reversed.

(E) ACID REACTIVITY

Acid reactivity of the bridge deck concrete curb was measured by placing a drop of concentrated hydrochloric acid on the surface and observing the reaction. Before the Surtreat applications the acid gave a vigorous foaming reaction and etched the surface. After the SURTREAT TPS II application the acid drop did not foam, penetrate or react in any way with the concrete surface.

(F) SILVER CHLORIDE HALF CELL CORROSION REBAR POTENTIAL

The corrosion potential of steel bars embedded in the ends of the bridge deck parapet which hold the guard rail cable was measured before and after application of SURTREAT TPS II. It is generally accepted that silver chloride half cell potentials above a negative 200mV indicates that corrosion may be occurring. The higher the negative mV reading the greater the corrosion potential. Photo 15 shows the corrosion potential measurement procedure in process. Measurements were made on all four parapet ends on each of the two steel bars before and after application of SURTREAT TPS II.

LOCATION	BEFORE APPLICATION NEGATIVE MV AVERAGE	AFTER APPLICATION NEGATIVE AVERAGE
NW - TOP	235	150
NW - BOTTOM	160	130
NE - TOP	217	127
NE - BOTTOM	50	63
SW - TOP	165	96
SW - BOTTOM	435	382
SE - TOP	285	150
SE - BOTTOM	400	247
AVERAGE	243	168

Examination of the above measurements indicates that the application of SURTREAT TPS II took the imbedded steel bars from a corrosive to a noncorrosive electrochemical condition.

(G) WATER REPELLENCY

SURTREAT TPS II inhibits water penetration by sealing porosity, REPEL-10 inhibits water penetration by reducing surface tension so that the water Will not cling to or wet the concrete surface. Photo 16 presents a visual indication of the water repellent effect before and after application of REPEL-10. The center section of the bridge was treated withREPEL-I0. Shortly thereafter it rained producing the dramatic contrast in color between the wet untreated area and the dry treated area in the center of the bridge.

The effective value of the rubber membrane should be obvious. It will present an impermeable barrier preventing water and salt from passing from the road surface into the reinforced concrete deck. The SURTREAT TPS II applied will inhibit any corrosive potential present prior to placement of the membrane.

CONCLUSION

The work was completed in the pre-planned two week period despite several days of poor weather.

SURTREAT® RESTORATION OF PA TURNPIKE BRIDGE EB - 526, TEST RESULTS TWO YEAR REVIEW (1996-98)

PROJECT DESCRIPTION

The Pennsylvania Turnpike bridge EB-526, mile marker 279.31 (Sandy Hill Road Bridge) was restored by Surtreat Corp. in the spring of 1996. The restoration process included pressure washing the structure, installation of SURTREAT TPS II, minor surface repairs and crack scaling and application of SURTREAT REPEL. A hot rubber membrane and two inches of asphalt overlay were also installed on the deck.

SURTREAT GPHP

Performance Characteristics SURTREAT TPS II is a water based formulation which when applied to a concrete surface permeates to combine with cement and solidify inside the concrete microstructure to:

- Increase compression strength
- Inhibit rebar corrosion
- Reduce porosity and inhibit penetration of water and chlorides
- Complex and purge water-soluble chlorides
- Pacify alkali-silica reaction
- Elevate pH

TESTING

The testing was performed before and after the application of SURTREAT TPS II and to verify the beneficial effects of the treatment. Tests included Compressive Strength (CAPO Pull-Out), Water Permeability (Pressure chamber), pH (Indicator dye). Acid Reactivity (Concentrated HC1), Corrosion Potential (Silver chloride half cell) and Chloride Content.

TEST RESULTS

CORROSION POTENTIAL

Corrosion Potential measurements were taken in different locations throughout the bridge using a silver chloride half cell method. The results were averaged at -243 mV before treatment and -168 mV after treatment (-190 mV is the threshold for corrosion). As the bridge showed excellent water repellency and conditions for the test (wet surface) could not be repeated, any attempt to repeat the test in 1998 would provide results that could not be compared to those of 1996. The bridge structure shows no symptoms of corrosion.

COMPRESSIVE STRENGTH

Compressive strength was was measured using the CAPO Pull Out method since it measures the strength of the top 1.5 -2 inches of the concrete where penetration has occurred.

CONDITION	PULL OUT FORCE (KN)	COMPARABLE COMPRESSION (PSI)
1996		
BEFORE APPLICATION	22.3	3,215
AFTER APPLICATION	32.8	5,038
CHANGE	10.5	1,823
1998		
AFTER 2 YEARS	34.0	5,429
TOTAL INCREASE	11.7	2,214

The fact that compression strength went up over time is consistent with the notion that the fits of SURTREAT treatment become greater over time as the chemical reaction progresses.

WATER PERMEABILITY

Water permeability is measured as the susceptibility of the concrete to absorb a certain amount of water under a constant pressure in a specific period of time.

CONDITION	SPECEFIC MEASUREMENT	RATE CC/MINUTE
1996		
BEFORE APPLICATION	10cc in4 minute	2.5cc per minute
AFTER APPLICATION	0.5cc in 10 minutes	0.05cc per minute
CHANGE		98% reduction
1998		
AFTER 2 YEARS	1cc in I0 minutes	0.10cc per minute
TOTAL INCREASE		96% reduction

The surface retained the ability to resist penetration by liquids, the porosity was reduced remained virtually unchanged (measured at hydrostatic pressure of 30 psi).

REACTIVITY

Reactivity was tested by applying a drop of concentrated HC 1 to the surface.

- Before treatment violent reaction. surface etching After treatment no reaction, no surface etching
- After two years no reaction, no surface etching

CHLORIDE ION CONTENT

Chloride ion content was established to be 0.032 weight percent (320 PPM) which is below 800 PPM level usually associated with chloride induced corrosion. Since the base line for Chloride ion and water permeability of the concrete after treatment are low no chloride testing was required in 1998. Generally SURTREAT treatment reduces water-soluble chloride content by approximately 50 % within the lop 1-2" of concrete surface.

WATER REPELLENCY

Water repellency after treatment was tested by applying water to the concrete surface.

1996 - Excellent water repellency no surface wetting.

1998- Excellent water repellency no surface wetting.

SURTREAT REPEL is also acting as an excellent safeguard against dirt and grime keeping the bridge very clean. This accounts for the reflective properties and greatly improved night visibility of the structure especially when driving conditions are poor (rain, snow).

BASED ON THE RESULTS OF A TWO YEAR STUDY THE BRIDGE HAS RETAINED THE CHEMICAL AND PHYSICAL PROPERTIES DELIVERED AS RESULT OF SURTREAT ® TREATMENT.

LEFT: *Surtreat being applied to bridge.*

RIGHT: *Permaquik water proofing system applied..*

We invite your comments, questions, and inquiries.
Reach us at one of the below.

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