NEBRASKA

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DEPARTMENT OF TRANSPORTATION

Resealing Concrete Median Barriers with Penetrating Concrete Sealers

Principle Investigators

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M&R MATERIALS & RESEARCH

Background

In 2013, concrete median barriers along I-80, I-480, and I-680 in Omaha, and West Limits North 27th street in Lincoln, Nebraska showed Alkali Silica Reaction (ASR) deterioration (Figure 1). To prevent further damage, the barriers were sealed with penetrating concrete sealer (PCS). The Department programmed a project in 2022 to seal additional concrete median barriers and to reapply PCS to the barriers that were sealed in 2013. However, the Pavement Design Engineer expressed the need for more information before the Lincoln and Omaha median barriers got programmed for the application and reapplication of concrete sealer.

Figure 1 - Concrete median barriers along I-80, I-480, and I-680 showed ASR deterioration.

Purpose of the Investigation

The purpose of this investigation was to determine:

1. if sealer remained in the structure after 9 years,
2. if power washing as a surface preparation is necessary,
3. the appropriate sealer application rate.

Field Investigation - Application and Analysis

The Pavement Design Engineer selected a test site for PCS reapplication on the eastbound lanes of I-680 near the Sprague Street bridge. Maintenance power washed a section of the barrier as the prepared surface test section. A section adjacent to the power washed section was designated as the control section and received no surface preparation. The PCS selected for this project was on the NDOT Approved Product List (APL).

The chemical engineer calculated the surface area of the barrier and estimated the amount of sealer needed to cover the test sections. The specific gravity of the sealer was determined by the chemistry laboratory at the Department. The sealers were loaded into four 3 ½-gallon handheld industrial concrete sprayers in the Portland Cement Concrete (PCC) laboratory at the Material and Research Division. Each sprayer was weighed three times; empty, loaded with sealer, and after sealer application. The application rate for each section was calculated from the mass change of each sprayer.

Maintenance power washed a 300 ft-long section of the barrier on March 25, 2022. Concrete moisture affects sealer penetration; so, the barriers were allowed to dry approximately 72 hours after they were power washed. The research team applied the sealer on March 29, 2022, following the manufacturer's application instructions, working from the bottom up and applying an amount that would bleed 6-8 inches down the surface. One coat of material was applied to the barriers in the test section. The linear distance covered was measured with a measuring wheel and the surface area calculated from barrier construction plans. The product appeared clear; both when applied to the barrier and after it dried. The air temperature was 45°F and relative humidity 48% at the time of application. Wind was blowing from southeast at approximately 10-12 MPH, with partly cloudy skies.

Figure 2 - The coring crew used a handheld coring drill to cut cores from the barrier.

The coring crew took four, 3"x3" cores from the barrier for this research (Figure 2). Two cores were taken from each section (control and power washed): one before sealer application and one six days after application. All four cores were taken to the PCC lab where they were examined for depth of penetration via visual examination. Finally, they were taken to the chemistry lab and examined via a blue dye test (BDT).

Results

Control Section

Researchers applied approximately 1.1 gallons of PCS to approximately 210 ft^2 area of the control section by two members of the coring crew (Figure 3). The calculated application rate was 191 ft^2/gallon. The sealer dried in approximately 30 minutes. The pre-application and post-application cores were examined for depth of penetration. The pre-application core showed no observable sealer present in the visual examination or the BDT (Figure 4). The post-application core showed partial penetration as deep as 1 inch, however PCS penetration was blotched (Figure 5). Researchers observed PCS wicking into cracks in the structure, some of which were likely blocked with dirt and debris causing the blotched penetration pattern. The results for control section are listed in Table 1.

Figure 4 - PCS was applied to the designated control section.

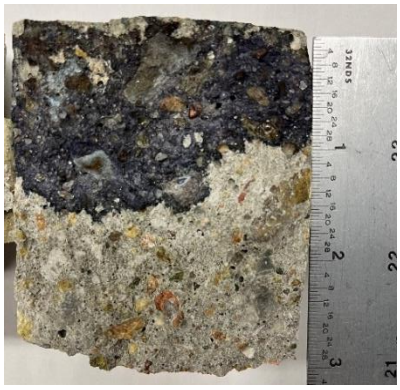

Figure 5- The control section core before sealer was applied.

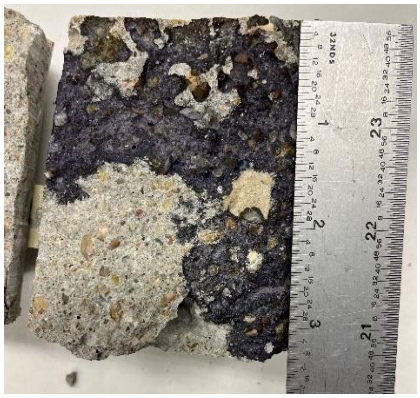

Figure 3- The control section core after sealer was applied.

Table 1 - Results from the control section (no power washing).

Location	Depth of Penetration Pre-Application	Depth of Penetration Post-Application	Application Rate	Drying Time	Weather Conditions
I-680	no observable presence	partial coverage along crack lines as deep as 1"	191 ft^2/ gallon	30 mins	45°F 48% Humidity Partly Sunny

Power Washed Section

Researchers applied approximately 3.15 gallons of PCS to about 900 ft^2 area of the control section by two members of the research team (Figure 6). The calculated application rate was 285 ft^2/gallon. The sealer dried in approximately 30 minutes. The pre-application and post-application cores were examined for depth of penetration. The core taken from the power washed section prior to PCS application showed little to no sealer present (Figure 7). The core from the power-washed section after application showed considerable depth of penetration. Researchers observed PCS wicking into cracks in the structure. Power washing appears to have cleared blockages and allowed thorough sealer penetration.

Figure 7 - The power washed section after sealer was applied.

Figure 8 - The power washed section core before sealer was applied.

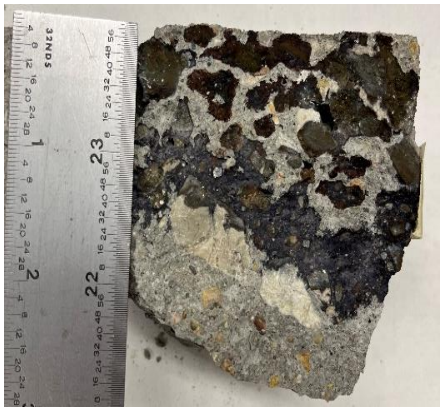

Figure 6 - The power washed section core after sealer was applied.

Table 2 - Results from the power washed section.

Location	Depth of Penetration Pre-Application	Depth of Penetration Post-Application	Application Rate	Drying Time	Weather Conditions
I-680	no observable penetration	extensive coverage along crack lines as deep as 1 ½"	285 ft^2/ gallon	30 mins	45°F 48% Humidity Partly Sunny

Observations

Based on the observations from the depth of penetration test, a significantly larger area of coverage is obtained by preparing the surface for application by power-washing which removes debris, dirt, ASR, and other materials which may block the sealer from penetrating. It is noted that the two test sections received different application rates, however both were applied according to the manufacturer's recommendation for vertical surface. The pattern of penetration is also more uniform in the core from the power-washed section, indicating that cleaning the surface will provide the best penetration.

Based on the results of this research, the Department will require the following:

Material Requirements:

The penetrating concrete sealer shall be selected from the Nebraska Approved Products List (APL)
Category: Concrete, Material: Penetrating Concrete Sealer

Prior to Applications:

All vertical surfaces shall be cleaned by power washing
All vertical surfaces should be dry for 72 hours prior to application.

Vertical Application:

Concrete Sealer shall be applied with low pressure sprayer (10 -25 psi) or roller to thoroughly saturate the concrete surface.

Application Rates:

According to the manufacture recommended rate and/or determined by application to a control section. Following the manufacturer's application instructions, working from the bottom up and applying an amount that would bleed 6-8 inches down the surface.

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			Josh Rodriguez
			Mike Molczyk

References

[1] Methods for Evaluating and Treating ASR-Affected Structures: Results of Field Application and Demonstration Projects- Volume II: Details of Field Applications and Analysis, FHWA-HIF-14-0003 Report, November 2013