



Concrete Bridge Deck Crack Sealant Evaluation and Implementation

Minnesota
Department of
Transportation

**RESEARCH
SERVICES
&
LIBRARY**

**Office of
Transportation
System
Management**

Matthew S. Oman, Principal Investigator
Braun Intertec Corporation

September 2014

Research Project
Final Report 2014-34



To request this document in an alternative format call [651-366-4718](tel:651-366-4718) or [1-800-657-3774](tel:1-800-657-3774) (Greater Minnesota) or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

Technical Report Documentation Page

1. Report No. MN/RC 2014-34	2.	3. Recipients Accession No.	
4. Title and Subtitle Concrete Bridge Deck Crack Sealant Evaluation and Implementation		5. Report Date September 2014	
		6.	
7. Author(s) Matthew S. Oman		8. Performing Organization Report No.	
9. Performing Organization Name and Address Braun Intertec Corporation 11001 Hampshire Avenue S Minneapolis, MN 55438		10. Project/Task/Work Unit No.	
		11. Contract (C) or Grant (G) No. (c) 95439	
12. Sponsoring Organization Name and Address Minnesota Department of Transportation Research Services & Library 395 John Ireland Boulevard, MS 330 St. Paul, Minnesota 55155-1899		13. Type of Report and Period Covered Final Report	
		14. Sponsoring Agency Code	
15. Supplementary Notes http://www.lrrb.org/pdf/201434.pdf			
16. Abstract (Limit: 250 words) A total of 12 sealant products were applied on the Smith Avenue High Bridge in St. Paul and evaluated over a three-year period. Details, such as surface preparation and application methods, were documented for each product and are conditions specific to each product. Sealant performance was evaluated through field permeability testing, visual observations, and petrographic examination. Visual observations provided evidence that approximately 67 percent of test sections were performing effectively after one winter but only 4 percent after two winters. After three winters, 58 percent of the test locations were visually characterized as ineffective and 42 percent as partially effective. Product performance significantly reduced over the third winter, primarily due to major loss of sealant and surface sand materials. Coring was performed after the second winter, and the cores were photographed and subjected to a petrographic evaluation. The observed depth of sealant penetration was highly variable and likely is dependent on the presence of debris within the crack, original crack width, and the deck temperatures during application. The predominant failure mode observed under magnification was detachment from the crack face and not within the sealant materials. Based on numerous factors, four epoxy and three methacrylate products were recommended for consideration on MnDOT's Approved Products List. Each product recommendation contains the surface preparation and application method conditions under which they were applied. It is also recommended that MnDOT look into increasing the frequency of its routine crack sealing maintenance program from the current five-year cycle.			
17. Document Analysis/Descriptors Sealing compounds, Coatings, fillers and paints, Epoxy, Methacrylate, MMA, HMWM, Cracking, Maintenance, Bridges		18. Availability Statement No restrictions. Document available from: National Technical Information Services, Alexandria, VA 22312	
19. Security Class (this report) Unclassified	20. Security Class (this page) Unclassified	21. No. of Pages 164	22. Price

Concrete Bridge Deck Crack Sealant Evaluation and Implementation

Final Report

Prepared by:

Matthew S. Oman
Braun Intertec Corporation

September 2014

Published by:

Minnesota Department of Transportation
Research Services & Library
395 John Ireland Boulevard, MS 330
St. Paul, MN 55155

This report represents the results of research conducted by the authors and does not necessarily represent the views or policies of the Minnesota Department of Transportation and/or Braun Intertec Corporation. This report does not contain a standard or specified technique.

The authors and the Minnesota Department of Transportation and/or Braun Intertec Corporation do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to this report.

ACKNOWLEDGMENTS

The author would like to thank the following members of the Technical Advisory Panel (TAP) for their participation in this project and valuable input:

- Sarah Sondag, MnDOT Bridge Office, technical liaison
- Bruce Holdhusen and Daniel Warzala, MnDOT Research Services, administrative liaisons
- Other members and guests
 - MnDOT Bridge Office – Mark Spafford and Ed Lutgen (former technical liaison)
 - MnDOT Office of Materials – Allen Gallistel, Ron Mulvaney, and Rob Golish
 - MnDOT Metro Maintenance – Pat O'Brien and Jack Pirkl

The author would also like to thank Jim Lilly for his role as MnDOT's technical liaison and Jim McGraw for his involvement with the TAP prior to their retirement from MnDOT. The author would also like to thank Greg Bauer for his role as co-Principal Investigator prior to his departure from Braun Intertec and his continued assistance. Finally, the author would like to thank Nick Hansen and John Weiss from Braun Intertec for their involvement during field evaluation and testing and Justin Lashley from Braun Intertec for his final deliverable review.

Table of Contents

CHAPTER 1:	PROBLEM STATEMENT AND SCOPE.....	1
1.1	Problem Statement	1
1.2	Contract Scope	1
CHAPTER 2:	BACKGROUND	3
2.1	General.....	3
2.2	Properties	3
2.3	Application.....	3
	2.3.1 <i>Surface Preparation</i>	3
	2.3.2 <i>Product Type</i>	4
	2.3.2 <i>Method</i>	5
	2.3.3 <i>Temperature</i>	5
	2.3.4 <i>Depth of Penetration</i>	5
2.4	Product Evaluation.....	5
2.5	MnDOT Approved Products.....	6
2.6	MnDOT Current Practices	6
CHAPTER 3:	TEST METHOD AND BRIDGE SELECTION.....	7
3.1	Test Method Selection	7
3.2	Bridge Selection.....	8
CHAPTER 4:	FIELD EVALUATION	9
4.1	Crack Survey.....	9
4.2	Test Sections	10
4.3	Products.....	10
4.4	Sealant Application.....	14
CHAPTER 5:	CRACK TESTING AND VISUAL OBSERVATIONS	18
5.1	Crack Testing: Pre-Sealing	18
5.2	Crack Testing: Post-Sealing.....	19
5.3	Crack Testing: 2012 (one winter)	19
5.4	Crack Testing: General Comments.....	22
5.5	Visual Observations	22
5.6	Visual Observations: 2012 (one winter)	23
5.7	Visual Observations: 2013 (two winters)	24
5.8	Visual Observations: 2014 (three winters)	25
5.9	Visual Observations: Summary	25

CHAPTER 6:	CONCRETE CORING AND PETROGRAPHIC OBSERVATIONS.....	27
6.1	2013 Coring (two winters).....	27
6.2	Laboratory Petrographic Observations	31
CHAPTER 7:	CONCLUSIONS AND RECOMMENDATIONS	36
7.1	Conclusions.....	36
	7.1.1 <i>Permeameter Test Results</i>	36
	7.1.2 <i>Visual Observations</i>	37
	7.1.3 <i>Petrographic Observations</i>	37
	7.1.4 <i>Application and Surface Preparation</i>	38
	7.1.5 <i>Material Properties</i>	39
7.2	Recommendations.....	39
7.3	Suggestions For Future Evaluation.....	42
REFERENCES	44

APPENDICES

Appendix 1: Top of Deck Crack Survey

Appendix 2: Bottom of Deck Crack Survey

Appendix 3: Test Section Layout, Products, and Evaluation Points

Appendix 4: Evaluation Point Photo Log (2012, 2013, and 2014)

Appendix 5: Product Technical Data Sheets

Appendix 6: Petrographic Photo Log

LIST OF FIGURES

Figure 1.	NCAT Field Permeameter	7
Figure 2.	Plan View of the Bridge Area Surveyed.....	9
Figure 3.	Test Sections, Locations, and Products.....	10
Figure 4.	Air and Deck Temperatures During Product Application	15
Figure 5.	Typical Operations During Application.....	16
Figure 6.	Crack Permeability Testing on the Smith Avenue High Bridge.....	18
Figure 7.	Products With No Cracking After One Winter.....	23
Figure 8.	Coring on the Smith Avenue High Bridge.....	27
Figure 9.	Patching the Core Holes on the Smith Avenue High Bridge.....	28
Figure 10.	Final Patched Bridge Deck and Original Test Location	28
Figure 11.	Typical Petrographic Photo Identifying Stabilizing Agent.....	31
Figure 12.	Sample As-Received Petrographic Observation Photos	35
Figure 13.	Sample Cut and Polished Petrographic Observation Photo.....	35
Figure 14.	Accuflex Gel-Seal Compared to Control Section.....	36
Figure 15.	Application Temperatures and Product Performance	38

LIST OF TABLES

Table 1.	Sample Bridge Crack Treatment Table.....	4
Table 2.	Test Sections, Locations, and Products.....	11
Table 3.	MnDOT Requirements and Material Properties – MMA.....	12
Table 4.	MnDOT Requirements and Material Properties – Epoxy.....	13
Table 5.	Material Properties of Selected Products – Silicate.....	14
Table 6.	Weather Data: Sealant Application to Three Days Prior to Application	14
Table 7.	Product Application Observations	17
Table 8.	Permeameter Head Loss – 2011 Pre-Application.....	21
Table 9.	Visual Observations Summary	26
Table 10.	Concrete Core Sampling Conditions	30
Table 11.	Laboratory Petrographic Observations	34
Table 12.	Evaluation Factors	40
Table 13.	Product Ranking Matrix Schematic	41
Table 14.	Recommended Epoxy Products, Application, and Performance Summary	42
Table 15.	Recommended MMA Products, Application, and Performance Summary	42

EXECUTIVE SUMMARY

The purpose of this project was to field evaluate crack sealant products and incorporate a 2009 University of Minnesota report published for the Minnesota Department of Transportation (MnDOT) titled *Crack and Concrete Deck Sealant Performance*. The work included examination of various crack sealant materials (deck sealants were not included) on an in-service bridge over a period of three winters.

The project included a total of 12 sealant products and three control sections. The Smith Avenue High Bridge (Br #62090) in St. Paul was selected because, according to maintenance records, it had not been sealed since 2002. The bridge also contained sufficient deck area to support the number of products included in the study.

The list of products evaluated in this study was developed in consultation with the Technical Advisory Panel (TAP). Several products included are on the current MnDOT Approved Products List while several are not. The MnDOT Bridge Office communicated with the product manufacturers and explained that the surface preparation, application methods, etc. would be documented and included as part of its product requirements. Several vendors opted to break their test section into two subsections and include an air blown section (MnDOT standard practice) and a sand or shot blast prepared section.

Field permeameter testing provided an initial step in the pre-qualification process, but visual observations and crack monitoring, in addition to petrographic examination, were necessary to evaluate sealer performance. Visual observations were performed each spring over a three year period. Each test location (two per product) was qualitatively rated for sealant effectiveness and given subjective ratings (values) of Effective (3), Semi-effective (2), and Ineffective (1). After one winter, 15 of the 24 product test locations were documented as effectively sealed. After two winters, only one test location remained in the effectively sealed category. After three winters, 18 (75%) of the test locations were documented as ineffectively sealed and 6 (25%) were documented as semi-effectively sealed.

Coring and petrographic observations were a necessary task to provide a detailed and thorough evaluation of the products and cracks. Extracting a statistically significant number of cores was not feasible to represent the various types of cracks, surface preparation methods, and sealant materials. As a result, the information obtained from the petrographic evaluation is considered, at most, semi-quantitative comparison of the various materials. The cores were not subjected to a full ASTM C856 petrographic examination, and the petrographic observation methods were specific to this project.

Coring was performed after the second winter in the spring of 2013. The observed depth of penetration was highly variable and is likely dependent on the original crack width and the deck temperatures during application. The primary influence on the depth of penetration was the presence of debris; every cored crack was filled with debris from the top (bridge surface) to the base of the core, regardless of surface preparation.

Two failure modes, detachment from the crack face and a lack of completely “bridging” the original crack, were documented during the petrographic observations. The predominant failure mode found in this study was detachment from the crack face, not within the sealant itself. Almost all sealants detached from one face of the crack, indicating that the sealant did not fail in cohesion but rather in adhesion between the crack face and the sealant. In some cracks, it was apparent that the sealant may have at one time “bridged” the crack but that was no longer the case at the time of the petrographic observations. In the cases where this was observed, the sealant was still attached to both faces of the crack.

The following highlight the conclusions:

- Most products appeared to reduce permeability after one winter, with the exception of Accuflex Gel-Seal. This product is unique to the experiment as it was the only product that is neither an epoxy nor methacrylate resin.
- Based on visual observations after one winter, most products showed signs or preliminary signs of cracking. There were several exceptions, but after a second winter, cracking was visually detectable at these test locations, too.
- The consensus opinion during field review after three winters was that performance was drastically reduced across the board from the previous field review. The major differences observed during this review were major loss of sealant and sand materials.
- After three winters, no product was performing at a fully acceptable level (subjective rating = 3). Seven products were given a rating of 2 (semi-effective) in at least one test location.
- In general, methacrylates and HMWM achieve deeper penetration than epoxy crack sealers. One epoxy achieved a similar depth of penetration (~0.3-inch) but has a low viscosity similar to that of methacrylate (MMA) and high molecular weight methacrylate (HMWM) sealers.
- No material property appears to be an indicator of field performance. This is the case for MMA, HMWM, and epoxy sealers.

The following highlight the recommendations:

- Four epoxy sealant products and three MMA/HMWM sealant products were recommended for consideration on MnDOT’s Approved Products Lists for crack sealants. Each product recommendation contains the surface preparation and application method conditions under which they were applied.
- Based on visual observation and performance of products after three (and even two winters), it is recommended that MnDOT look into increasing the frequency of its routine crack sealing program from the current five-year cycle. If an increase in internal resources or funding is not available and a three-year cycle is not feasible, perhaps bridge candidates for sealing could be identified by structure type, age, condition, and/or other factors.
- Suggestions for future crack sealant evaluation based on lessons learned on this large-scale evaluation project are also included.

CHAPTER 1: PROBLEM STATEMENT AND SCOPE

1.1 Problem Statement

The University of Minnesota (U of M) published a report for the Minnesota Department of Transportation (MnDOT) titled “Crack and Concrete Deck Sealant Performance” in 2009 [1]. This report included a comprehensive literature review of bridge crack sealant materials and deck sealants, a performance survey, and product assessments. However, it did not include any field testing.

The purpose of this project was to field evaluate crack sealant products based on the U of M study. The work included examination of various crack sealant materials (deck sealants were not included) in a designated bridge deck over a three year period. The final deliverables included a comprehensive report with observations and recommendations and a separate best practices guidance document for MnDOT practitioners.

1.2 Contract Scope

MnDOT was responsible for providing a candidate bridge, providing traffic control and inspection access equipment as needed, and performing any required coring. Braun Intertec was responsible for conducting field and laboratory testing, preparing annual interim reports, and providing a comprehensive final report along with a guidance document for implementation by MnDOT.

The overall project included the following tasks and deliverables:

Task 1: Selection of Bridges, Products and Test Methods

Description:

- Select candidate bridge
- Select crack sealant products
- Determine test methods

Deliverables:

- Documentation of the Plan in tabular format (bridges, crack sealant products, laboratory tests, and
- Proof-of-concept field tests

Task 2: Initial Testing, Crack Repairs and Post-Repair Testing and Reporting

Description:

- Visually examine selected bridges
- Map the cracks
- Perform baseline testing
- Perform post-sealing testing

Deliverables:

- Report: including bridge selection, test methods and the rationale for test methods selected

Task 3: Inspection and Testing Report for 2011, 2012 and 2013

Description:

- Evaluate annual performance of the products and document visual observations of sealed and unsealed (control) cracks
- Extract cores for petrographic examination in 2013.

Deliverables:

- 2012 Baseline Report: Baseline report including crack maps, product and control layout, product application information, visual observations, permeameter results, photographs and interim conclusions and recommendations
- 2013 Interim Report: continuation report including updated visual observations of the sealed and unsealed cracks, core locations, petrographic observations of cores, and interim conclusions and recommendations.

Task 4: Final Report and Draft Guidance Document

Description:

- Submit final deliverables for MnDOT review.

Deliverables:

- Final Report
- Draft Field Guide

CHAPTER 2: BACKGROUND

2.1 General

This research project was initiated to field evaluate crack sealant products in Minnesota. Preceding work performed by the U of M in 2009 included a comprehensive literature review of crack and deck sealants, a performance survey, and product assessments [1].

A 2002 research assessment by the South Dakota Department of Transportation (SDDOT) conducted a survey of 40 northern states and Canadian provinces with respect to current bridge deck crack sealing strategies. A total of 25 states/provinces participated in the survey and 40% of respondents indicated that they employ a crack sealing program for concrete bridge decks [2]. Products identified included epoxy and methacrylate sealants.

The 2009 Minnesota study also included the use of other materials that are designed to react with free calcium in the concrete. Particularly, experiments have been conducted by MnDOT into the use of Accuflex Gel-Seal [1]. The product functions as both a deck and crack sealer, although medium to large cracks are not sealed. Crack sealers focused on in the Minnesota study included epoxy, high molecular weight methacrylates (HMWM), and methyl methacrylates (MMA).

2.2 Properties

In general, epoxy sealers tend to have higher bond strengths than HMWM and MMA sealers. However, HMWM and MMA sealers tend to achieve a great depth of penetration due to their low viscosities. The following are recommended from the U of M literature study [1]:

- Maximum viscosity
 - Epoxies: 500 cP (centipoise)
 - Methacrylates: 25 cP
- Tensile strength: 1160 psi
- Tensile elongation: $\geq 10\%$

A 2014 presentation by the Florida Department of Transportation (FLDOT) indicated that specifications should include a minimum of 10 percent for elongation of MMAs. However, it was also noted in the presentation that a minimum elongation of 20 percent should be specified on bridges supported by steel girders [4].

2.3 Application

2.3.1 Surface Preparation

It has also been noted that surface preparation has no impact on penetration depth of crack sealants [2]. The study indicated that the sandblasted surface produced the greatest water ingress and indicated this was likely caused by opening the surface pore structure during blasting. The recommended option was “do nothing”, but where excessive debris is noted, power broom/forced air is the preferred option. The U of M study points out that this contradicts

practices identified in their survey as most agencies indicated the use of some form of surface preparation [1].

The following surface preparations are recommended in the U of M literature study [1]:

- cracks should be cleaned by some form of surface preparation prior to sealing;
- the bridge deck should be dry for two to three days prior to sealing.

The Michigan Department of Transportation (MDOT) requires moisture testing on all contracted projects [3]. In addition, if moisture is suspected, a polyethylene sheet can be taped to the deck at least two hours prior to sealing. If excess moisture is present, condensation will appear on the polyethylene sheeting. The details of the test method are specified in ASTM D 4236.

2.3.2 Product Type

The Florida Department of Transportation (FLDOT) provides recommendations for sealant type, whether further investigation is necessary, or whether complete removal and replacement is required. The decisions are based on ranges of average crack widths and a calculated “Cracking Significance Range”. This calculated value is based on the ratio of the area of cracks to the area of a given evaluation lot. Categorical ratings of Cracking Significance Range include Isolated, Occasional, Moderate, and Severe [5].

Several large tables are presented in Section 400 of the FLDOT Specifications. A recent report published by MnDOT includes a simplified version of the FLDOT tables and a recreated version is shown in Table 1 [6]. The “Investigate” or “Remove and Replace” options are included for completeness but are not relevant to this particular research project.

Table 1. Sample Bridge Crack Treatment

Average Crack Width Range (in)	Crack Density Within Lot			
	Isolated (<0.005%)	Occasional (0.005% to < 0.017%)	Moderate (0.017% to < 0.029%)	Extensive (> 0.029%)
<0.004	No Treatment	No Treatment	No Treatment	MM
0.004 to <0.008			Epoxy or MM	Investigate
0.008 to <0.012		Epoxy or MM		
0.012 to <0.016	Epoxy or MM	Investigate	Investigate	Remove and Replace
0.016 to <0.020	Epoxy			
0.020 to <0.024	Epoxy			
0.024 to <0.028	Investigate			
>0.028	Investigate			

The table presents “Cracking Density Within Lot” which should be calculated for each particular project. For simplicity, however, this number is essentially average crack width divided by average crack spacing for full-width deck cracks.

2.3.2 Method

Crack sealants can be applied directly along a crack (“crack chase” or “bottle” method) or by a flood coat method. There is little published guidance regarding when to chase cracks and when to apply a flood coat. According to the Michigan DOT, a general rule of thumb is to use the crack chase method if crack spacing is greater than two feet [3]. However, this is not a hard and fast rule and other factors should be considered including deck size and surface texture (tining depth).

In a flood coat application, the sealant is poured on the deck surface and squeegees or brooms are used to spread the sealant to cover the entire surface. Typically with a flood coat, silica sand or other aggregate is broadcast on top of the sealant to provide texture and slip resistance.

2.3.3 Temperature

The gel time of sealants is directly related to temperature. If the product is applied at high temperatures, penetration depth can be limited due to rapid curing time [1].

Research suggests that crack sealing activities take place at night when the crack widths will typically be at their largest over a 24-hour period. Sealing cracks in this relatively wide condition could also conceptually increase the longevity of the bond because the crack will be a state of compression during the day and neutral at night [1].

Therefore, the following practices are recommended from the U of M literature study [1]:

- crack sealers should be applied between temperatures of 45 °F to 90 °F;
- ideally, crack sealers should be applied between 11:00 PM and 7:00 AM.

2.3.4 Depth of Penetration

Penetration depth of epoxy sealers is highly variable based on field studies [1]. Similar evidence exists for HMWM and MMA sealers. It should be noted that studies in other states identify penetration of HMWM and MMA to depths of two inches or greater, while a study conducted on a bridge on TH 100 in Minnesota, determined maximum penetration depths of 3/8-inch [1].

2.4 Product Evaluation

In a laboratory testing project published by the Wisconsin Department of Transportation (WisDOT), products were evaluated at several different crack widths [7]. It was concluded in that project that crack width did not appear to have a significant impact on the performance of the sealant. However, the failure mode typically depends on crack width; concrete failures are common in hairline cracks and bond and/or sealant failures are common in wider cracks. It was also determined that freeze-thaw cycles negatively affected sealant performance and should be evaluated in future studies.

A follow up project conducted by WisDOT to evaluate field performance identified the following approaches for evaluating crack sealant effectiveness [8]:

- conduct ponding tests on core samples extracted at crack locations;
- measure the depth of penetration of the sealants in the field and the laboratory.

2.5 MnDOT Approved Products

MnDOT currently has four methacrylate products and five epoxy products on their Approved Products list. It is the author's understanding that the current requirements and product list was established partially based on WisDOT preliminary recommendations in 2005 [9]. Some of the products have been "grandfathered" while others have gone through independent laboratory testing as is currently required by MnDOT

(www.dot.state.mn.us/products/bridge/bridgesurfacecracksealer.html).

2.6 MnDOT Current Practices

In Minnesota, bridge deck crack sealing is typically performed by MnDOT District bridge crews; however, some crack sealing is also performed by Contract. In general, the approach taken by bridge maintenance crews is:

- Surface Preparation Method: Air blown;
- Application Method: Crack chase method using a bottle or pump (typical), or in some cases, a flood seal;
- Product: Paulco TE-2501 epoxy is the most commonly used product;
- Interval: Cracks are typically sealed on a five year cycle.

CHAPTER 3: TEST METHOD AND BRIDGE SELECTION

3.1 Test Method Selection

The original research approach was to observe the underside of the bridge deck after rain or flooding to identify functional or failed sealants. However, field visits to candidate bridges after saturating rain events revealed that the undersides of the deck were absolutely dry, thus invalidating this research approach. It was postulated that thermal expansion of the cracks or the cracks being filled by efflorescence and debris could be the explanation.

The researchers and MnDOT desired another evaluation approach, in addition to coring and visual observations, to assess the effectiveness of the crack sealant products. However, there was no standard test or procedure available to measure the loss of water into a crack in concrete over a given time period. Various test methods, such as a “vacuum test” used in Iowa to evaluate compression seals and a ponding test with a 5 gallon bucket full of water were eliminated due to issues of obtaining an adequate seal between the test device and tined bridge decks.

A test method using a tiered, falling head permeameter (Figure 1) had been developed by the National Center for Asphalt Technology (NCAT) at Auburn University to measure permeability of asphalt materials. To the knowledge of the research team, its use had never been experimented on a PCC surface.



Figure 1. NCAT Field Permeameter (Photo from www.globalgilson.com)

The test device can be purchased from Gilson, Incorporated. According to their website, NCAT designed the device for evaluating asphalt permeability in the field to eliminate the need for coring, patching, and laboratory testing. Rate of water flow is calculated using Darcy’s Law and NCAT studies produced good correlations between field and laboratory test results.

The test is very simple and requires about 15 minutes to setup and tear down and another 20 minutes to conduct the permeability test. The supplies necessary for testing include the permeameter, duct seal, an ample supply of water, a weight to apply uniform pressure to the base, and a stopwatch. If no head loss occurs after 20 minutes of testing, it is assumed that the surface is impermeable.

In terms of test repeatability, the MnDOT Office of Materials provided a summary of analysis performed on hundreds of tests conducted on hot mix asphalt. From this unpublished research, they indicated an average coefficient of variation of about 39% (three runs at each location) with hydraulic conductivities in the range of 10^{-5} and 10^{-3} cm/sec. With variation and repeatability at that level, it is expected that the device would be capable of qualitatively identifying bridge deck crack sealant performance.

In September of 2010, Braun Intertec and MnDOT staff from the Bridge Office, Office of Materials, and Metro District performed proof of concept testing of the NCAT permeameter on two parallel bridges on Trunk Highway (TH) 12 east of Norwood Young America. The east bound bridge had been sealed in summer of 2010 and the west bound bridge was unsealed. The following lessons were learned during the concept testing:

- Sealed cracks definitely did not take in any water.
- Unsealed cracks clearly allowed water to flow into the cracks. However, the base seal and the joints on the device both leaked.
- Substantially better test results were achieved using a double base seal at the permeameter/concrete interface.

3.2 Bridge Selection

It was necessary to identify a candidate bridge that would provide enough deck area for the application of 12 sealant products and three control sections. Having all products evaluated at a single site would limit the number of variables such as traffic volume, bridge type, and snow and ice operations. The Smith Avenue High Bridge (TH 149) in St. Paul appeared to be a good candidate because, according to maintenance records, it had not been sealed since 2002.

Preliminary testing was performed on the Smith Avenue High Bridge in three locations using the NCAT permeameter. Two of the three locations selected for testing were over cracks and the third was in an un-cracked area. The tests over the cracks both exhibited measurable water loss into the cracks, while the tests over un-cracked concrete produced minimal head losses.

Based on the preliminary permeability test results and the fact that the bridge had not been recently sealed, the Smith Avenue High Bridge (Br #62090) was selected as the single candidate for field evaluation. The following provides a snapshot of bridge structure and traffic conditions:

- Built in 1986
- Two lanes of through traffic
- Cast-in-place PCC deck with low-slump PCC wearing surface
- Approximately a four percent grade increasing from the south to the north
- Average annual daily traffic of 13,900 (2010) with 270 heavy commercial vehicles (1.9%)

CHAPTER 4: FIELD EVALUATION

4.1 Crack Survey

Crack mapping of the bottom of the Smith Avenue High Bridge deck was performed in May of 2011 with access provided by the Xcel Energy High Bridge Facility. The bottom of the deck was mapped based on visual inspection of the cracks from the ground.

Crack mapping of the top of the deck was performed in June of 2011. The crack mapping was performed in the southbound lane from approximately Pier 9 through Pier 5 consisting of approximately 6,500 square feet of potential test area. Piers 5 through 9 are all north of the main span over the Mississippi River.

The mapping of the top of the deck was performed utilizing plan and profile drawings from the MnDOT Bridge Office and a measuring wheel. A plan view of the bridge area surveyed is shown in Figure 2; larger versions of both the top and bottom crack surveys are attached in the Appendix. For reference, Pier 5 is immediately adjacent to the north side of the Mississippi River and the main river span.

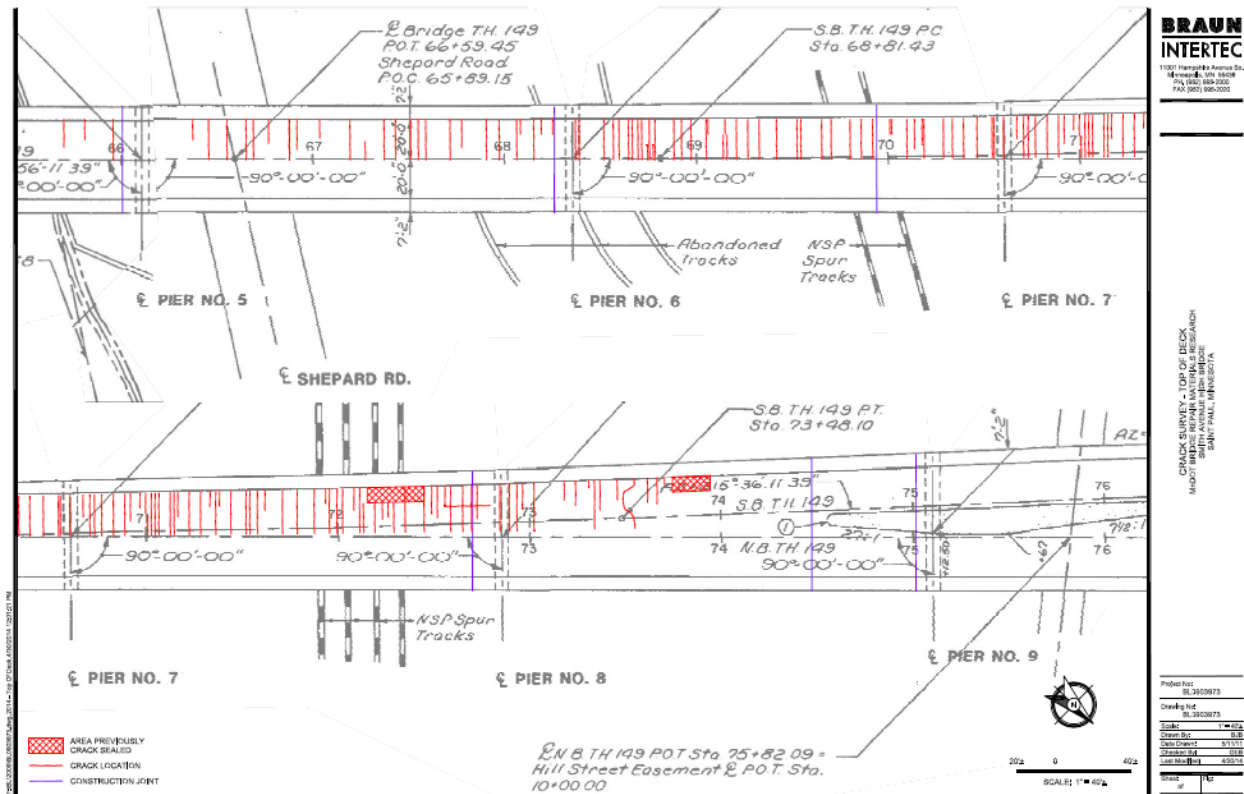


Figure 2. Plan View of the Bridge Area Surveyed (top cracks indicated).

Visible cracks in the southbound lane and shoulder were documented. A total of 48 cracks were observed between Piers 5 and 6, 44 between Piers 6 and 7, and 48 between Piers 7 and 8. Crack

widths were estimated with a crack comparator and ranged from 0.016 to 0.040 inches (16 to 40 mils).

4.2 Test Sections

This study included the evaluation of 12 crack sealant products and three control sections. In order to evaluate the proposed products, two permeability tests per section were necessary. A maximum 50-foot test section size was originally provided for products applied with a flood coat and smaller test sections were reserved for products applied using the “bottle” crack chase method.

The test sections were modified to accommodate manufacturer requests. The final test section layout is shown in Figure 3. Product name, surface preparation, evaluation point ID, and dimensions are also show in the figure. A larger sketch is shown in the Appendix.

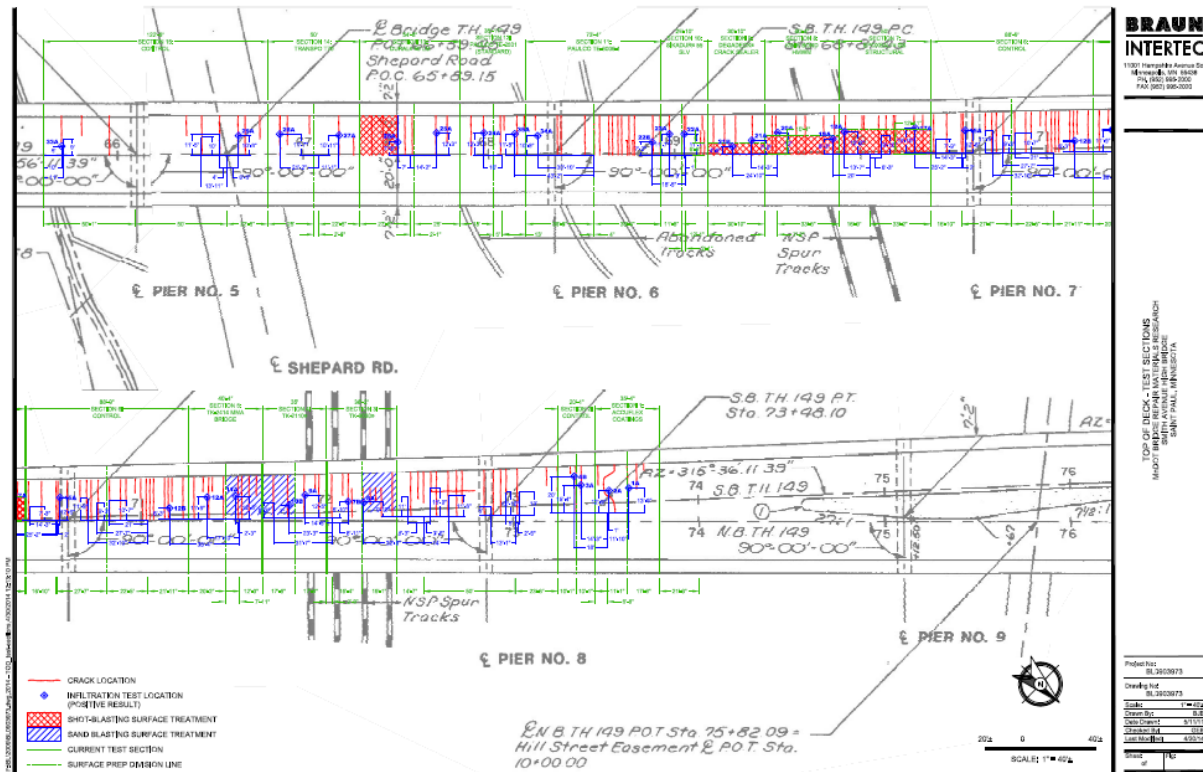


Figure 3. Test Sections, Locations, and Products

4.3 Products

The list of products evaluated in this project was determined in consultation with the Technical Advisory Panel (TAP). Several of the products are on the current MnDOT Approved Products List while others are not. Table 2 presents the products included in this study and identifies the test section number, test location ID, surveyed Ramsey County coordinates, product type, and application method. Copies of the Technical Data Sheets provided by the manufacturers are included in the Appendix for reference.

MnDOT communicated with the product manufacturers and explained that the surface preparation, application methods, etc. would be documented and included as part of their products requirements. Several vendors opted to break their test section into two subsections and include an air blown section (MnDOT standard practice) and a sand or shot blast prepared section.

Table 2. Test Sections, Locations, and Products

Test Section	Test ID	Ramsey County Coordinates		Manufacturer	Product	Type	Application
		Northing (ft)	Easting (ft)				
1	1A	152811	571393	Accuflex Coatings	Gel-Seal	Silicate	Flood
	2A	152804	571401				
2	3A	152791	571410	CONTROL			
	4B	152786	571408				
3	7B	152709	571496	TK Products	TK-9030	Epoxy	Bottle
	8A	152703	571501				
4	9A	152683	571514	TK Products	TK-2110*	Epoxy	Flood
	10B	152680	571523				
5	11A	152656	571539	TK Products	TK-2414*	MMA	Flood
	12A	152644	571550				
6	12B	152632	571568	CONTROL			
	15A	152585	571603				
7	17A	152564	571620	BASF	Epoxeal GS Structural*	Epoxy	Flood (cracks)
	19A	152537	571647				
8	18A	152535	571654	Kwik Bond	KBP 204 P	HMWM	Flood
	20A	152510	571671				
9	21A	152502	571684	BASF	Degadeck Crack Sealer Plus*	MMA	Flood
	21B	152496	571693				
10	22A	152466	571710	Sika Corp	Sikadur 55 SLV*	Epoxy	Pump (cracks)
	23A	152466	571710				
11	22B	152462	571720	Viking Paints, Inc.	Paulco TE 3008-1	Epoxy	Bottle
	34A	152413	571759				
12	24A	152404	571766	Viking Paints, Inc.	Paulco TE-2501	Epoxy	Bottle
	35A	152391	571776				
13	25A	152372	571794	Euclid Chemical	Dural 50 LM*	Epoxy	Flood (cracks)
	26A	152360	571811				Flood
14	27A	152333	571830	Transpo Industries	T70-MX-30	HMWM	Flood
	28A	152309	571850				
15	29A	152292	571867	CONTROL			
	33A	152220	571938				

Note: * Currently on the MnDOT Approved Products List.

Tables 3 and 4 present the current MnDOT requirements for methacrylate resins and epoxy sealants, respectively. Table 5 presents the properties of the Accuflex Coatings Gel-Seal, which is a silicate solution. The products within each table are presented in order of increasing cost per gallon.

The tables also contain the corresponding properties of the products included in this research. It should be noted that the test results presented are provided directly by the manufacturers and are not from an independent testing laboratory or any laboratory testing related to this project.

Table 3. MnDOT Requirements and Material Properties – MMA Resins

Methacrylate Resins	MnDOT Req's	Kwik Bond KBP 204	BASF, Degadeck Crack Sealer Plus	TK Products, TK-2414	Transpo T-70 MX-30
Viscosity (Brookfield RVT)	≤ 25 cps	19 cps (ASTM D445)	5 to 15 cps	<25 cps	10-25 cps (ASTM D2395)
Gel Time, ASTM D2471	≤ 60 min	Approx. 40 min.	15 min (ASTM D1475)	25 to 35 min	50-60 min. (AASHTO T237)
Tack Free Time, ASTM D1640	≤ 5 hr @ 72 °F and 50 % R.H.	400 min (Cal-Trans Test 551)	55 min (ASTM D14750)	30 to 60 min @ 70 F	6-8 hrs (AASHTO T237)
Tensile Elongation, ASTM D638	≥ 5%	2%	5%	30%	30%
Shear Bond Adhesion, ASTM C882	>1,500 psi	3,282 psi	2,215 psi	2,188 psi	2,310 psi
Cost (per gallon)	--	\$42	\$75	\$77	\$87

Notes:

1. Test results as provided by the manufacturers and not an independent laboratory.
2. Values that do not meet MnDOT's current requirements are **red**.

Table 4. MnDOT Requirements and Material Properties – Epoxy

Epoxy Crack Sealers	MnDOT Req's	Dural 50 LM	Paulco TE-3008-1	TK-9030	Epoxeal GS Structural	Sikadur 55 SLV	Paulco TE-2501	TK-2110
Viscosity, ASTM C881	≤ 125 cps	80-120 cps	100 cps	20-25 cps	95 cps	105 cps	240 cps (ASTM D2393)	124 cps
Gel Time, ASTM C881	≥ 20 min	45 min	--	3-6 min @ 70° F	45 min	20 min	9 min	36 min @ 70° F
Gel Time, ASTM D2471	≤ 60 min	--	--	--	--	--	--	--
14 Day Bond Strength, ASTM C882	≥ 1500 psi	> 2,000 psi	--	4,154 psi	3,450 psi	1,600 psi	360 psi	2,757 psi
Compressive Yield Strength, ASTM C881	≥ 4000 psi (7-day)	--	--	--	10,800 psi	7,800 psi @ 40° F	830 psi (ASTM D695)	14,560 psi
Tensile Strength, ASTM C881	≥ 4000 psi	800 psi (ASTM D638)	--	4,230 psi	7,100 psi	7,100 psi (ASTM D638)	190 psi (ASTM D638)	8,563 psi
Tensile Elongation, ASTM C881	≥ 2.5%	65% (ASTM D638)	--	3.3%	2.9%	10%	57% (ASTM D638)	2.6%
Shear Bond Adhesion, ASTM C882	> 1500 psi	--	--	--	--	--	--	--
Cost (per gallon)	--	\$42	\$50	\$59	\$65	\$72 ⁺	\$73	\$81

Notes:

1. Test results as provided by the manufacturers and not an independent laboratory.
2. "--" indicates either Not Available, Not Tested, or Not Provided.
3. Values that do not meet MnDOT's current requirements are red.
4. ⁺ Cost not provided by manufacturer. Estimated value based on internet sales search.

Table 5. Material Properties of Selected Products – Silicate

Parameter	MnDOT Req's	Accuflex Gel-Seal
Compressive Yield Strength (average)	N/A	3,990 psi, (ASTM C140)
Cost (per gallon)	--	\$15

4.4 Sealant Application

All surface preparation and sealing operations took place on September 8, 2011. Weather information three days prior to application, based on www.wunderground.com historical data at the St. Paul airport (approximately one mile east of the bridge), is shown in Table 6.

Table 6. Weather Data: Sealant Application to Three Days Prior to Application

Date	Maximum Temperature (°F)	Minimum Temperature (°F)	Dew Point (°F)	Precipitation (in)
September 8, 2011 (Application)	83	56	56	0.00
September 7, 2011	76	50	50	0.00
September 6, 2011	71	49	48	0.00
September 5, 2011	69	47	47	0.00

Traffic control was set up and the first deck preparation began shortly after 9:00 AM. The final product was tack free and traffic control was removed shortly after 3:00 PM. The weather during application was very good with clear skies and wind speeds between 3 miles per hour (MPH) and 13 MPH, based on the www.wunderground.com historical data at the St. Paul airport.

Air temperatures during application ranged from about 68° F to 85° F. Deck temperatures measured with an infrared handheld device ranged from about 74° F to 104° F during the application period.

A graphical representation of the weather station air temperature and measured deck temperature variations by product is shown in Figure 4. According to a University of Minnesota research report, crack sealing products should be applied at temperatures between 45° F and 90° F [1]; this range is shown by the horizontal red (upper bound) and blue (lower bound) dashed lines on Figure 4.

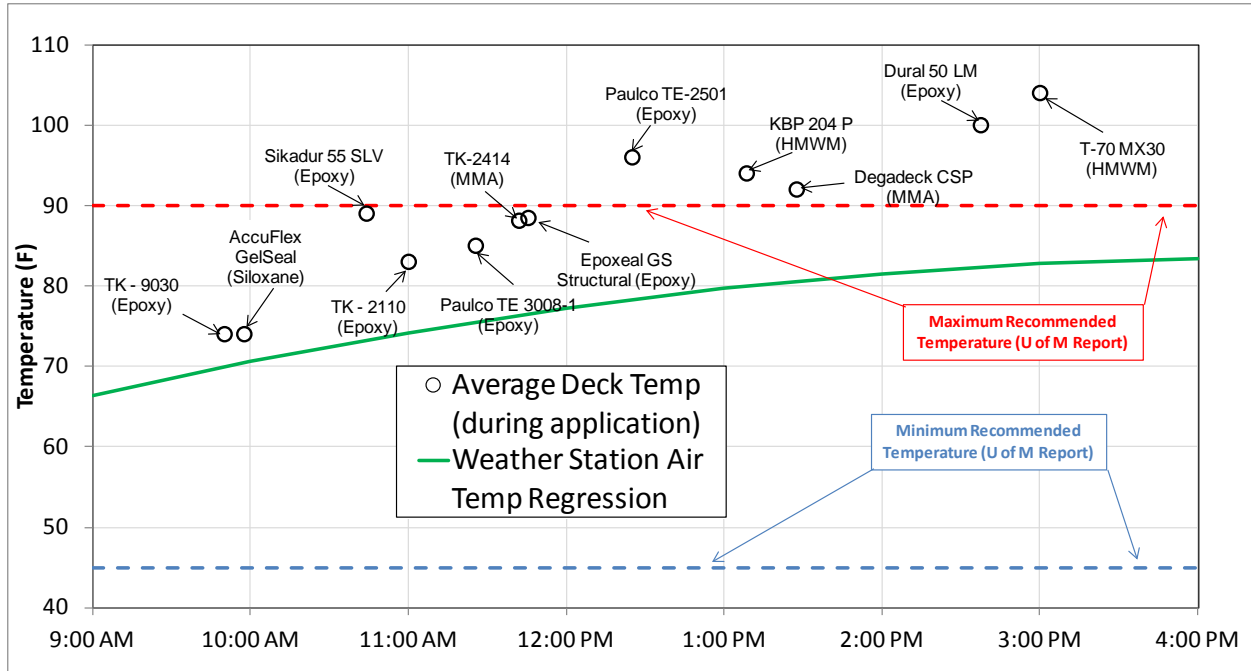


Figure 4. Air and Deck Temperatures During Product Application.

In the U of M report, it is unclear whether the temperature range recommendation applies to air temperatures or deck temperatures. Note that the air temperature during application remained below the recommended upper limit, whereas the measured deck temperatures exceeded this recommendation.

As previously stated, surface preparation was left up to the discretion of each product vendor and all work was performed by the respective product vendors. One exception was that the Transpo Industries T70 MX-30 product was applied by MnDOT Bridge Office staff.

Typical examples of surface preparation, product mixing, product application, and sanding are shown in Figure 5 a) through h). All videos, photos, and notes from the September 8, 2011, application are on file with the MnDOT Bridge Office.



Figure 5. Typical Operations During Application. a) blowing surface with air b) sand blasting c) shot blasting d) bottle application e) caulk gun application f) pump application g) flood application h) sand casting on surface.

Table 7 presents a summary of the observations and notes made during application to evaluate both the application process and ease of application.

Table 7. Product Application Observations

Product	Test Section Information			Preparation and Application Details						Safety Protection Observed During Application		Required Safety Protection per Manufacturer's Requirements
	Test ID	Cracks, lin. Ft.	Test Section, s.f.	Surface Prep.	Crack Prep.	Application Time, min.	Application Type	Sand Coat	Application Rate	Odor	Safety Protection Used During Application	
Accuflex Gel-Seal	1A	60	750	Air Hose	Pretreat*	34	Flood	No	127 sf/gal	Weak	Skin, Eyes	Dust and mist respirator, body-covering protective clothing and gloves, wear chemical goggles
	2A											
TK-9030	7B	64	400	Sand Blast	None	22	Bottle	No	75-100 lf/600 mL package	Moderate	Skin, Eyes	Safety glasses with side shields or face shield, chemical resistant gloves and impervious clothing, and suitable respiratory protection
	8A	68	400	Air Hose								
TK-2110	9A	72	370	Air Hose	None	30	Flood	Yes	150 sf/gal	Moderate	Skin, Eyes, Cleats	Chemical resistant gloves and safety goggles
	10B	42	370	Sand Blast								
TK-2414	11A	74	430	Sand Blast	None	6	Flood	Yes	120 sf/gal	Strong	Skin, Eyes, Respirator, Cleats	Chemical resistant gloves and safety goggles
	12A	79	420	Air Hose								
Epoxal GS Structural	17A	69	400	Air Hose	None	15	Flood	Yes	150 – 200 sf/gal	Weak	Skin, Eyes	Safety glasses with side shields or face shield, chemical resistant gloves and impervious clothing, and suitable respiratory protection
	19A	79	655	Shot Blast								
KwikBond	18A	62	420	Shot Blast	None	15	Flood	Yes	90 sf/gal	Weak	Skin, Eyes, Rubber Boots	Safety glasses with side shields or face shield, chemical resistant gloves and impervious clothing, and suitable respiratory protection
	20A	66	450	Air Hose								
Degadeck CSP	21A	60	465	Air Hose	Pretreat*	15	Flood	Yes	100 sf/gal	Strong	Skin, Eyes, Dust Mask, Cleats	Safety glasses with side shields or face shield, chemical resistant gloves and impervious clothing, and suitable respiratory protection
	21B	25	190	Shot Blast								
Sikadur 55 SLV	22A	86	560	Air Hose	Route	34	Pump	Yes	180 sf/gal	Strong	Skin, Eyes	Safety glasses with side shields or face shield, chemical resistant gloves and impervious clothing, and suitable respiratory protection
	23A											
Paulco TE-3008-1	22B	297	1585	Air Hose	None	90 (3 apps)	Bottle	No	3 applications	Weak	Skin	Safety glasses with side shields or face shield, neoprene gloves and impervious clothing, and suitable respiratory protection
	34A											
Paulco TE-2501	24A	100	785	Air Hose	None	60 (3 apps)	Bottle	No	3 applications	Weak	Skin	Monogoggles, rubber apron, butyl gloves and impervious clothing, and respiratory mask
	35A											
Dural 50 LM	25A	78	740	Air Hose	Pretreat*	45	Bottle	Yes	100 – 200 sf/gal	Weak	Eyes	Impervious rubber or vinyl gloves and protective apparel to reduce exposure
	26A	63	450	Shot Blast			Flood				Eyes, Cleats	
Transpo T70	27A	78	1090	Air Hose	None	10	Flood	Yes	150 sf/gal	Moderate	Skin, Eyes	Goggles, rubber boots and gloves
	28A											

*Pretreat refers to the sealant being applied to the crack prior to applying a flood coat of the same sealant.

CHAPTER 5: CRACK TESTING AND VISUAL OBSERVATIONS

As indicated in Chapter 3, proof of concept testing had been performed using the NCAT device and was agreed upon by the TAP for the field evaluation method for this project. The permeability results would be used in conjunction with visual and petrographic observations to fully evaluate the products and performance.

5.1 Crack Testing: Pre-Sealing

In order to properly evaluate the proposed products, two permeability tests per test section were necessary. A total of 40 locations were tested with the intent to identify at least 30 cracks for on-going testing and evaluation. The individual test locations were tested to verify that the crack would allow water to infiltrate into the crack.

The test sections were divided into two subsections (with an identified test location in each subsection) to allow product vendors to prepare surface and cracks differently, if desired. The product test section sketch with permeameter test locations identified is included in the Appendix.

Initial permeameter testing was performed on the Smith Avenue High Bridge on June 3, 6, 7 and 8 in 2011. The initial testing indicated that the NCAT Field Permeameter would be best utilized to evaluate performance by a “Pass/Fail” measure rather than quantifiable means. Site observations during permeameter testing indicated that if a head loss greater than 15 cm was observed, it appeared that water was flowing through the crack and not into the crack and back to the surface outside the permeameter.

Figure 6 illustrates the relative stages of permeameter testing: setup, testing, and apparatus water removal after permeameter removal from the surface.



Figure 6. Crack Permeability Testing on the Smith Avenue High Bridge

All permeameter test results are shown in Table 8 at the end of Section 5.3.

5.2 Crack Testing: Post-Sealing

Permeameter testing was performed within one week of sealing on September 15 and 16, 2011, as close as possible to the locations previously tested. The intent was to evaluate the performance of the crack sealant products shortly after application under similar weather conditions.

Three observations were noted during the post-sealing testing:

- The crack sealant products generally filled the cracks. However, the putty used to seal the permeameter to the bridge deck surface was not soft enough to penetrate the test crack and therefore, did not form a seal with the top surface of the sealant. Consequently, the permeability rate recorded was a function of the volume of the space between the putty and crack sealant product.
- Products applied with a flood coat and a sand coat (for surface friction characteristics) were more difficult to test with the permeameter. Essentially the additional surface roughness made it more difficult to obtain a stable seal between the NCAT device and the deck surface during testing. The solution was to lightly brush the surface at these test locations using a steel brush around the interface ring.
- As more permeameter data was collected, it became apparent that many variables, such as crack width and deck temperature, affect the results obtained using the permeameter. It was hypothesized that the thermal expansion and contraction of the concrete affects the profile and size of the crack, thus affecting the permeability of the water flowing through the crack. This effect can be seen in the Control Sections for Tests 12B, 29A and 33A, where head loss was observed during initial testing in June but was not observed in September. These Control Sections were not sealed yet did not show water infiltration when tested. This could be attributed to cooler temperatures than those during initial testing. This data suggests that factors other than sealant performance likely influence the permeameter test results.

All permeameter test results are shown in Table 8 at the end of Section 5.3. Negative numbers in the change (Δ) column (highlighted in red text) indicate an increase in head loss after sealing compared to the testing conducted prior to sealing. This data has not been adjusted to account for any air and/or deck surface temperature effects.

In most cases, the crack sealant dramatically reduced the head loss observed in the field. In other cases, the head loss was somewhat reduced, and in a few cases, the permeability rate actually increased when compared to the pre-sealing test results.

5.3 Crack Testing: 2012 (one winter)

Testing was performed from May 9 to May 11, 2012, as close as possible to the same locations tested and evaluated in 2011. The test point was located using GPS survey data and confirmed by visual evidence, where possible, of the putty used to seal the NCAT device interface.

Comparison of the 2012 permeability results to the pre-sealing permeability results indicates that, with the exception of the Accuflex Gel-Seal test section, a reduction in head loss was observed at each sealed test location. In addition, three of the six control section locations exhibited an increase in permeability between 2012 and the pre-sealing results.

The cause of the increase in permeability in the Accuflex Gel-Seal test section is unknown. It is understood that the Gel-Seal product is a silicate-based sealer that reacts with calcium hydroxide in the concrete and produces calcium-silicate-hydrate within the crack to function as a sealer. Perhaps a significant amount of calcium hydroxide was not present to initiate this reaction. Regardless of the cause, it appears that the Accuflex Gel-Seal section behaved like some of the control sections over this performance period. However, determination of the cause for this reduced performance is beyond the scope of this work.

When comparing the 2012 permeability results to the 2011 post-sealing permeability results (not including Accuflex), four of the test locations showed no change, nine of the test locations showed a further reduction in head loss and another nine test locations showed an increase in head loss over one winter.

In 2012, 15 out of 24 (62.5%) of the sealed test locations (and three of the control locations) exhibited 0.0 cm of headloss:

- TK -9030 (7B and 8A)
- TK-2110 (10B)
- TK-2414 (11A)
- Epoxeal (17A)
- Kwikbond (18A and 20A)
- Degadeck (21B)
- Sikadur (23A)
- Paulco 3008 (22B)
- Paulco 2501 (24A and 35A)
- Dural 50 (26A)
- T-70 MX-30 (27A and 28A)

This is an increase from the post-sealing permeability results in 2011. At that time, there were 10 sealed test locations that exhibited 0.0 cm of headloss. This could be attributed to the higher air and surface temperatures recorded in 2012.

In some cases, visible bubbles within the test apparatus caused false positive head loss results. In the case where bubble loss resulted in positive permeability results, it was observed that no additional head loss was noted after bubble loss.

All permeameter test results are shown in Table 8. Negative numbers in the change (Δ) column (highlighted in red text) indicate an increase in head loss after sealing compared to the testing conducted prior to sealing. This data has not been adjusted for any sort of air or surface temperature effects. The locations where bubble loss was observed during the testing are highlighted in blue.

Table 8. Permeameter Head Loss Testing Summary

Test Section	Test ID	Surface Prep	Product	2011 Pre Application (Jun 3, 6-8 & Aug 31)			2011 Post Application (Sep 15-16)			2012 Post Application (May 9-11)				Pre- to Post Sealing (Δ head loss, cm)	Pre- vs 1 yr after Sealing (Δ head loss, cm)
				Air Temp (9 AM - 3 PM) (°F)	Surface Temp (°F)	Head Loss (cm) t=20 min	Air Temp (9 AM - 3 PM) (°F)	Surface Temp (°F)	Head Loss (cm) t=20 min	Air Temp (9 AM - 3 PM) (°F)	Surface Temp (°F)	Head Loss (cm) t=20 min	Sealant Crack Width, in.		
1	1A	Air Hose	Gel-Seal	71 - 87	--	3.0	43 - 56	51	22.5	54 - 63	87	39.5	0.025	-19.5	-36.5
	2A	Air Hose	Gel-Seal	71 - 87	--	27.5	43 - 56	51	52.0	54 - 63	84	33.0	0.030	-24.5	-5.5
2	3A	--	CONTROL	71 - 87	--	2.0	43 - 56	58	34.5	54 - 63	72	39.0	0.040	-32.5	-37.0
	4B	--		71 - 87	--	5.5	43 - 56	56	35.0	54 - 63	77	11.5	0.025	-29.5	-6.0
3	7B	Sand Blast	TK-9030	75 - 90	--	26.0	43 - 56	66	0.5	65 - 71	70	0.0	0.030	25.5	26.0
	8A	Air Hose	TK-9030	75 - 90	--	2.0	43 - 56	64	0.0	54 - 63	81	0.0	0.060	2.0	2.0
4	9A	Air Hose	TK-2110	75 - 90	--	18.0	43 - 56	72	0.0	54 - 63	87	4.0	0.009	18.0	14.0
	10B	Sand Blast	TK-2110	75 - 90	--	19.0	43 - 56	75	0.0	54 - 63	96	0.0	0.005	19.0	19.0
5	11A	Sand Blast	TK-2414	75 - 90	--	1.5	50 - 60	56	10.5	54 - 63	80	0.0	0.009	-9.0	1.5
	12A	Air Hose	TK-2414	67 - 78	72	26.5	43 - 56	82	0.0	54 - 63	82	0.5	0.025	26.5	26.0
6	12B	--	CONTROL	67 - 78	72	18.0	43 - 56	83	0.5	57 - 71	70	0.0	0.016	17.5	18.0
	15A	--		81 - 99	--	15.0	43 - 56	84	17.0	57 - 71	68	24.0	0.030	-2.0	-9.0
7	17A	Air Hose	Epoxeal GS Structural	81 - 99	--	1.5	43 - 56	80	0.0	57 - 71	82	0.0	0.005	1.5	1.5
	19A	Shot Blast	Epoxeal GS Structural	67 - 78	81	33.0	50 - 60	57	1.0	57 - 71	72	6.5	0.005	32.0	26.5
8	18A	Shot Blast	KBP 204 P	67 - 78	81	50.0	43 - 56	84	2.0	57 - 71	76	0.0	0.005	48.0	50.0
	20A	Air Hose	KBP 204 P	81 - 99	--	16.5	43 - 56	88	0.0	57 - 71	84	0.0	0.016	16.5	16.5
9	21A	Air Hose	Degadeck Crack Sealer Plus	81 - 99	--	14.5	50 - 60	57	16.5	57 - 71	86	4.5	0.005	-2.0	10.0
	21B	Shot Blast	Degadeck Crack Sealer Plus	67 - 78	72	57.0	50 - 60	59	4.0	57 - 71	86	0.0	0.005	53.0	57.0
10	22A	Air Hose	Sikadur 55 SLV	67 - 78	71	11.0	50 - 60	69	0.5	57 - 71	90	0.5	0.000	10.5	10.5
	23A	Air Hose	Sikadur 55 SLV	81 - 99	--	6.5	50 - 60	63	2.0	57 - 71	90	0.0	0.060	4.5	6.5
11	22B	Air Hose	Paulco TE 3008-1	67 - 78	73	47.0	50 - 60	62	4.5	57 - 71	91	0.0	0.010	42.5	47.0
	34A	Air Hose	Paulco TE 3008-1	67 - 78	75	27.5	50 - 60	66	0.5	57 - 71	92	6.5	0.005	27.0	21.0
12	24A	Air Hose	Paulco TE-2501	81 - 99	--	10.5	50 - 60	66	0.0	57 - 71	95	0.0	0.005	10.5	10.5
	35A	Air Hose	Paulco TE-2501	67 - 78	74	16.5	50 - 60	67	0.0	57 - 71	95	0.0	0.005	16.5	16.5
13	25A	Air Hose	Dural 50	81 - 99	--	10.0	50 - 60	64	9.0	65 - 71	73	9.0	0.016	1.0	1.0
	26A	Shot Blast	Dural 50	76 - 77	--	16.5	50 - 60	64	2.0	57 - 71	100	0.0	0.025	14.5	16.5
14	27A	Air Hose	T70-MX-30	76 - 77	--	38.5	50 - 60	62	0.0	65 - 71	75	0.0	0.005	38.5	38.5
	28A	Air Hose	T70-MX-30	76 - 77	--	32.0	50 - 60	67	2.5	65 - 71	79	0.0	0.005	29.5	32.0
15	29A	--	CONTROL	76 - 77	--	11.5	50 - 60	66	6.0	65 - 71	80	0.0	0.025	5.5	11.5
	33A	--		76 - 77	--	2.0	50 - 60	67	0.0	65 - 71	86	0.0	0.016	2.0	2.0

Notes:

1. Air temperature range obtained from Weather Data at St. Paul Airport (2 miles east of bridge)
2. Surface temperature not recorded in June 2011 testing. June 6th and 7th in 2011 were substantially hotter than any other day of testing.
3. If head loss increased after sealing or after one winter, value is red.
4. Permeameter testing with observed bubble loss and no further loss in head after bubble loss are highlighted in blue.

5.4 Crack Testing: General Comments

Several easily quantifiable variables are likely responsible for the variation in the permeability test results. Such variables include air temperature, cloud cover, and surface temperature. Other variables, such as the amount of debris present within a crack, could be quantified but would be cost-prohibitive. There are also unquantifiable variables, such as the existence of non-detectable previously applied sealant.

Surface temperatures were not collected during the initial testing in June of 2011. This gap in the data somewhat limits the categorical comparisons that can be done between the pre- and post-sealing test results. Most notably, one of the control sections increased from 2 to 5.5 cm of head loss to 34.5 to 35 cm of head loss. Of course, the crack was not sealed so another factor(s) explains the large deviation. It is believed that surface temperature is a primary factor. The low head loss values in this control section were observed on a date with a maximum air temperature of approximately 90° F which can lead to deck expansion and narrower crack widths, whereas the dramatically higher head loss values were observed on a date with maximum air temperatures of approximately 58° F, which is substantially lower.

Accurately characterizing each crack and the cause, such as drying shrinkage or from bending stresses, could identify crack sensitivity to temperature changes. For example, if a crack is located over a pier, it may behave quite differently than a crack that is located in the middle of a span. Additional analysis would be required to evaluate this further and was not included in the scope of this project.

The permeameter testing has proven to be an initial step in the pre-qualification process, but visual observations and crack monitoring, in addition to petrographic examination, are necessary to evaluate sealer performance. Due to number of unknown variables, the number of resources required for permeameter testing, and the variable results, the permeameter testing was excluded from 2013 and 2014 field evaluations.

5.5 Visual Observations

Braun Intertec and MnDOT Bridge Office staff performed visual observations each spring over a three year period. During the field evaluation, photos were taken of each test location and observations were documented. Each test location was then qualitatively rated for sealant effectiveness. The following criteria were used to assign an effectiveness rating:

- **Effective (3):** Sealant fully intact or essentially intact with a hairline crack
- **Semi-effective (2):** Sealant mostly intact, but exhibiting small cracks, holes or debonding
- **Ineffective (1):** No evidence of sealant or some sealant present but larger cracks and/or holes present.

5.6 Visual Observations: 2012 (one winter)

The winter of 2011-12 was pretty mild for Minnesota. According to a MnDOT press release, MnDOT spent approximately \$46 million on winter maintenance and snow and ice activities compared to \$81 million the previous winter

[\[http://www.dot.state.mn.us/newsrels/12/05/18winter.html\]](http://www.dot.state.mn.us/newsrels/12/05/18winter.html). This reduced amount of snow plowing and sanding operations limited the potential for surface wear and abrasion.

Based on visual observations, most products exhibited cracking or at least preliminary signs of cracking. The test locations that exhibited no visual signs of cracking after one winter were as follows.

- TK-9030 (Test 7B): Epoxy / sand blast / bottle
- KwikBond (Test 20A): HMWM / air / flood
- Sikadur 55 SLV (Test 22A): Epoxy / route cracks / air / pump
- Dural 50 LM (26A): Epoxy / shot blast / pretreat / flood.

Photos of the bridge deck surface are shown in Figure 7.

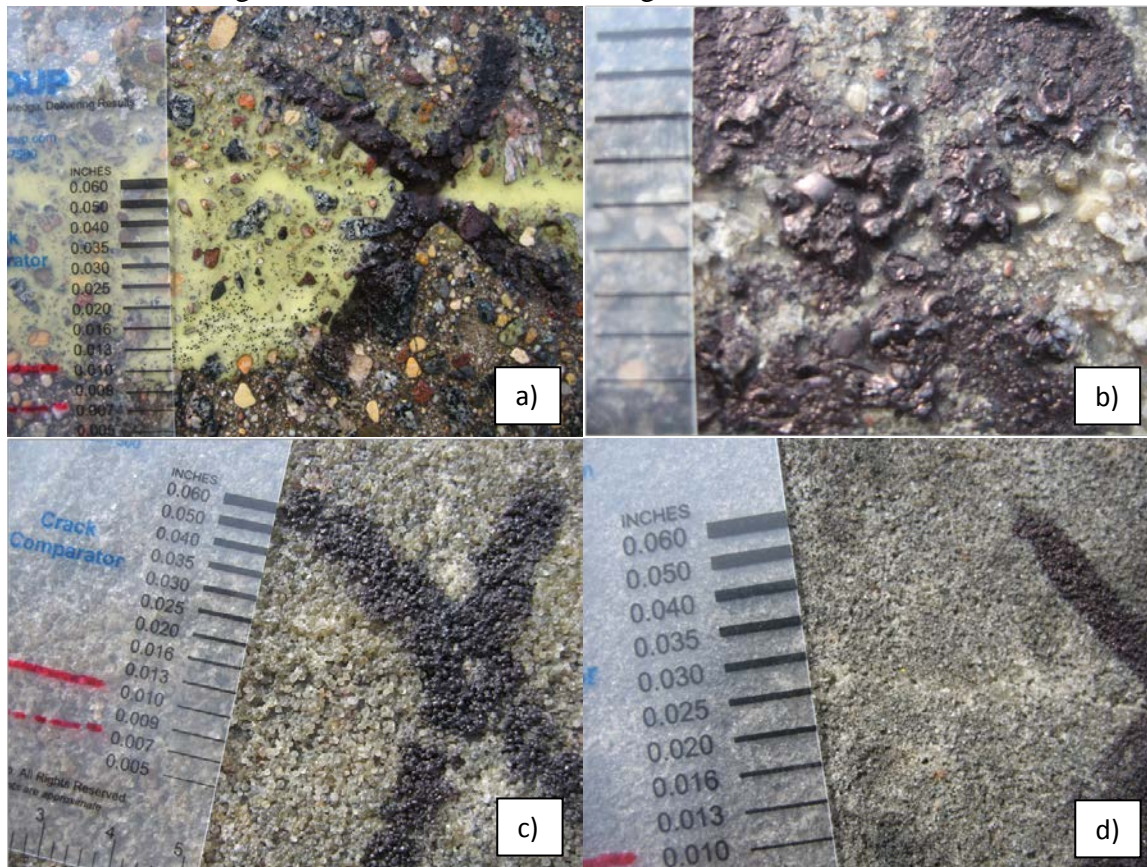


Figure 7. Products With No Cracking After One Winter: a) TK Products TK-9030 [Test 7B] b) KwikBond [Test 20A] c) Sikadur 55 SLV [Test 22A] d) Dural 50 LM [Test 26A].

The test locations presented in Figure 7 were all given the highest visual rating (3 on a scale of 1 to 3).

The following test locations were also given the highest visual rating, although very small hairline cracks or sand loss was evident:

- TK-2110 (9A, 10B): Epoxy / air / flood
- Epoxeal (17A, 19A): Epoxy / air, shot blast / flood
- KwikBond (18A): HMWM / shot blast / flood
- Degadeck (21A, 21B): MMA / air, shot blast / flood
- TE-2501 (35A, 24A): Epoxy / air / bottle
- Dural 50 LM (25A): Epoxy / air / pretreat / bottle (squeegee)
- Transpo T70-MX (27A, 28A): MHWM / air / flood.

Visible failures and features typical among the remaining products and test sections included no evidence of sealant [Gel-Seal (1A, 2A), TK-2414 (11A, 12A)], bubbles and holes [TK-9030 (8A)], debonding from one crack face [TK-2110 (10B), TE-3008-1 (34A)], and cracking in the sealant [TE-3008-1 (22B)].

Table 9 in Section 5.9 provides a comprehensive summary of visual observations at all evaluation locations. Please refer to the Appendix for a complete set of comparison photos of the test section locations for the spring 2012, 2013, and 2014 field reviews.

5.7 Visual Observations: 2013 (two winters)

The winter of 2012-13 was a far more “typical” Minnesota winter with colder temperatures, significant snow, plowing, salting and sanding. According to a MnDOT press release, MnDOT spent approximately \$91 million on winter maintenance activities [<http://www.dot.state.mn.us/newsrels/13/06/5winter.html>]. Based strictly on budget, it is feasible that twice the snow plowing and sanding activities took place on the Smith Avenue High Bridge as the previous winter, which definitely had an effect on sealant performance.

It was visually evident that substantially more surface abrasion, presumably from plowing, had occurred over this winter season. This was mostly obvious because any evidence of test location marking and previous testing (flexible NCAT sealant residue) had been absolutely eliminated.

Observation of the surfaces within individual test sections provided the same evidence of surface wear. As such, test sections with silica sand exhibited loss of granules. Some cracks also exhibited slight signs of sealant loss between the two winters. Only Sikadur 55 SLV (22A) was still documented as fully effective in 2013 after two winters. However, note that the other Sikadur 55 SLV test location (23A), which was prepared identically, was documented as ineffective already in 2012. Test locations documented as semi-effective in 2013 included:

- TK 2110 (9A and 10B)
- Epoxeal GS Structural (17A and 19A)
- Kwik Bond KBP 204 P (18A and 20A)
- BASF Degadeck Crack Sealer Plus (21A)
- Paulco TE-3008-1 (22B and 34A)

- Paulco TE-2501 (24A and 35A)
- Dural 50 (25A and 26A)
- Transpo T70-MX-30 (27A and 28A)

Table 9 in Section 5.9 provides a comprehensive summary of visual observations at all evaluation locations. Please refer to the Appendix for a complete set of comparison photos of the test section surfaces for the spring 2012, 2013, and 2014 field reviews.

5.8 Visual Observations: 2014 (three winters)

The 2013-14 winter had more snow and snow events than the previous winter. In fact, according to a MnDOT Commissioner interview, MnDOT spent approximately \$121 million on snow and ice removal, which is a dramatic increase over the past two years (unadjusted for inflation) [<http://www.mprnews.org/story/2014/04/29/daily-circuit-zelle-transportation-bill>]. As a result, the test sections on the Smith Avenue High Bridge were subjected to another winter of aggressive surface abrasion from snow plows and salt and sand.

The initial opinion during field review was that the performance was drastically reduced from the previous field review. The majority of the sand that had been cast on flooded sections for skid resistance was gone. There was some evidence of sealant in the cracks, but not to the point that it would be detected without a very close review.

The major differences observed during this review were major loss of sealant and sand materials. No product was performing at a fully acceptable level (subjective rating = 3) and seven products were given at least one rating of 2 (on a scale of 1 to 3). The products that were observed to be performing the best were TK-2110 (9A, 10B), KwikBond (18A, 20A), TE 3008-1 (22B), TE 2501 (24A, 35A), Epoxeal (19A), Degadeck (21A), and Transpo T70 (27A).

Table 9 in Section 5.9 provides a comprehensive summary of visual observations at all evaluation locations. Please refer to the Appendix for a complete set of comparison photos of the test section surfaces for the spring 2012, 2013, and 2014 field reviews.

5.9 Visual Observations: Summary

A summary of the 2012, 2013, and 2014 visual observations by product is presented in Table 9. After one winter, 15 of the test locations were documented as effectively sealed. After two winters, only one test location was still documented as effectively sealed (Sikadur 55 SLV, 22A). After three winters, 14 (58%) of the test locations were documented as ineffective and 10 (42%) were documented as semi-effective.

Table 9. Visual Observations Summary

Section & ID		Manufacturer & Product		May 2012	April 2013	April 2014
1	1A	Accuflex Coatings	Gel-Seal	No sealant observed.	No sealant observed.	No sealant observed.
	2A			No sealant observed.	No sealant observed.	No sealant observed.
3	7B	TK Products	TK-9030	Yellow. Tiny bubbles caused by CO ₂ released during curing evident. Sealant in crack intact.	Appearance of bubbles where sealant was intact previous year. Slight cracking evident.	Continued degradation of sealant and loss of sealant material. Debonding from one crack face.
	8A			Yellow. Voids from bubbles (CO ₂ released during curing). Not completely sealed.	Loss of sealant and breakdown of bubbles into larger holes. No cracking evident.	Loss of sealant and larger holes due to bubbles. Debonding from one crack face.
4	9A	TK Products	TK-2110	Light gray. Hairline crack. Sand coat present.	Cracking present - either debonding or product. Loss of sealant and sand coat on surface.	Further loss of sealant and sand coat. Sealant still evident in crack and spots of sealant on surface.
	10B			Light gray. Debonding from one crack face. Sand coat present.	Increase in debonded crack size. Minimal loss of sand coat.	Evidence of abrasion as sand coat nearly gone. Sealant still evident in crack but no longer on surface.
5	11A	TK Products	TK-2414	Sealant debonding from crack face. No sand coat observed.	Increase in debonded crack size and loss of sealant material.	Loss of sealant. Crack appears to be full of debris and some sealant.
	12A			Very little sealant present in crack. No sand coat observed.	Very little sealant present in crack. No sand coat observed.	Wide open crack that resembles control section.
7	17A	BASF	Epoxeal GS Structural	Very slight crack developing. Surface covered with sealant and sand coat.	Crack size increased. Some sealant loss in crack. Significant sand coat loss on surface.	Further material loss. Crack size increased. Very little sand coat visible.
	19A			Sealant intact with hairline crack developing. Surface covered with sealant and sand coat.	Crack size increased but white sealant still evident. Some sand loss and voids where sand dislodged.	Apparent crack size increased. Epoxy still evident on surface; sand dislodged.
8	18A	Kwik Bond	KBP 204 P	Original crack is detectable but full of sealant and sand coat. Shot blast surface rougher than 20A.	Loss of sealant and sand coat in crack. Little sand coat remaining on surface.	Further loss of sealant and sand coat. Sealant still evident in crack but not on the surface.
	20A			Translucent sealant in crack. No apparent cracking. Some sand present.	Major loss of sealant and sand from previous year. Gray sealant visible in crack with slight debonding.	No evidence of sealant or sand coat on surface. Some sealant visible in crack.
9	21A	BASF	Degadeck Crack Sealer Plus	Gray sealant in crack but little surface sand. Slight debonding from one crack face.	Loss of sealant and deeper set in crack. Debonding from both crack faces. No sand present.	More loss of sealant. Crack appears to include sealant and debris. Sealant still on deck.
	21B			Gray sealant in crack but little surface sand. Very slight debonding from one crack face.	Increase in apparent crack size but only debonded from one crack face. No sand visible.	No significant change from previous year. Sealant not visible on deck (shot blast).
10	22A	Sika Corp	Sikadur 55 SLV	No observable cracking. Sand in place.	Narrow crack developed with loss of sand granules along crack. Sealant and sand coat on surface.	Major loss of sealant and sand coat granules.
	23A			Slight crack developed but may be due to loss of sand granules. Sand in place on surface.	Routed crack contains some sand granules and little sealant. Little sealant and no sand on surface.	Sealant is almost entirely gone from crack and surface. No sand coat evident.
11	22B	Viking Paints, Inc.	Paulco TE 3008-1	Apparent crack through the sealant material and not debonding from crack face.	Crack through material only slightly larger in size.	Loss of sealant and debonding evident along portions of the crack.
	34A			Cracking present and due to debonding on one crack face.	Product appears similar to previous year but now debonded from both crack faces.	Loss of sealant and almost no sealant evident in large portions of crack.
12	24A	Viking Paints, Inc.	Paulco TE 2501	Translucent sealant. Very small hairline crack developed in sealant.	Cracks through sealant increased in size. Portions of the sealant almost appear to have tears.	No loss of sealant. Large cracks through the sealant and debonding on both sides of crack face.
	35A			Translucent sealant. Very small hairline crack developed in sealant.	Some loss of sealant. Likely debonding from one crack face.	Significant cracking through the product. Some loss of sealant and debonding from one crack face.
13	25A	Euclid Chemical	Dural 50	Sealed crack was visible but no clear crack in sealant. Some loss of sand granules in crack.	Very minor loss of sealant and sand coat. Surface very white in appearance.	Almost complete loss of sealant from crack. Sand entirely absent and very little sealant on the surface.
	26A			Sealed crack was visible but no clear crack in sealant. Some loss of sand granules in crack.	Narrow crack developed but very little loss of sealant or sand.	Very little evidence of sealant in the crack or on the surface. No evidence of sand coat.
14	27A	Transpo Industries	T70-MX-30	Translucent sealant with hairline crack. Very little evidence of sand coat.	Loss of sealant. Debonding from one crack face.	Loss of sealant and increase in apparent crack size from previous review.
	28A			Translucent sealant with hairline crack. No evidence of sand coat.	Cracking and loss of sealant.	Further loss of sealant. Debonding from one crack face.

CHAPTER 6: CONCRETE CORING AND PETROGRAPHIC OBSERVATIONS

6.1 2013 Coring (two winters)

Since extracting a statistically significant number of cores is not feasible to represent the various types of cracks, surface preparation, and sealant materials, the information obtained should be considered, at most, semi-quantitative rather than a definitive comparison of the various materials. MnDOT crews extracted two 3 ¾" diameter cores on April 30, 2013, from each product test section and two total from the control sections (26 total cores). The coring and patching operation is shown in Figures 8 through 10.

The cores were taken adjacent (approximately one foot towards the centerline) to the locations previously tested with the NCAT permeameter and evaluated and documented during visual observations. This offset was done to preserve the location for future visual observations. To further preserve the test location, the area was covered with a rubber mat during patching as shown in Figure 9. The final patched surface shown in Figure 10 illustrates the location of the core in relation to the test point, which was always towards the inside of the lane or east.



Figure 8. Coring on the Smith Avenue High Bridge.



Figure 9. Patching Core Holes on the Smith Avenue High Bridge.



Figure 10. Final Patched Bridge Deck and Original Test Location.

The weather during coring and visual observation was overcast with consistent winds of about 17 MPH out of the west. Table 10 provides a summary of the field conditions under which the cores were sampled and any observations and notes taken during extraction.

Following extraction, the cores were marked and photographed in the field and then brought to Braun Intertec for detailed observations. The following steps were followed as part of the petrographic observations (not a full ASTM C856 petrographic examination):

1. Receiving and photographing the as-received condition of the cores;
2. Photographing the top and sides of the sealed crack;
3. Documenting crack orientation and surface width (assuming the core did not split during coring);
4. Cutting the cores perpendicular to the crack;
5. Polishing one face of the cut cores for microscopic examination. An inspection of the core face will be performed before and after cutting and then compared to the polished face to make sure no damage of the sealant has occurred during polishing;
6. Microscopic documentation of the condition of the concrete-sealant interface and the sealant itself; and
7. Microscopic documentation of the penetration depth of the sealant in the crack.

Table 10. Concrete Core Sampling Conditions

Test ID	Section	Product	Time	Deck Temp	Air Temp	Humidity	Notes
1A	1	Gel-Seal	9:45	77	73	44	
2A			9:51	75	74	45	
4B	2	Control	11:52	76	69		
7B	3	TK-9030	9:57	75	75	43	
8A			9:40	76	73	47	
9A	4	TK-2110	10:00	75	72	42	
10B			10:04	76	73	41	
11A	5	TK-2414	10:10	75	72	42	
12A				75	72	42	Core separated while securing with tape
12B	6	Control	10:17	74	71	43	
17A	7	Epoxeal	10:22	76	72	43	
19A			10:28	76	71	43	
18A	8	Kwik Bond	10:32	74	72	41	
20A			10:37	73	70	43	
21A	9	Degadeck	10:41	74	70	44	
21B			10:45	74	70	43	
22A	10	Sikadur	10:50	75	71	43	
23A			10:55	78	71	43	Core chipped when extracting
22B	11	Paulco TE-3008-1	11:00	72	70	43	
34A			11:06	76	69	39	
24A	12	Paulco TE-2501	11:17	74	69	40	
35A			11:12	74	68	41	
25A	13	LM 50	11:24	76	71	42	
26A			11:29	82	72	41	
27A	14	Transpo T70	11:34	76	69	41	
28A			11:40	76	70	42	

6.2 Laboratory Petrographic Observations

The concrete cores were returned to Braun Intertec's Bloomington laboratory to evaluate the penetration depth and the condition of the sealant after exposure to two winter cycles. The petrographer also observed and noted the condition of the crack itself.

Cutting was performed at a very slow rate to minimize damage to the core and sealant. In general, most of the sealants did not appear to be brittle so chipping was unlikely. It was possible that saw vibrations could cause some detachment but full-scale loss was not expected at slow cutting rates.

To prevent the loss of sealant after cutting, a stabilizing agent was added to the surface and crack prior to polishing. The stabilizing agent consisted of a viscous epoxy with blue dye to easily differentiate the sealant from the stabilizing agent. The stabilizing agent is identified and labeled where it is visible on the petrography core logs. An example is shown in Figure 11; all petrographic photos can be found in the Appendix.

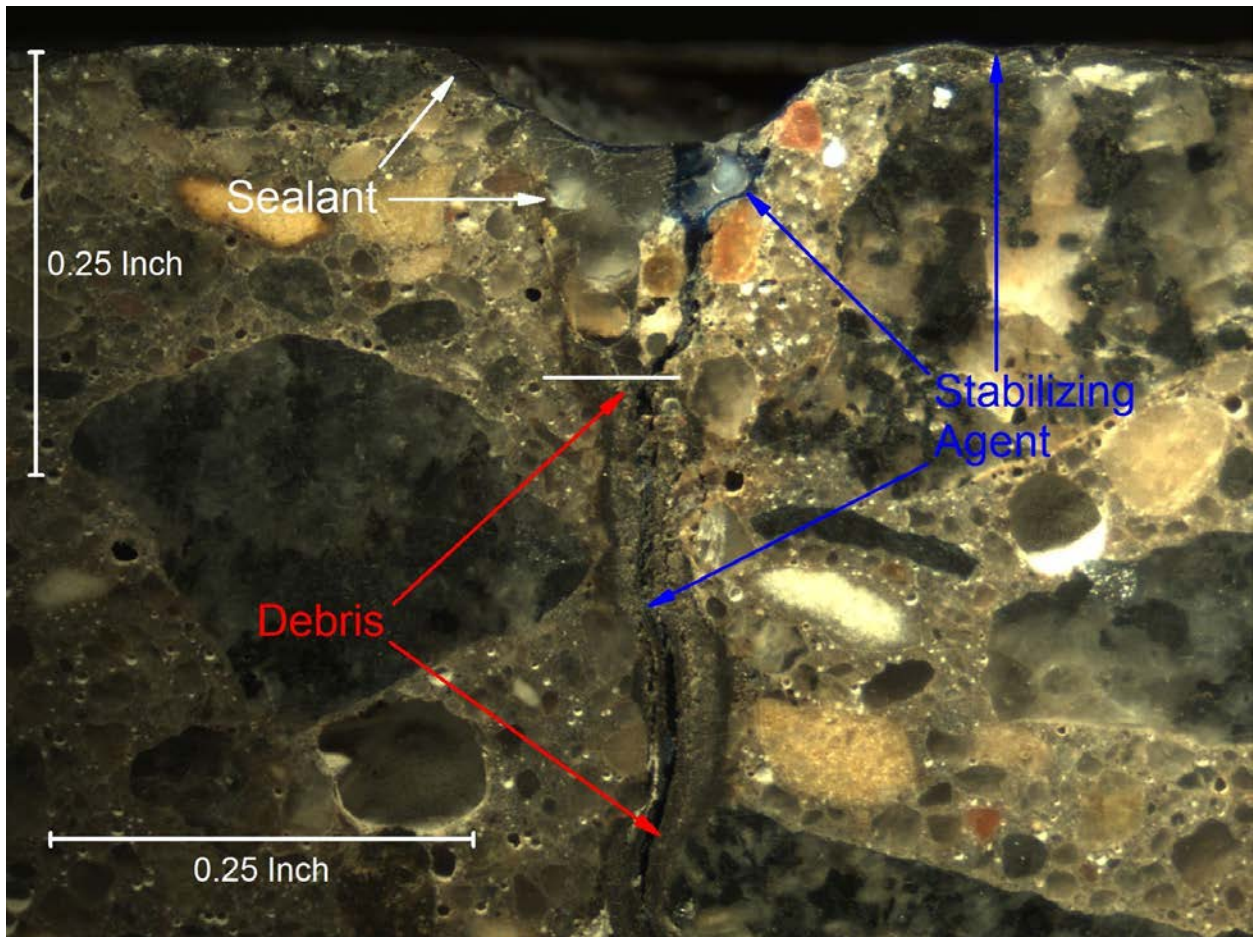


Figure 11. Typical Petrographic Photo Identifying Stabilizing Agent.

For documentation and consistency, each core had a photo taken at seven times (7x) magnification before and after polishing. Measurements were not made on these photos but rather on higher magnification photos, taken mostly at twenty times (20x) magnification, to obtain more detail and better determine the depth of penetration.

The following general protocol was followed during petrographic observations:

1. Is the sealant visible? If yes, document the depth.
2. If sealant is visible, is it physically attached to both sides of the core? If one side only, document the attached face.
3. If sealant is visible, is the sealant itself cracked (not just debonded from the concrete)?
4. If sealant is visible, does it “bridge” the original crack?

Examples of the as-received and macro photos are shown in Figures 12 and 13, respectively. A complete log of the petrographic photos of the cores is attached in the Appendix. Laboratory observations, including depth of penetration and comments, for each core are detailed in Table 11. A summary of the observations noted during the petrographic analysis are detailed below.

- More often than not, polishing provided a better view of the crack profile so that a clear demarcation of the penetration depth could be determined. In fact, the sealant in Core 24A (Paulco TE-2501) was not even visible until after polishing. After polishing, it was determined that the sealant actually mixed with debris to make a sealant-debris mixture. No other product exhibited this type of behavior. In contrast, Core 21A (Degadeck) exhibited a significant loss of sealant from the cut face to the polished face. It is unknown whether this was due to loss of sealant during polishing or from polishing through the sealant.
- The depth of penetration was highly variable and is likely dependent on the original crack width and the deck temperatures during application. However, based on examination of the measured crack widths the week following application and the petrographically determined depth of penetration, there is little to no correlation between the two. Based on petrographic observations, the primary factor influencing depth of penetration was likely debris present within the cracks.
- Every crack was filled with debris from the top (bridge surface) to the base of the core, regardless of surface preparation.
- Two failure modes were documented during the petrographic observations: whether the sealant was detached from the crack face or whether the sealant did not fully “bridge” the original crack.
 1. Almost all sealants detached from one face of the crack, indicating that the sealant did not fail in cohesion but rather in adhesion between the crack face and the sealant. In fact, only two sealants TK-2110 (9A) and Paulco TE-2501 (24A and 35A) were not observed to be detached from either crack face during petrographic

observations. One sealant, Paulco TE-3008-1 (22B, 34A), exhibited both detachment from the crack face and cracking within the sealant itself.

2. In other cases the sealant was visible, but did not “bridge” the original crack, such as for TK-9030 (8A), Sikadur 55 SLV (22A) and Dural 50 LM (25A, 26A). The sealant may at one time have “bridged” the crack but that was no longer the case at the time of the petrographic observations. It was not apparent whether this occurred during application or after hardening. In the cases where this was observed, the sealant was still attached to both faces of the crack. It is possible that the presence of debris could lead to failure within the sealant material. However, the predominant failure mode found in this study was detachment from the crack face, not within the sealant itself.
- In a few cases, sealant was not present in the crack at all. This was noted for Accuflex Gel-Seal (1A, 2A), TK 2414 (12A) and Transpo T70 (28A).

Table 11: Laboratory Petrographic Observations

Product	Test ID	Surface Prep.	Crack Prep.	App. Type	Cut-Face Penetration Depth* (in.)	Polished-Face Penetration Depth* (in.)	Comments
Accuflex Gel-Seal	1A	Air Hose	Pretreat	Flood	0.000	0.000	No sealant observed in crack. Debris present throughout the crack.
	2A	Air Hose	Pretreat	Flood	0.000	0.000	No sealant observed in crack. Debris present throughout the crack.
Control	4B	None	None	None	0.000	0.000	No sealant observed in crack.
	12B	None	None	None	0.000	0.000	No sealant observed in crack.
TK-9030	7B	Sand Blast	None	Flood	0.274	0.302	Sealant is a milky white color. Debris present throughout the crack. Sealant is free of cracks; sealant is detached from North face of crack.
	8A	Air Hose	None	Flood	0.134	0.136	Sealant is a milky white color. Debris present throughout the crack. Sealant is free of cracks; sealant does not bridge crack but is adhered to both faces of the crack.
TK-2110	9A	Air Hose	None	Flood	0.092	0.118	Sealant is colorless with quartz sand grains. Debris present throughout the crack. Sealant is free of cracks; sealant is not detached from either face of crack.
	10B	Sand Blast	None	Flood	0.117	0.122	Sealant is colorless with quartz sand grains. Debris present throughout the crack. Sealant is free of cracks; sealant is detached from North face of crack.
TK-2414	11A	Sand Blast	None	Flood	0.088	0.094	Sealant is colorless with quartz sand grains. Debris present throughout the crack. Sealant disappeared during polish. The penetration depth here is to a remnant portion attached to the North face of the crack.
	12A	Air Hose	None	Flood	0.000	0.000	No sealant observed in crack. Debris present throughout the crack.
Epoxeal GS Structural	17A	Air Hose	None	Flood	0.115	0.121	Sealant is colorless with quartz sand grains. Debris present throughout the crack. Sealant is free of cracks; sealant is detached from North face of crack.
	19A	Shot Blast	None	Flood	0.202	0.211	Sealant is colorless with quartz sand grains. Debris present throughout the crack. Sealant is free of cracks; sealant detached from South face of crack.
KwikBond	18A	Shot Blast	None	Flood	0.193	0.204	Sealant is colorless. Debris present throughout the crack. Sealant is free of cracks; sealant is detached from South face of crack.
	20A	Air Hose	None	Flood	0.239	0.266	Sealant is colorless with quartz sand grains. Debris present throughout the crack. Sealant is free of cracks; sealant is detached from North face of crack.
Degadeck CSP	21A	Air Hose	Pretreat	Flood	0.226	0.057	Sealant is colorless with quartz sand grains. Debris present throughout the crack. Sealant is free of cracks; sealant is a remnant attached to the South face of the crack.
	21B	Shot Blast	Pretreat	Flood	0.134	0.158	Sealant is colorless with quartz sand grains. Debris present throughout the crack. Sealant is free of cracks; sealant is detached from North face of crack.
Sikadur 55 SLV	22A	Air Hose	Route	Pump	0.159	0.180	Sealant is colorless with quartz sand grains. Debris present throughout the crack. Sealant is free of cracks; sealant does not bridge crack but is adhered to both faces of the crack.
	23A	Air Hose	Route	Pump	0.124	0.135	Sealant is colorless with quartz sand grains. Debris present throughout the crack. Sealant is free of cracks; sealant is detached from North face of crack.
Paulco TE-3008-1	22B	Air Hose	None	Bottle	0.109	0.113	Sealant is colorless. Debris present throughout the crack. Sealant is cracked; sealant is detached from both the North and South face of the crack.
	34A	Air Hose	None	Bottle	0.111	0.113	Sealant is colorless. Debris present throughout the crack. Sealant is cracked; sealant is detached from the South face of the crack.
Paulco TE-2501	24A	Air Hose	None	Bottle	0.000	0.108	Sealant observed in crack, mixed with debris. Sealant was not observed until after polishing. Debris present throughout the crack. Sealant is not cracked; sealant is not detached from either face of the crack.
	35A	Air Hose	None	Bottle	0.041	0.106	Sealant is colorless. Debris present throughout the crack. Sealant is not cracked; sealant is not detached from either face of the crack.
Dural 50 LM	25A	Air Hose	Pretreat	Flood	0.194	0.196	Sealant is colorless with quartz sand grains. Debris present throughout the crack. Sealant is not cracked; sealant does not bridge the crack but is on both the North and South face of the crack.
	26A	Shot Blast	Pretreat	Flood	0.064	0.066	Sealant is colorless with quartz sand grains. Debris present throughout the crack. Sealant is not cracked; sealant does not bridge the crack but is on both the North and South face of the crack.
Transpo T70	27A	Air Hose	None	Flood	0.214	0.299	Sealant is colorless. Debris present throughout the crack. Sealant is not cracked; sealant is detached from the South face of the crack.
	28A	Air Hose	None	Flood	0.000	0.000	Sealant noted on top of core but not in the crack. Sealant is colorless. Debris present throughout the crack. There is a small amount of sealant on the surface of the core but not in the crack.

*Indicates the maximum depth that sealant was observed. The penetration depth does not equate to observed sealant thickness.

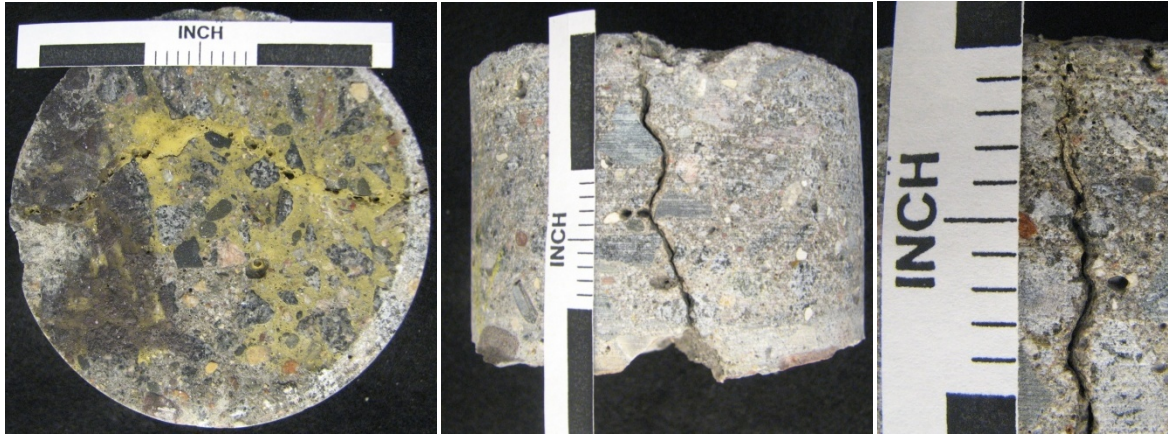


Figure 12. Sample As-received Petrographic Observation Photos.

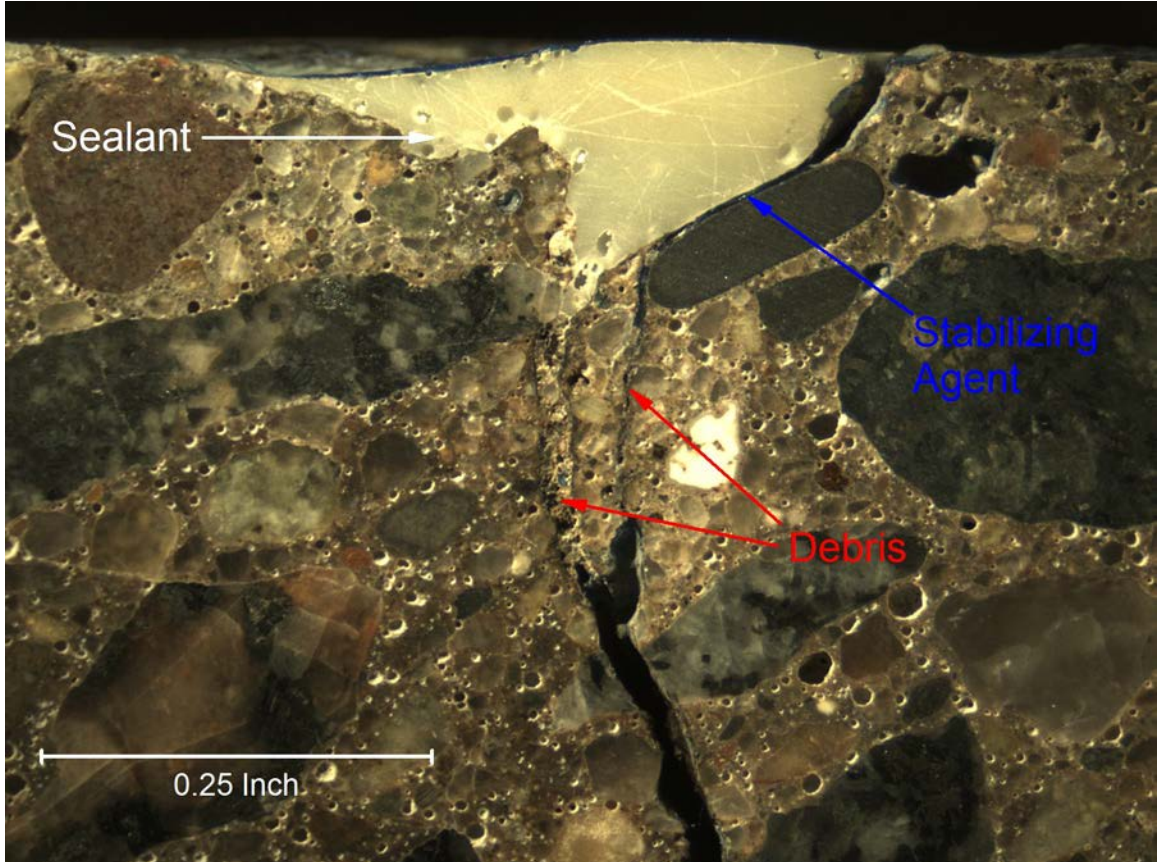


Figure 13. Sample Cut and Polished Petrographic Observation Photo.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The intent of this project was to evaluate crack sealant product performance. This evaluation occurred through subjective visual ratings and evaluation criteria. The permeameter data provided a qualitative idea of how well a sealant protects against water ingress; however, the presence and amount of debris, deck temperature, and other factors prevented this data to be used as a reliable independent variable. Although the petrographic analysis provided a high level of detail, a statistically relevant number of cores and petrographic observations was not feasible given the resources available. The following sections present conclusions from this project.

7.1.1 Permeameter Test Results

- Examination of the control section test results can identify potential flaws in the test device and method to adequately characterize bridge cracks and sealant performance. The results indicated that three control section tests produced head loss initially, yet in subsequent tests, these same locations did not allow water to infiltrate even though they were not sealed. It is clear that deck temperature, crack characteristics and debris also affect the head loss through the cracks.
- Due to the variability of test results and inability to characterize all factors, the permeameter data should only be used to justify recommendations based on visual and petrographic observations.
- Most products appeared to reduce permeability after one winter, with the exception of Accuflex Gel-Seal. This product is unique to the experiment as it was the only product that is neither an epoxy nor methacrylate resin.

Figure 14 shows a close up of Gel-Seal and compares it to a control section. Visually, there is little to no evidence that this product was applied. The petrographic evaluation corroborates the field visual observations as no sealant was observed in the cracks.



Figure 14. Accuflex Gel-Seal (left) Compared to Control Section (right)

The mechanism that reportedly produces the sealant benefits is a chemical reaction between the available calcium hydroxide in the concrete and silicates in the Gel-Seal. Chemical core analysis would be necessary to investigate the reaction at this test location but was beyond the scope of this project.

- Head loss exceeding 15 cm was treated as a “failing” test. The Accuflex Gel-Seal product was identified as the only product receiving a “failing” test result, with the exception of Degadeck that had one “passing” test and one “failing” test by a small margin.

7.1.2 *Visual Observations*

- The winter of 2011-12 was pretty mild for Minnesota standards but 2012-13 and 2013-14 were more typical if not extreme. In general, most products appeared to perform similarly after one winter. Understandably, additional surface wear and loss of sealant and/or loss of sand granules was evident after the second and third winters. Additionally, cracking and debonding from one or both of the crack faces continued during the second and third winters and the associated colder temperatures.
- Based on visual observations after one winter, most products showed signs or preliminary signs of cracking. The exceptions were TK-9030, KwikBond, Sikadur 55 SLV, and Dural 50 LM, but after a second winter, cracking was visually detectable at these test locations.
- The initial opinion during the 2014 field review was that the performance across the board was drastically reduced from the previous field review. The major differences observed during this review were major loss of sealant and sand materials.
- During the 2014 review, no product was performing at a fully acceptable level (subjective rating = 3), and in fact, only four products were given a rating of 2 (on a scale of 1 to 3). The products that were observed to be performing the best were TK-2110 (9A, 10B), KwikBond (18A, 20A), TE 3008-1 (22B), TE 2501 (24A, 35A), Epoxeal (19A), Degadeck (21A), and Transpo T70 (27A).
- It appears that performance is dependent on the location within the lane. In general products showed greater wear and more likelihood of failure when placed in the wheelpaths. However, in production, an entire crack will be sealed, so a failure, whether in the wheelpath or non-wheelpath, is still a failure.

7.1.3 *Petrographic Observations*

- Most cores exhibited evidence of sealant during petrographic observation. However, both cores in the Gel-Seal (1A, 2A) product, one in TK-2414 (12A), and one in Transpo T70 (28A) showed no evidence of sealant under magnification.
- Only two products were found to be adhered to both sides of the cracks after coring and petrographic observation; TK-2110 and Paulco TE-2501. Looking at the permeability data, both of these test sections performed exceptionally well in regards to eliminating

penetration of water. However, after one winter, the TK-2110 product did increase from 0 cm of head loss to 4 cm of head loss. This could be due to the test apparatus and/or test procedure but should be noted.

- In general, methacrylates and HMWM achieve deeper penetration than epoxy crack sealers. The one epoxy that achieved a similar depth of penetration (~0.3-inch) was TK-9030, which has a low viscosity similar to methacrylate and HMWM sealers. This section also differed from the other TK-9030 section in that the surface preparation included sand blasting.

7.1.4 Application and Surface Preparation

- There does not appear to be an isolated relationship between product performance and the air and deck temperatures during application shown in Figure 3. Referencing the maximum recommended temperature to deck temperature, four of the five products applied above the suggested upper temperature range performed quite well (KwikBond, TE-2501, Dural 50 LM, and Transpo T-70). All products were applied at air temperatures below the recommended maximum.

Figure 15 is a slight modification of Figure 3, with the highest ranked products highlighted in green (at least one of the two test locations). The results indicate that, at least based on the environmental conditions, preparation and application procedures, and products included in this study, performance is independent of application temperature. The ranking process is described in Section 7.2.

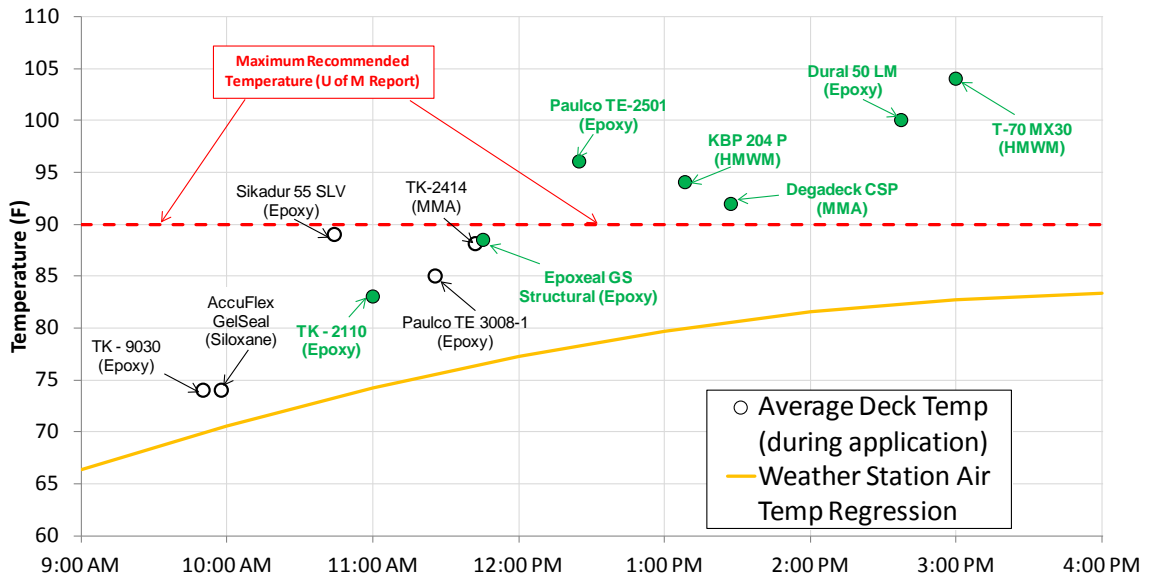


Figure 15. Application Temperatures and Product Performance

- It appears that air blown surface preparation leads to better performance based on visual and petrographic observations, which does support MnDOT’s current practices. For the seven products that were applied with two different surface preparation methods, the air

blown section is always ranked higher with the exception of TK-2414 and TK-9030. The ranking process is described in Section 7.2.

- Interaction effects with other factors is likely, but the products with crack pre-treatment (Gel-Seal, Degadeck CSP, and Dural 50 LM) generally ranked lower than the products without pre-treatment.

7.1.5 *Material Properties*

- For methacrylate and HMWM sealers, it does not appear that any material property can be easily identified as a key factor for good performance. Most of the properties and characteristics identified in Table 2 are fairly comparable. The one factor that differs is tensile elongation. KwikBond has an elongation of approximately 2 percent (below MnDOT's requirement) whereas Transpo T-70 has an elongation of about 30 percent. As a result, based on performance observations in this study, tensile elongation does not appear to be significant to methacrylate resin performance.
- For methacrylate and HMWM sealers, it should be noted that the two products that were ranked the highest (KwikBond and Transpo T-70) exceed MnDOT's requirement for tack free time; however, both products cite test different methods than what is listed in MnDOT's requirement, so the comparison may not be correct.
- Epoxy sealers also do not appear to have any material properties listed in Table 3 that can easily be identified as a key factor for performance. For example, the product with viscosity that far exceeds MnDOT's maximum value was one of the better performing products (TH-2501). Further, TE-2501 has bond, compressive, and tensile strengths that are far below MnDOT's requirements. One could try to point to elongation as being a critical factor since TE-2501 has a very high value. However, TK-2110, TK-9090, and Epoxéal all exhibit significantly lower values (near MnDOT's limit), yet they performed well.
- For epoxy sealers, tensile elongation does not appear to be a factor in regards to adhering to both sides of the crack walls since the two products that did not detach are TE-2501 (elongation = 57%) and TK-2110 (elongation = 2.6%).

7.2 **Recommendations**

Based on permeability testing, almost all products were able to prevent or reduce the intake of water after one winter. The exception is Accuflex Gel-Seal, which behaved quite similarly to the Control Sections. It is recommended that this product is not considered for the Approved Products list for crack sealers until the vendor has further field performance tests to show otherwise.

In an effort to simplify product evaluation given the many parameters and factors identified in this research study, a simple ranking approach with weighting factors was developed. The evaluation factors are shown in Table 12. Every test location (1A, 2A, etc) was assigned a value of 1, 2 or 3 (1 is the worst and 3 is the best) for each factor based on the product information,

application details, and performance data gathered within the study. Values were assigned with considerations based on resources (cost, time), safety, and product performance (visual observations, petrographic observations, and permeameter).

Table 12: Evaluation Factors

Evaluation Category	Factor	Rank 1 (Worst)	Rank 2	Rank 3 (Best)
Product	Meet MnDOT Req	--	No	Yes
	Cost	Highest Cost	Intermediate Cost	Lowest Cost
Application	Surface Prep	Shot Blast	Sand Blast	Air
	Crack Prep	Route	Pretreat	None
	Application Type	Flood	Bottle	Pump
	No. Of Applications	3	2	1
	Level of PPE	High	Medium	Low
	Odor	Strong	Moderate	Weak
Petrography	Penetration	Bottom Third	Middle Third	Top Third
	Sealant Cracked?	No Sealant Present	Yes	No
	Sealant Detached?	No Sealant Present	Yes	No
Visual Observations	Visual_1yr	Ineffective	Semi-Effective	Effective
	Visual_2yr	Ineffective	Semi-Effective	Effective
	Visual_3yr	Ineffective	Semi-Effective	Effective
Permeameter	HL_post*	>15	> 3 to 15	3 or less
	HL_1yr*	>15	> 3 to 15	3 or less

*HL = Head Loss

A separate weight factor was used to fully account for all the different parameters in the final results. The weight factors were assigned on a scale of 0 to 5 based on the importance rank of the parameter. The importance rank was determined from the perspective of typical crack sealing practices and considerations when the activity is performed by MnDOT bridge maintenance crews. The evaluation categories, evaluation factors, importance factors and ranks, and weight factors are shown in Table 13. This weighted ranking system was used to semi-qualitatively evaluate the products. A similar approach was used by WisDOT [7].

Table 13: Product Ranking Matrix Schematic

Evaluation Category	Factor	Importance Factor	Criteria Importance Rank	Weight Factor
Product	Meet MnDOT Req	--	--	--
	Cost	M	9	2.5
Application	Surface Prep	H	4	4.5
	Crack Prep	H	3	4.5
	Application Type	M	10	2
	No. Of Applications	H	6	4
	Level of PPE	M	11	2
	Odor	H	5	4
Petrography	Penetration	M	8	3
	Sealant Cracked?	H	1	5
	Sealant Detached?	H	2	5
Visual Observations	Visual_1yr	L	12	1.5
	Visual_2yr	H	7	3.5
	Visual_3yr	H	7	4
Permeameter	HL_post	L	14	0.5
	HL_1yr	L	13	0.5

With the exception of the permeameter results, performance data was given the highest importance rank. But, in addition to product performance, the amount of surface preparation and crack preparation required is critical when scheduling crack sealing activities for MnDOT bridge maintenance crews, and therefore, was also given a higher importance rank. In general, a high importance rank was assigned a weight factor of 3.5 to 5, a medium importance rank was assigned a weight factor of 2 to 3, and a low importance rank was assigned a weight factor of 0 to 1.5.

Based on visual observation of product performance after three (and even two) winters, it is recommended that MnDOT look into increasing the frequency of routine crack sealing program from the current five-year cycle. For the conditions evaluated in this study, none of the products would likely provide significant benefit for a period of five years. If there is no increase in internal resources and a more frequent sealing cycle is not feasible, perhaps bridges for sealing could be identified by structure type, age, condition, and/or other factors.

Based on this product ranking method and other recommendations included herein, four epoxy products and three MMA products are recommended for consideration on the MnDOT Approved Products List. Details of the recommended products are shown in Tables 14 and 15. The final ranking matrix is on file with the MnDOT Bridge Office.

Table 14: Recommended Epoxy Products, Application, and Performance Summary

Product	Test	Surf Prep	Application	Additional Details	Visual Observations*			Petrography	Estimated Service Life
					1 year	2 years	3 years		
TK-2110	9A	Air Blown	Flood	--	E	SE	SE	Free of cracks. Not detached.	3 to 4+ years
Paulco TE-2501	24A	Air Blown	Bottle	3 applications	E	SE	SE	Free of cracks. Not detached.	3 to 4+ years
	35A	Air Blown	Bottle	3 applications	E	SE	SE	Free of cracks. Not detached.	3 to 4+ years
Dural 50 LM	25A	Air Blown	Flood	Pre-treated cracks	E	SE	I	Free of cracks. Not detached. Does not "bridge" crack.	2 to 3 years
Epoxeal GS Structural	17A	Air Blown	Flood	--	E	SE	I	Free of cracks. Detached.	2 to 3 years

* E = Effective, SE = Semi-effective, I = Ineffective

Table 15: Recommended MMA Products, Application, and Performance Summary

Product	Test	Surf Prep	Application	Additional Details	Visual Observations*			Petrography	Estimated Service Life
					1 year	2 years	3 years		
KBP 204 P	20A	Air Blown	Flood	--	E	SE	SE	Free of cracks. Detached.	3 to 4+ years
T-70-MX-30	27A	Air Blown	Flood	--	E	SE	SE	Free of cracks. Detached.	3 to 4+ years
Degadeck CSP	21A	Air Blown	Flood	Pre-treated cracks	E	SE	SE	Free of cracks. Detached.	3 to 4+ years

* E = Effective, SE = Semi-effective, I = Ineffective

7.3 Suggestions For Future Evaluation

The following are considerations for future research and evaluation of bridge deck crack sealant products.

- Lessons Learned
 - If a similar project is conducted, it would simplify the analysis and comparisons if surface preparation and application methods were controlled so that every test section is theoretically the same.
 - It would also be very beneficial to clearly identify and define performance measures at the onset of the project.
 - This project was very large in scope and simple, product-to-product comparisons were difficult. Given that each MnDOT District manages maintenance and product selection internally, the Districts could easily monitor performance of

different products applied to different, yet similar, bridges and determine their own performance expectations based on their practices.

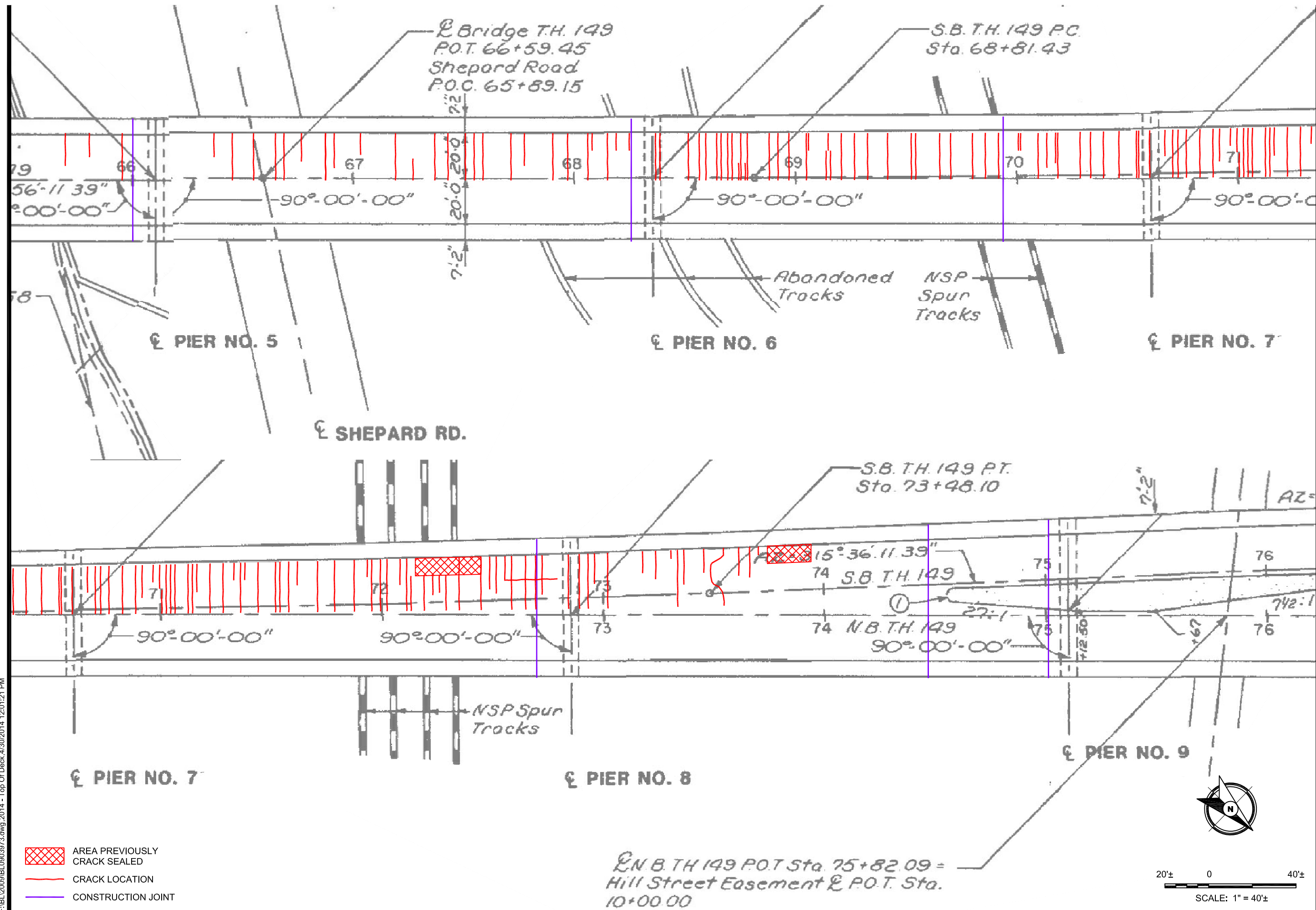
- The traffic volumes on the Smith High Bridge are relatively high compared to a typical MnDOT rural bridge. It is likely that traffic contributed to a portion of the wear and abrasion.
- Evaluate the Smith Avenue High Bridge test sections in the spring of 2015 and spring of 2016. The last rating would provide information regarding the possible condition of bridge decks at the time crack sealing is due again (on a five year cycle).
- Past MnDOT design-build projects have included requirements that the Contractor seal cracks in bridge decks. If that practice continues in the future, the evaluation of products could become part of the Contractor's warranty evaluation period.

REFERENCES

- [1] K. Johnson, A. Schultz, C. French, and J. Reneson (2009). *Crack and Concrete Deck Sealant Performance*. Minnesota Department of Transportation, Office of Research Services. St. Paul, MN.
- [2] A. Soriano (2002). *Alternative Sealants for Bridge Decks: Final Report*. South Dakota Department of Transportation, Office of Research, Pierre, SD.
- [3] Michigan Department of Transportation. Accessed December 2013.
http://www.michigan.gov/documents/mdot/StructureMaintenanceBulletin4_Final_381367_7.pdf
- [4] I. Lasa (2014). Sealing Cracks on Bridge Decks (Changes to Section 413 of FDOT Specifications). Accessed March 2014. Retrieved from
<http://www.ftba.com/CWT/EXTERNAL/WCPAGES/WCMEDIA/DOCUMENTS/SEALINGCRACKS/ONBRIDGEDECKS-IVANLASA.PDF>
- [5] Florida Department of Transportation. Accessed April 2014.
<http://www.dot.state.fl.us/specificationsoffice/Implemented/SpecBooks/2013/Files/SS4000000.pdf>
- [6] D. L. Rettner, M. S. Fiegen, M.B. Snyder, and K.A. MacDonald (2014). *Analysis of Bridge Deck Cracking Data: A Review of Mechanisms, Analysis of MnDOT Bridge Construction Data, and Recommendations for Treatment and Prevention*, Minnesota Department of Transportation, St. Paul, MN.
- [7] J.A. Pincheira and M.A. Dorshorst (2005). *Evaluation of Concrete Deck and Crack Sealers*. Wisconsin Highway Research Program. Madison, WI.
- [8] J.A. Pincheira (2009). *Development and Layout of a Protocol for the Field Performance of Concrete Deck and Crack Sealants*, Department of Civil and Environmental Engineering, University of Wisconsin, Madison, WI.
- [9] CTC & Associates, LLC (2006). *Bridge Deck Surface Treatment Practices Of Five Midwest State DOTs*, Research and Communication Services, Wisconsin Department of Transportation. Madison, WI.

APPENDIX

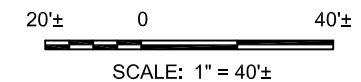
APPENDIX 1 – Top of Deck Crack Survey



F:\BL2009\BL0903973.dwg, 2014 - Top Of Deck, 4/30/2014, 12:01:21 PM

- AREA PREVIOUSLY CRACK SEALED
- CRACK LOCATION
- CONSTRUCTION JOINT

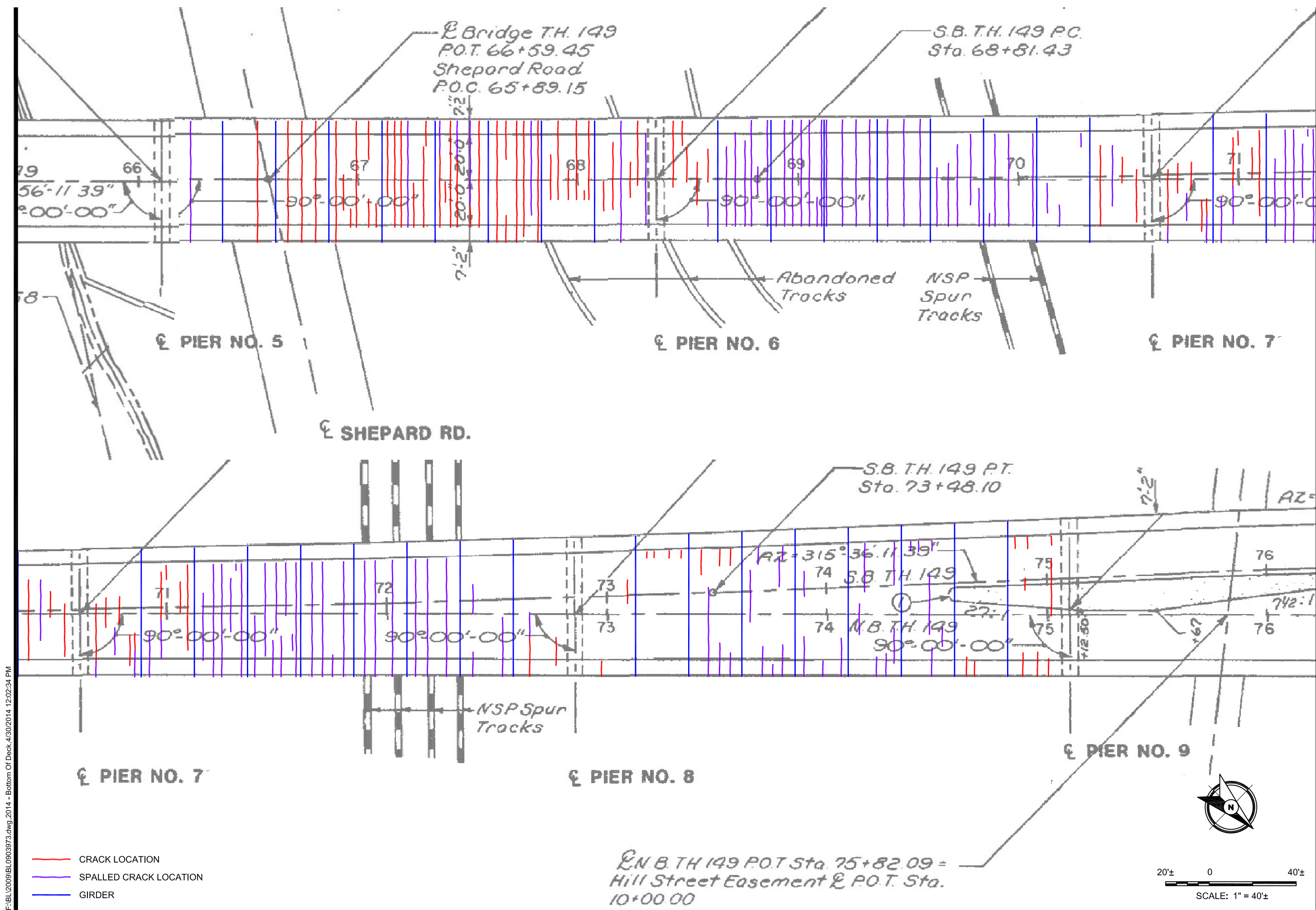
N.B.T.H. 149 P.O.T. Sta. 75+82.09 =
Hill Street Easement & P.O.T. Sta.
10+00.00



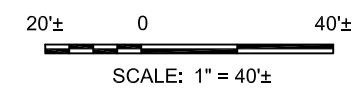
CRACK SURVEY - TOP OF DECK
MnDOT BRIDGE REPAIR MATERIALS RESEARCH
SMITH AVENUE HIGH BRIDGE
SAINT PAUL, MINNESOTA

Project No:	BL0903973
Drawing No:	BL0903973
Scale:	1" = 40'±
Drawn By:	BJB
Date Drawn:	5/11/11
Checked By:	GEB
Last Modified:	4/30/14
Sheet:	Fig:
of	

APPENDIX 2 – Bottom of Deck Crack Survey



- CRACK LOCATION
- SPALLED CRACK LOCATION
- GIRDER

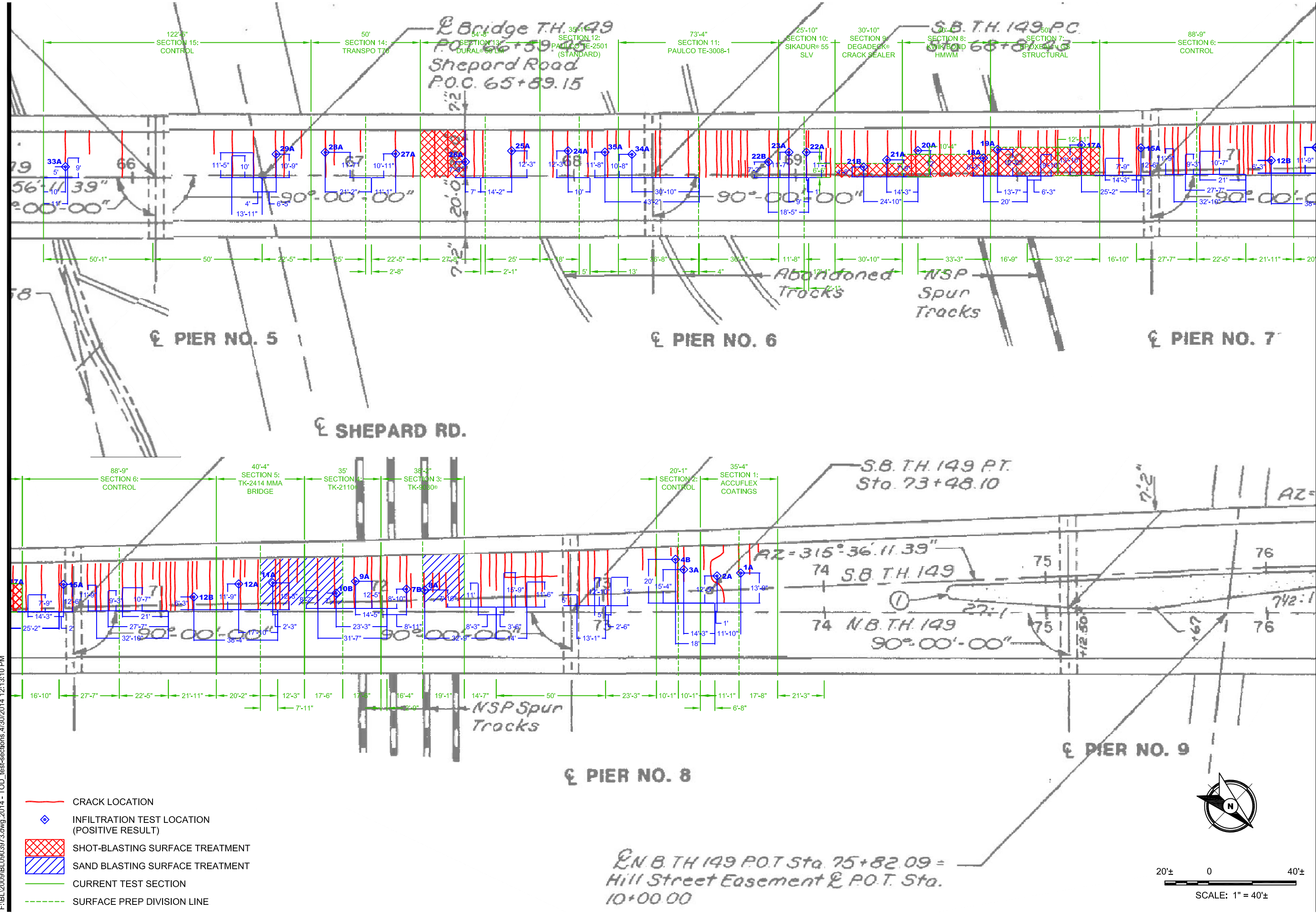


CRACK SURVEY - BOTTOM OF DECK
 MnDOT BRIDGE REPAIR MATERIALS RESEARCH
 SMITH AVENUE HIGH BRIDGE
 SAINT PAUL, MINNESOTA

Project No:	BL0903973
Drawing No:	BL0903973
Scale:	1" = 40'±
Drawn By:	BJB
Date Drawn:	5/11/11
Checked By:	GEB
Last Modified:	4/30/14
Sheet:	Fig:
of	

F:\BL\2009\BL0903973.dwg, 2014 - Bottom Of Deck, 4/30/2014, 12:02:34 PM

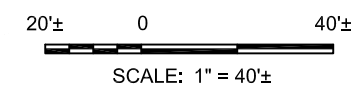
APPENDIX 3 – Test Section Layout, Products, and Evaluation Points



TOP OF DECK - TEST SECTIONS
MnDOT BRIDGE REPAIR MATERIALS RESEARCH
SMITH AVENUE HIGH BRIDGE
SAINT PAUL, MINNESOTA

F:\BL2009\BL0903973.dwg, 2014 - TOD_test-sections, 4/30/2014 12:13:10 PM

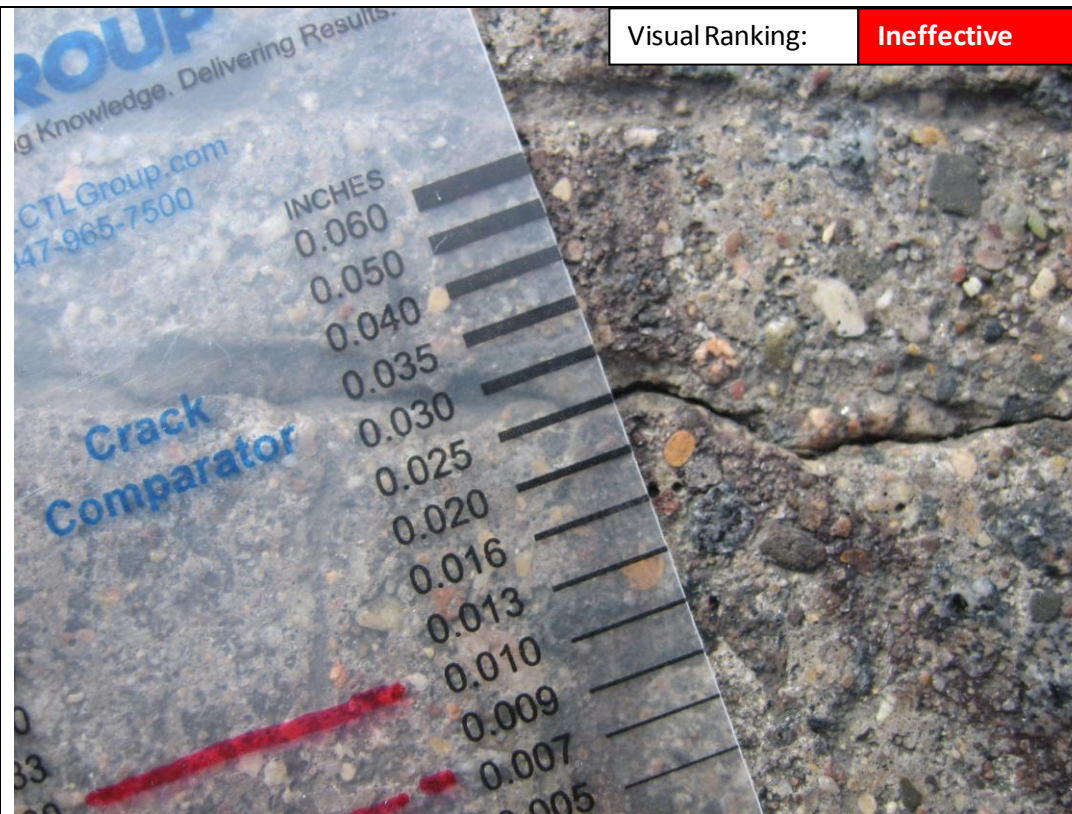
- CRACK LOCATION
- INFILTRATION TEST LOCATION (POSITIVE RESULT)
- SHOT-BLASTING SURFACE TREATMENT
- SAND BLASTING SURFACE TREATMENT
- CURRENT TEST SECTION
- SURFACE PREP DIVISION LINE



N.B.T.H. 149 P.O.T. Sta. 75+82.09 =
Hill Street Easement & P.O.T. Sta.
10+00.00

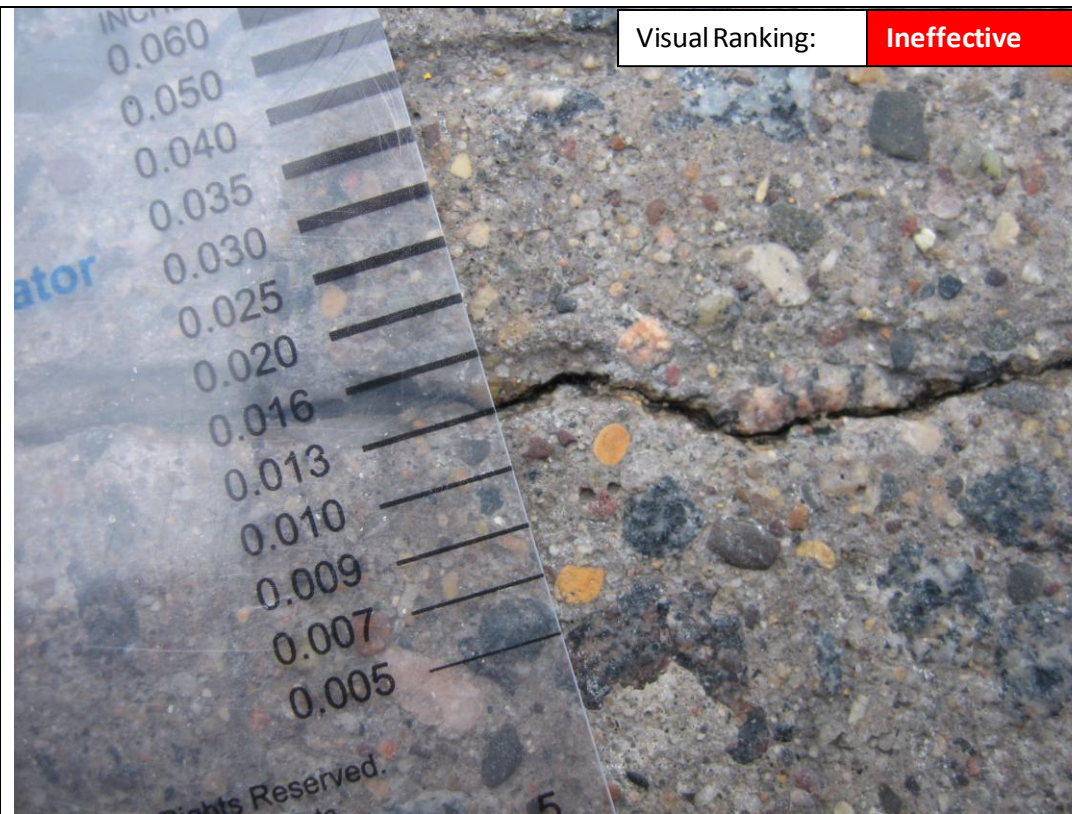
Project No:	BL0903973
Drawing No:	BL0903973
Scale:	1" = 40'±
Drawn By:	BJB
Date Drawn:	5/11/11
Checked By:	GEB
Last Modified:	4/30/14
Sheet:	Fig:
of	

APPENDIX 4 – Evaluation Point Photo Log (2012, 2013, and 2014)



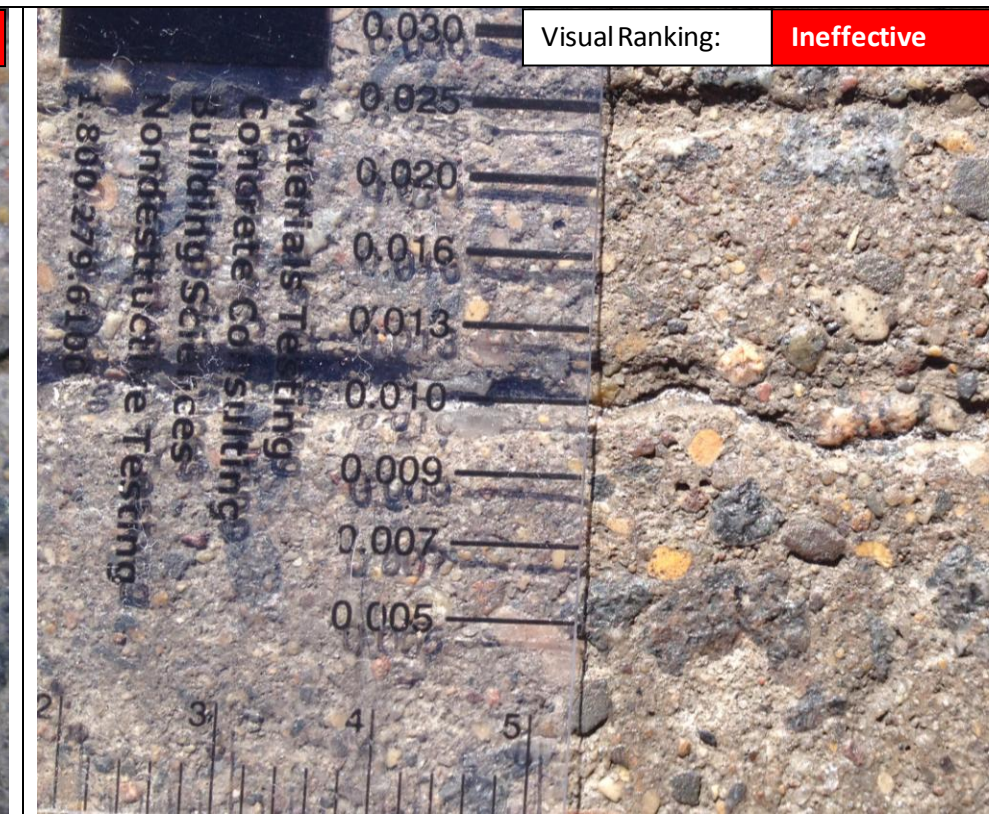
Visual Ranking: **Ineffective**

Photograph #: 1
 Test Information: Test Section 1, Test 1A - Accuflex Coatings Gel-Seal (Silicate)
 Surface Prep & Application: Air Hose, Pretreat, Flood, Sand Coat: No
 Date: May 11, 2012
BRAUN INTERTEC



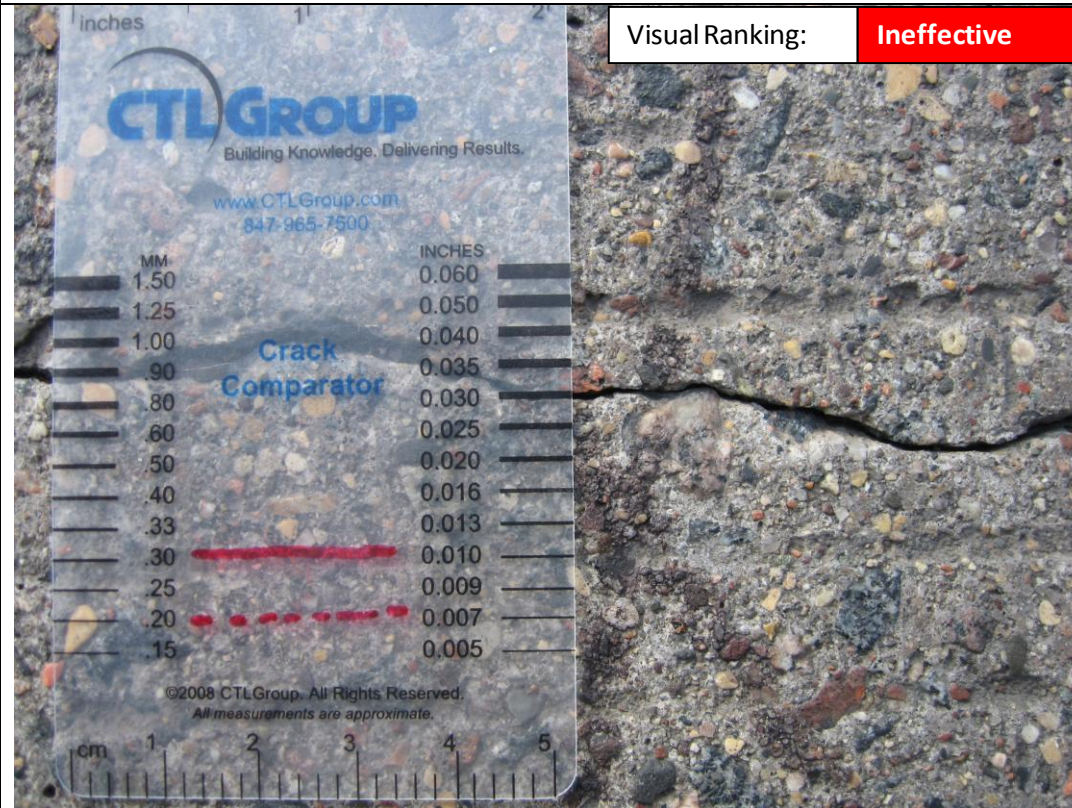
Visual Ranking: **Ineffective**

Photograph #: 2
 Test Information: Test Section 1, Test 1A - Accuflex Coatings Gel-Seal (Silicate)
 Surface Prep & Application: Air Hose, Pretreat, Flood, Sand Coat: No
 Date: April 30, 2013
BRAUN INTERTEC



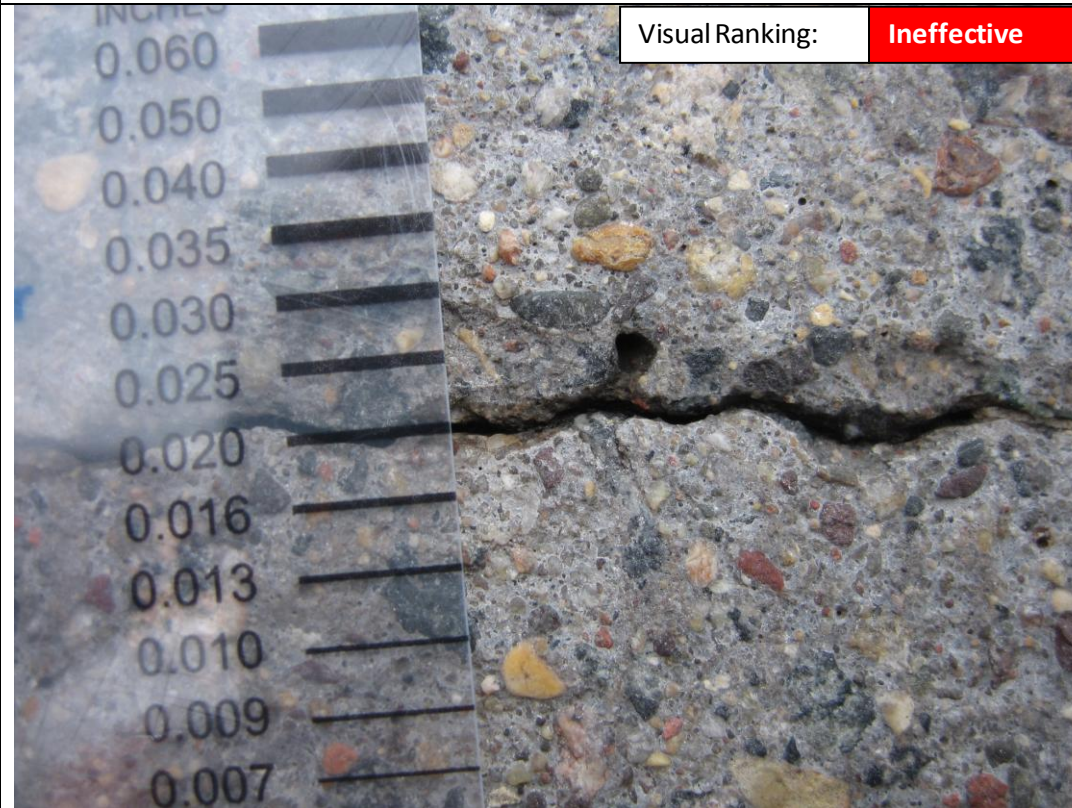
Visual Ranking: **Ineffective**

Photograph #: 3
 Test Information: Test Section 1, Test 1A - Accuflex Coatings Gel-Seal (Silicate)
 Surface Prep & Application: Air Hose, Pretreat, Flood, Sand Coat: No
 Date: April 8, 2014
BRAUN INTERTEC



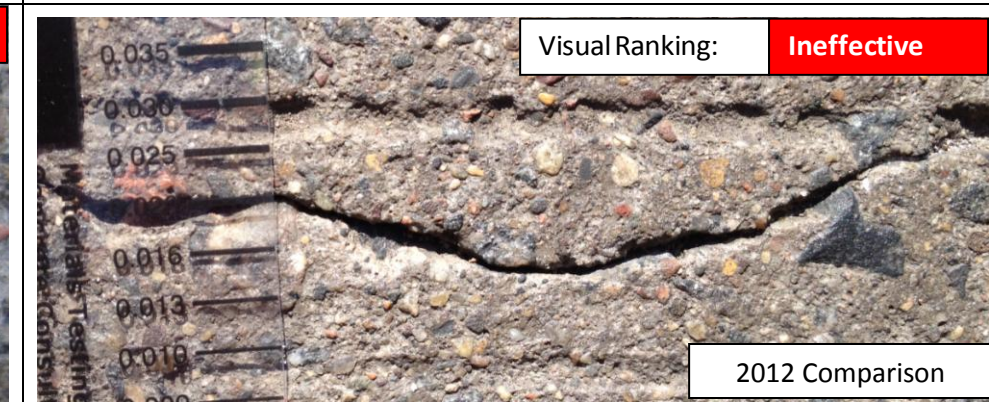
Visual Ranking: **Ineffective**

Photograph #: 4
 Test Information: Test Section 1, Test 2A - Accuflex Coatings Gel-Seal (Silicate)
 Surface Prep & Application: Air Hose, Pretreat, Flood, Sand Coat: No
 Date: May 11, 2012
BRAUN INTERTEC



Visual Ranking: **Ineffective**

Photograph #: 5
 Test Information: Test Section 1, Test 2A - Accuflex Coatings Gel-Seal (Silicate)
 Surface Prep & Application: Air Hose, Pretreat, Flood, Sand Coat: No
 Date: April 30, 2013
BRAUN INTERTEC

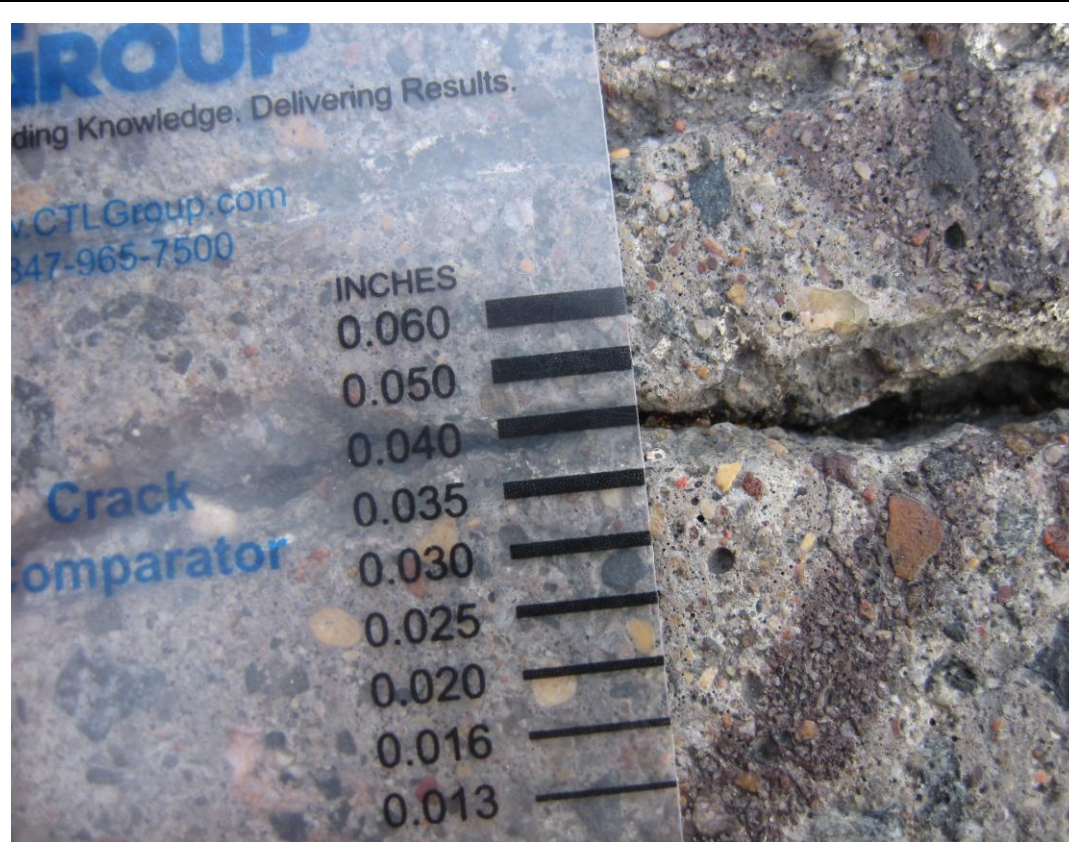


Visual Ranking: **Ineffective**



Visual Ranking: **Ineffective**

Photograph #: 6
 Test Information: Test Section 1, Test 2A - Accuflex Coatings Gel-Seal (Silicate)
 Surface Prep & Application: Air Hose, Pretreat, Flood, Sand Coat: No
 Date: April 8, 2014
BRAUN INTERTEC



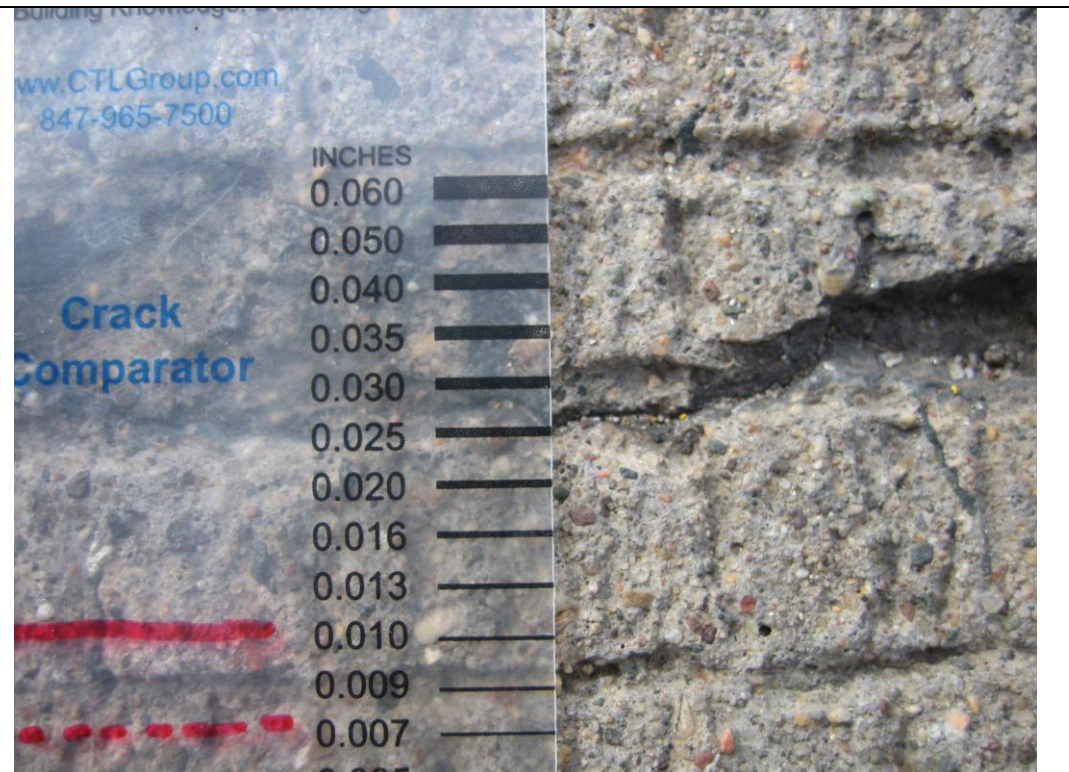
Photograph #: 7
 Test Information: Test Section 2, Test 3A - CONTROL
 Surface Prep & Application: CONTROL
 Date: May 11, 2012
 Project BL-09-03973
BRAUN
INTERTEC

Not cored/re-surveyed in 2013. No photograph.

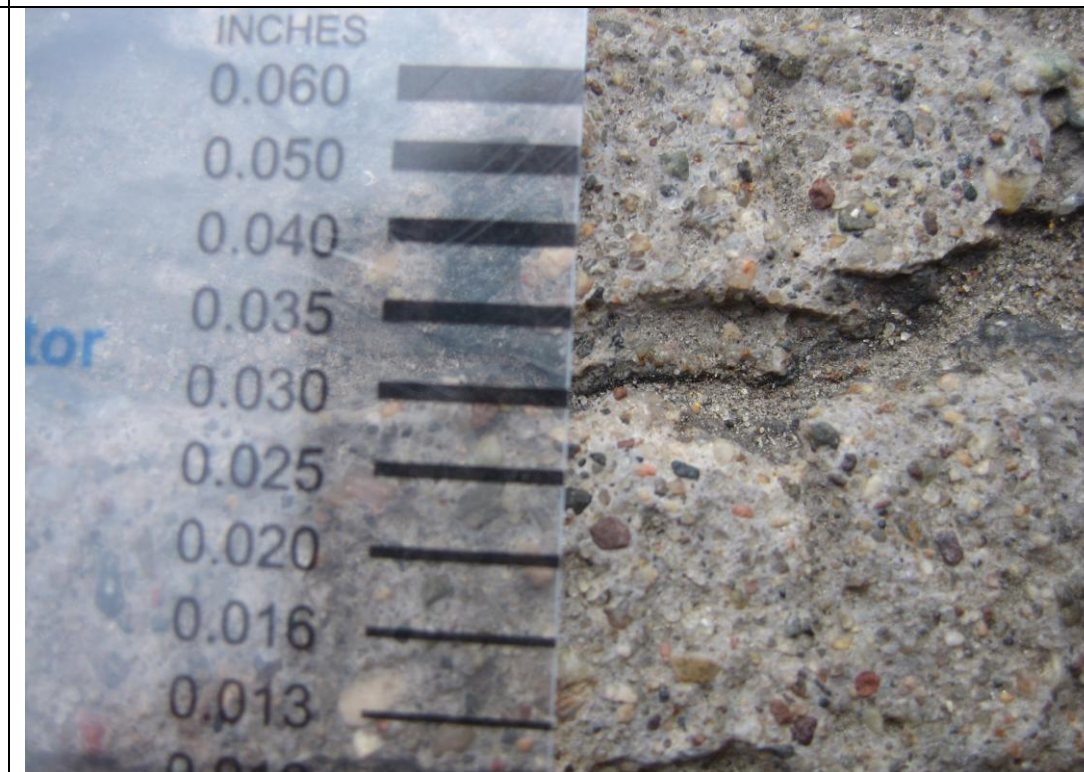
Photograph #: 8
 Test Information: Test Section 2, Test 3A - CONTROL
 Surface Prep & Application: CONTROL
 Date: April 30, 2013
 Project BL-09-03973
BRAUN
INTERTEC



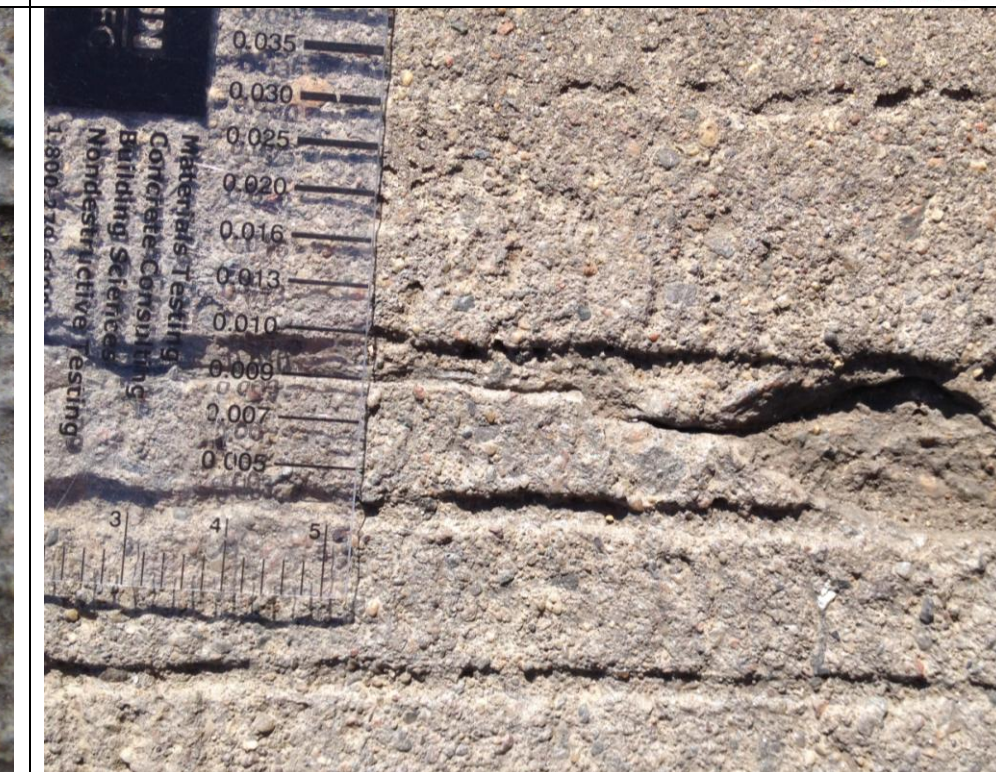
Photograph #: 9
 Test Information: Test Section 2, Test 3A - CONTROL
 Surface Prep & Application: CONTROL
 Date: April 8, 2014
 Project BL-09-03973
BRAUN
INTERTEC



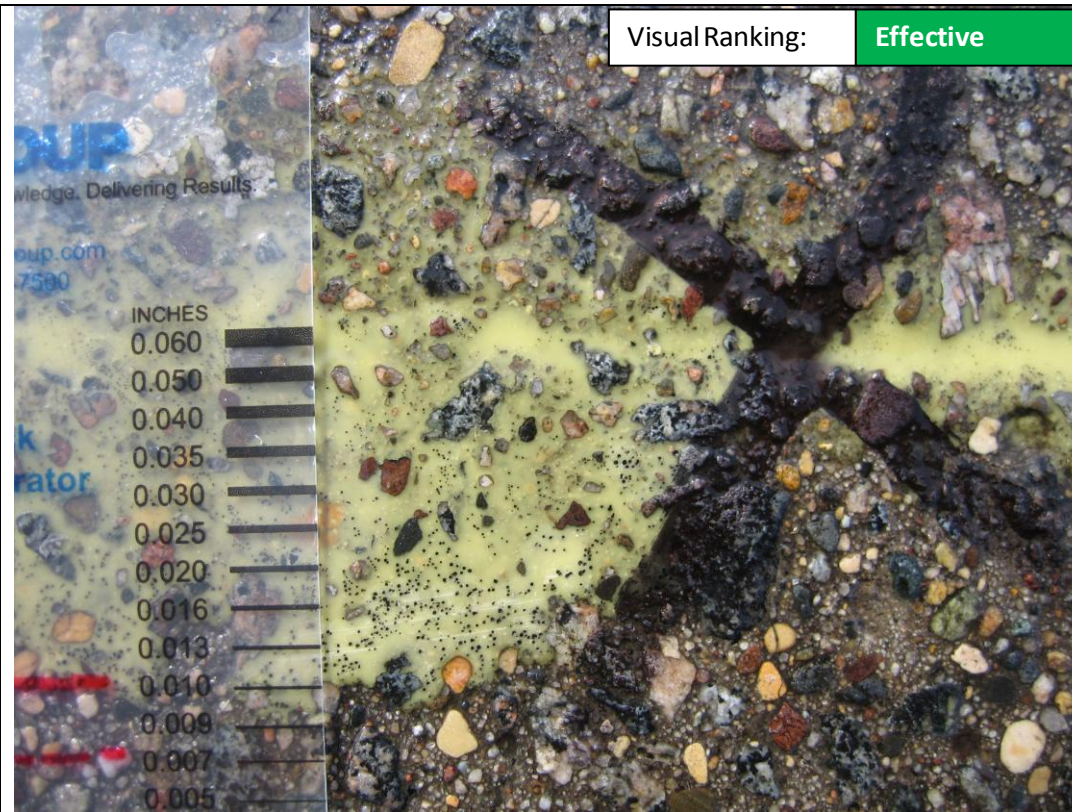
Photograph #: 10
 Test Information: Test Section 2, Test 4B - CONTROL
 Surface Prep & Application: CONTROL
 Date: May 11, 2012
 Project BL-09-03973
BRAUN
INTERTEC




Photograph #: 11
 Test Information: Test Section 2, Test 4B - CONTROL
 Surface Prep & Application: CONTROL
 Date: April 30, 2013
 Project BL-09-03973
BRAUN
INTERTEC



Photograph #: 12
 Test Information: Test Section 2, Test 4B - CONTROL
 Surface Prep & Application: CONTROL
 Date: April 8, 2014
 Project BL-09-03973
BRAUN
INTERTEC




Photograph #: 13
 Test Information: Test Section 3, Test 7B - TK Products TK-9030 (Epoxy)
 Surface Prep & Application: Sand Blast, Bottle, Sand Coat: No
 Date: May 11, 2012

Project BL-09-03973





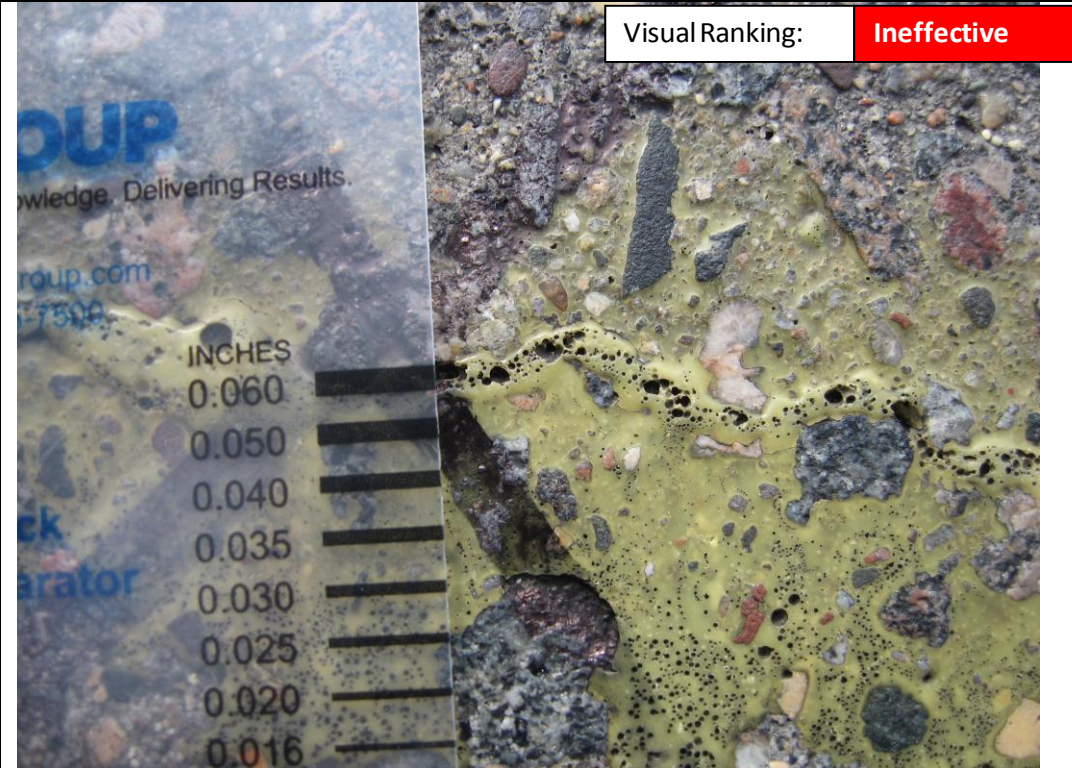
Photograph #: 14
 Test Information: Test Section 3, Test 7B - TK Products TK-9030 (Epoxy)
 Surface Prep & Application: Sand Blast, Bottle, Sand Coat: No
 Date: April 30, 2013

Project BL-09-03973





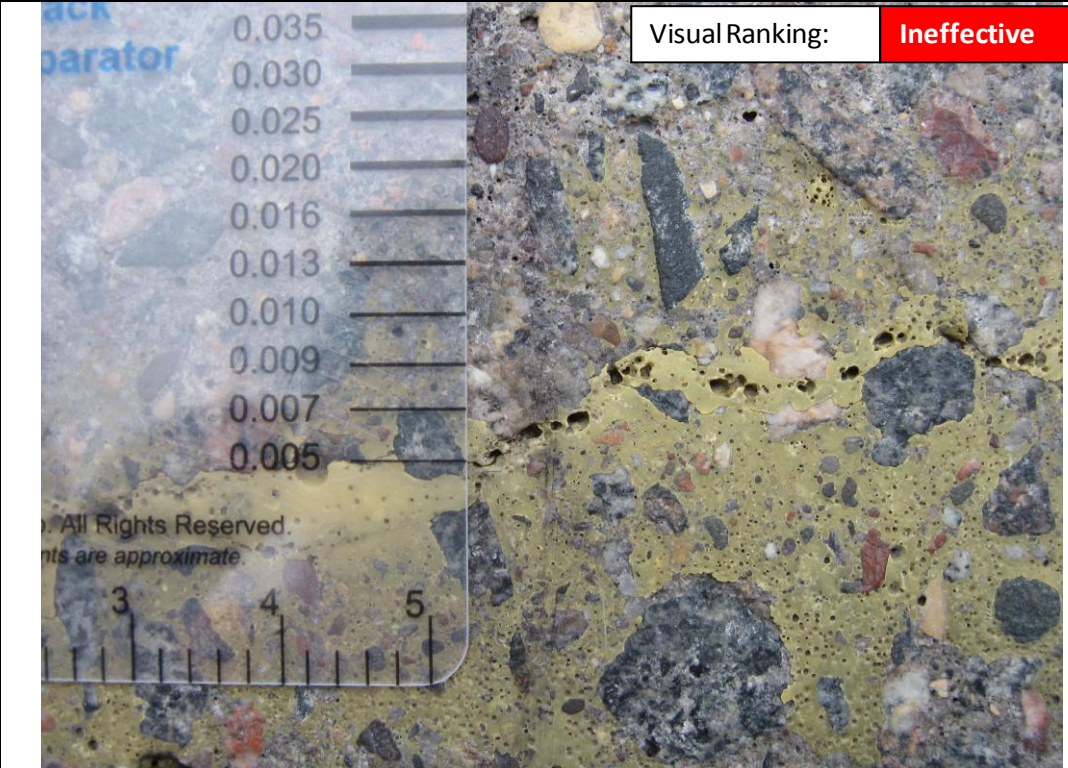
Photograph #: 15
 Test Information: Test Section 3, Test 7B - TK Products TK-9030 (Epoxy)
 Surface Prep & Application: Sand Blast, Bottle, Sand Coat: No
 Date: April 8, 2014

Project BL-09-03973





Photograph #: 16
 Test Information: Test Section 3, Test 8A - TK Products TK-9030 (Epoxy)
 Surface Prep & Application: Air Hose, Bottle, Sand Coat: No
 Date: May 11, 2012

Project BL-09-03973





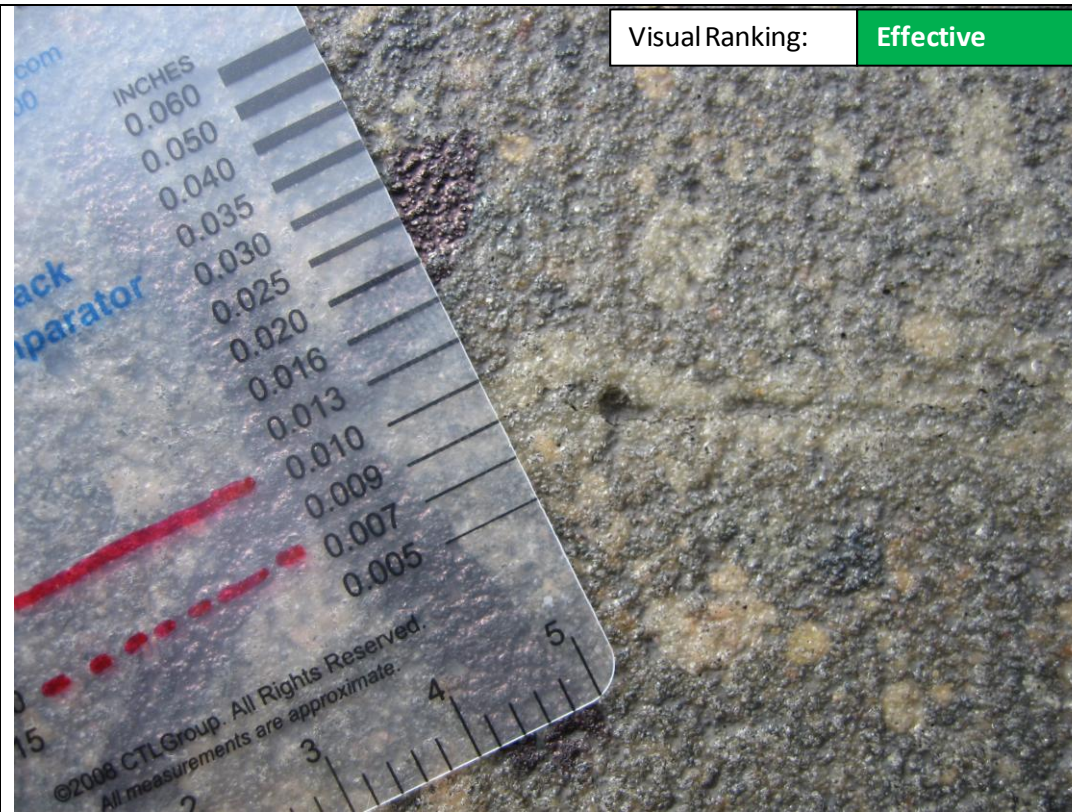
Photograph #: 17
 Test Information: Test Section 3, Test 8A - TK Products TK-9030 (Epoxy)
 Surface Prep & Application: Air Hose, Bottle, Sand Coat: No
 Date: April 30, 2013

Project BL-09-03973




Photograph #: 18
 Test Information: Test Section 3, Test 8A - TK Products TK-9030 (Epoxy)
 Surface Prep & Application: Air Hose, Bottle, Sand Coat: No
 Date: April 8, 2014

Project BL-09-03973




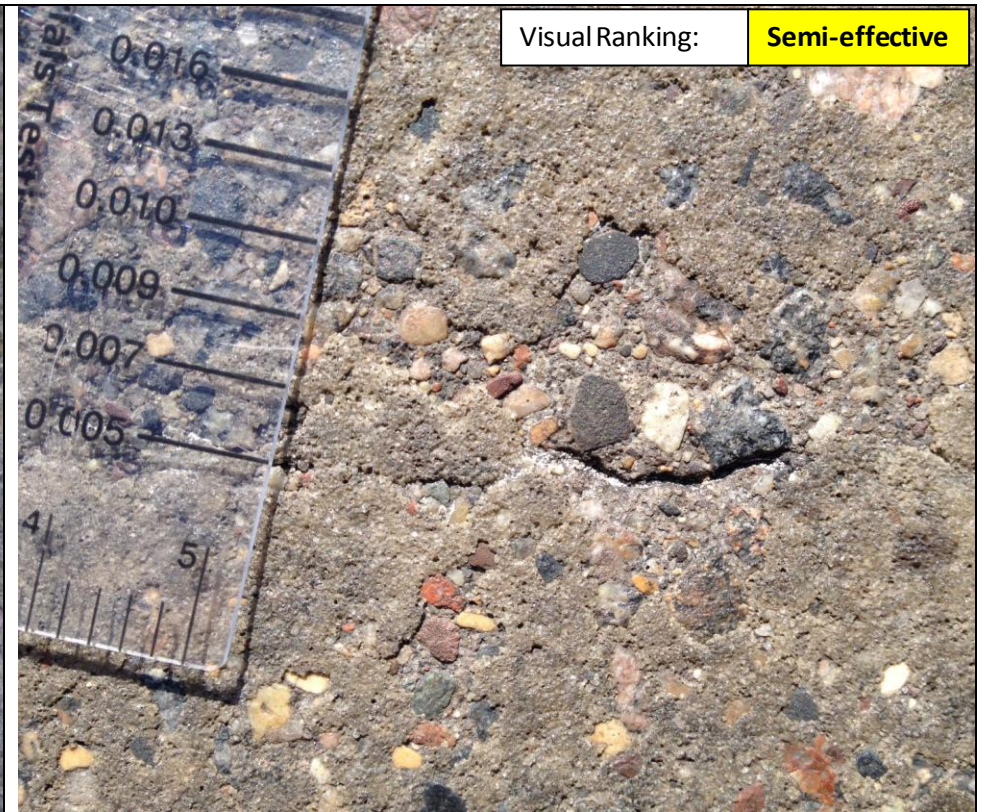
Visual Ranking: **Effective**

Photograph #: 19
Test Information: Test Section 4, Test 9A - TK Products TK-2110 (Epoxy)
Surface Prep & Application: Air Hose, Flood, Sand Coat: Yes
Date: May 11, 2012
Project BL-09-03973
BRAUN INTERTEC



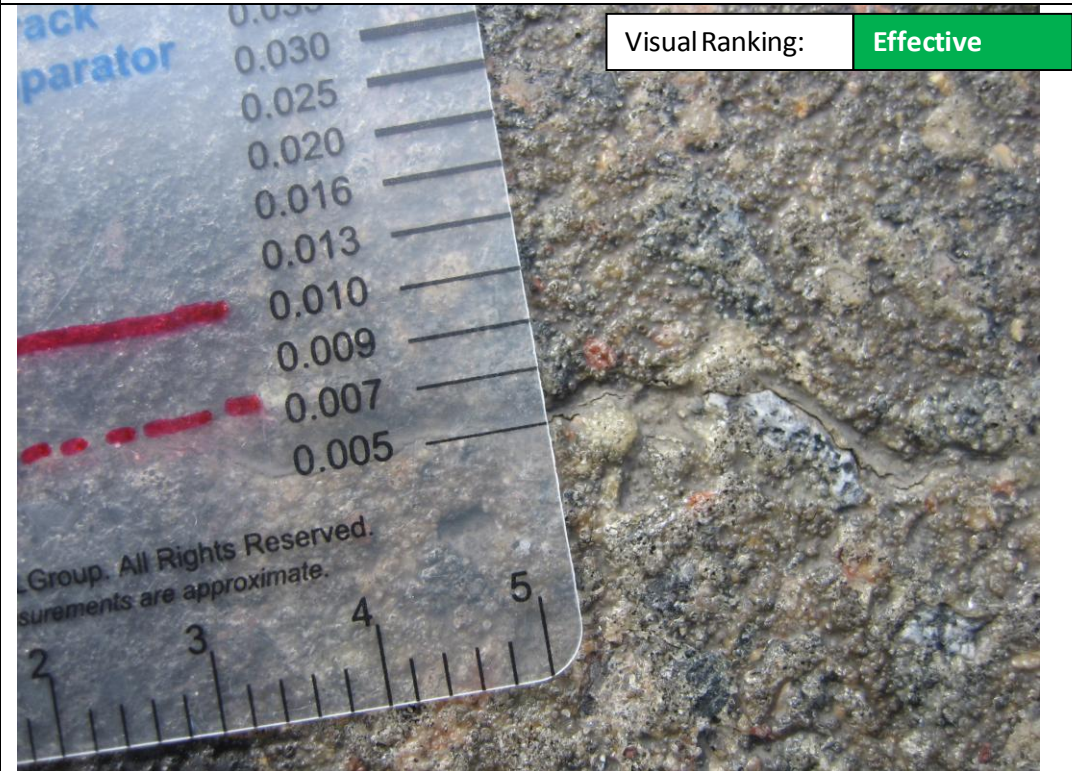
Visual Ranking: **Semi-effective**

Photograph #: 20
Test Information: Test Section 4, Test 9A - TK Products TK-2110 (Epoxy)
Surface Prep & Application: Air Hose, Flood, Sand Coat: Yes
Date: April 30, 2013
Project BL-09-03973
BRAUN INTERTEC



Visual Ranking: **Semi-effective**

Photograph #: 21
Test Information: Test Section 4, Test 9A - TK Products TK-2110 (Epoxy)
Surface Prep & Application: Air Hose, Flood, Sand Coat: Yes
Date: April 8, 2014
Project BL-09-03973
BRAUN INTERTEC



Visual Ranking: **Effective**

Photograph #: 22
Test Information: Test Section 4, Test 10B - TK Products TK-2110 (Epoxy)
Surface Prep & Application: Sand Blast, Flood, Sand Coat: Yes
Date: May 11, 2012
Project BL-09-03973
BRAUN INTERTEC



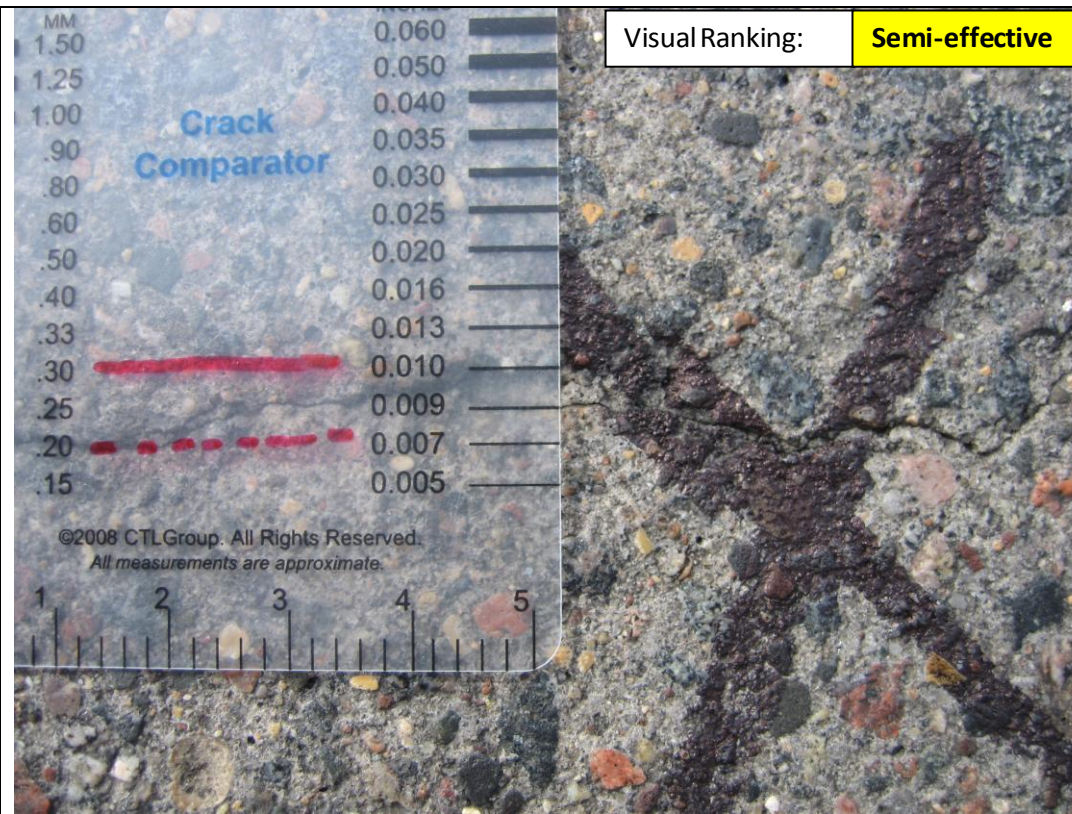
Visual Ranking: **Semi-effective**

Photograph #: 23
Test Information: Test Section 4, Test 10B - TK Products TK-2110 (Epoxy)
Surface Prep & Application: Sand Blast, Flood, Sand Coat: Yes
Date: April 30, 2013
Project BL-09-03973
BRAUN INTERTEC



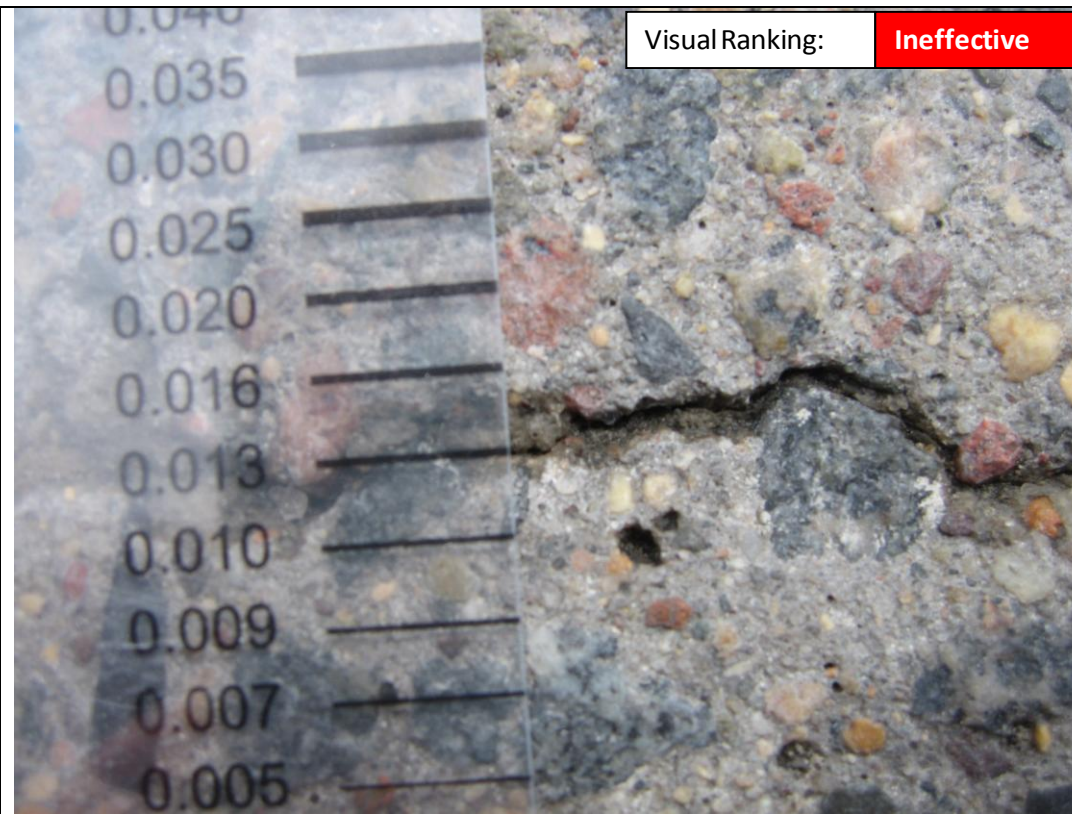
Visual Ranking: **Semi-effective**

Photograph #: 24
Test Information: Test Section 4, Test 10B - TK Products TK-2110 (Epoxy)
Surface Prep & Application: Sand Blast, Flood, Sand Coat: Yes
Date: April 8, 2014
Project BL-09-03973
BRAUN INTERTEC



Visual Ranking: **Semi-effective**

Photograph #: 25
 Test Information: Test Section 5, Test 11A - TK Products TK-2414 (MMA)
 Surface Prep & Application: Sand Blast, Flood, Sand Coat: Yes
 Date: May 11, 2012
 Project BL-09-03973
BRAUN INTERTEC



Visual Ranking: **Ineffective**

Photograph #: 26
 Test Information: Test Section 5, Test 11A - TK Products TK-2414 (MMA)
 Surface Prep & Application: Sand Blast, Flood, Sand Coat: Yes
 Date: April 30, 2013
 Project BL-09-03973
BRAUN INTERTEC

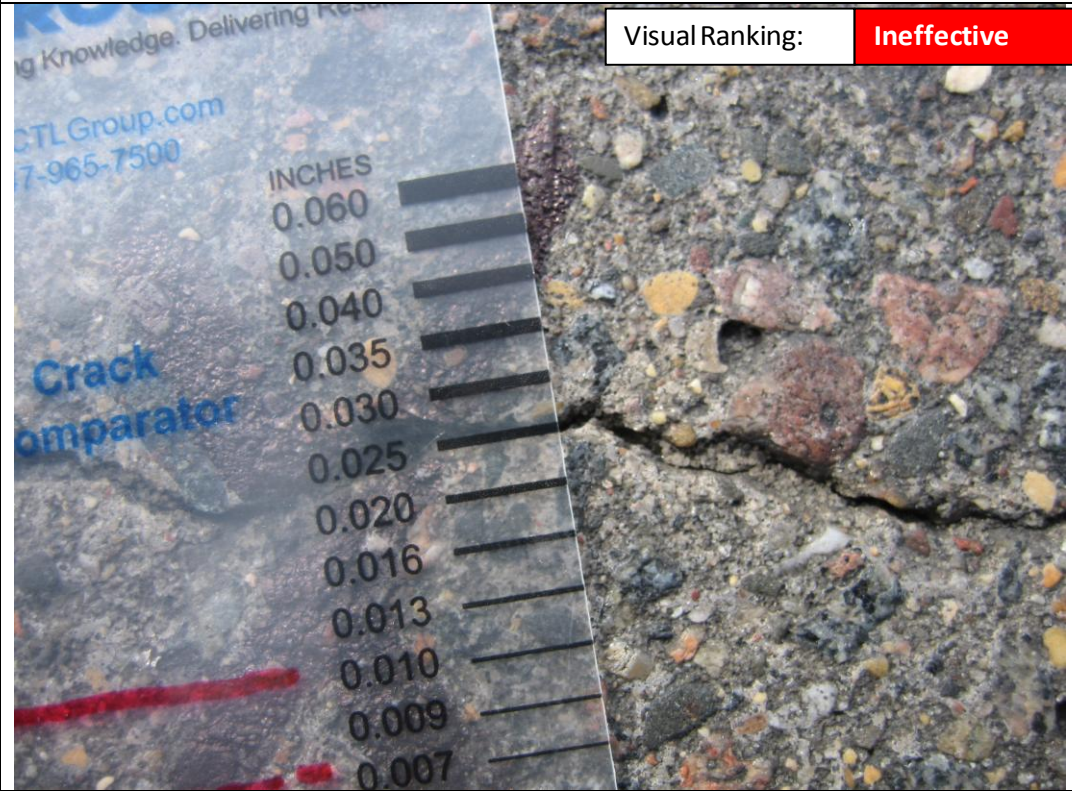


Visual Ranking: **Ineffective**



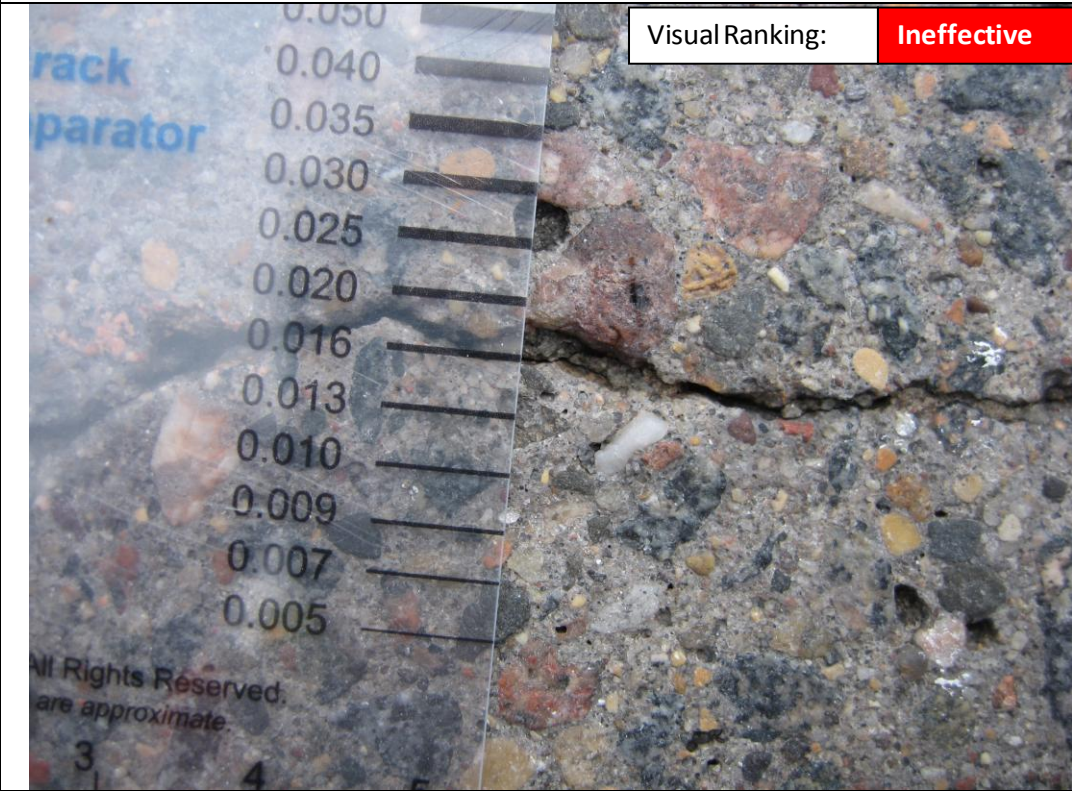
2013 Comparison

Photograph #: 27
 Test Information: Test Section 5, Test 11A - TK Products TK-2414 (MMA)
 Surface Prep & Application: Sand Blast, Flood, Sand Coat: Yes
 Date: April 8, 2014
 Project BL-09-03973
BRAUN INTERTEC



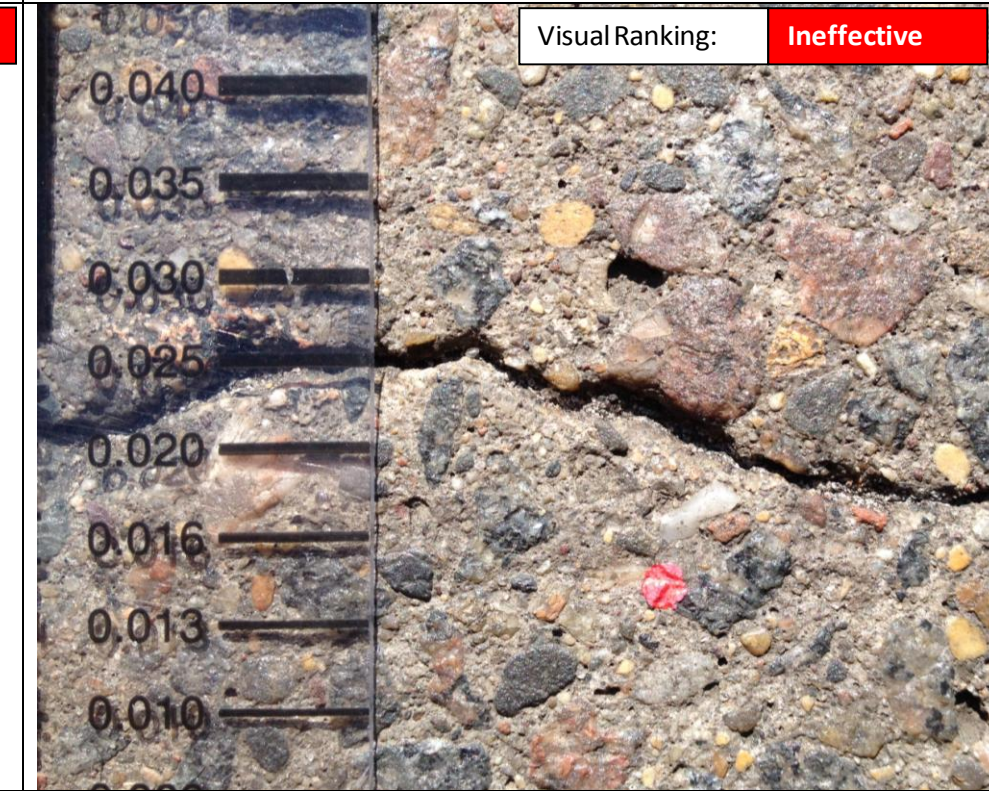
Visual Ranking: **Ineffective**

Photograph #: 28
 Test Information: Test Section 5, Test 12A - TK Products TK-2414 (MMA)
 Surface Prep & Application: Air Hose, Flood, Sand Coat: Yes
 Date: May 11, 2012
 Project BL-09-03973
BRAUN INTERTEC



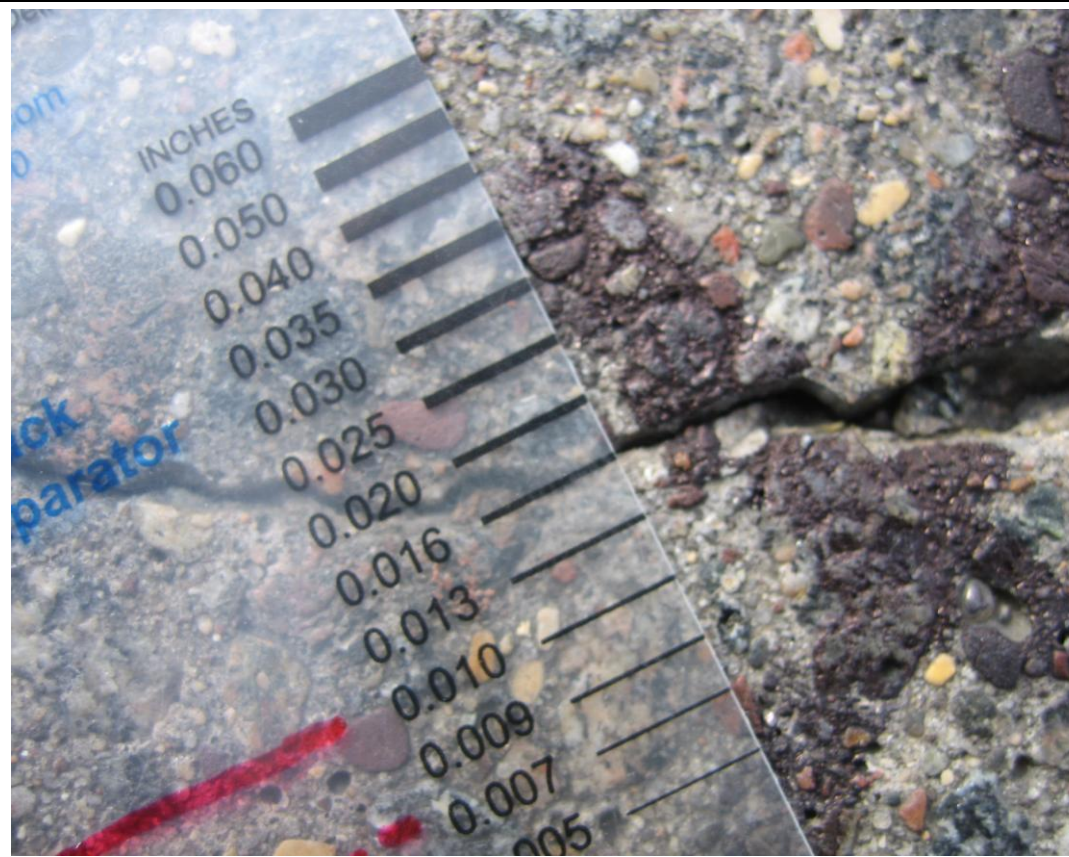
Visual Ranking: **Ineffective**

Photograph #: 29
 Test Information: Test Section 5, Test 12A - TK Products TK-2414 (MMA)
 Surface Prep & Application: Air Hose, Flood, Sand Coat: Yes
 Date: April 30, 2013
 Project BL-09-03973
BRAUN INTERTEC



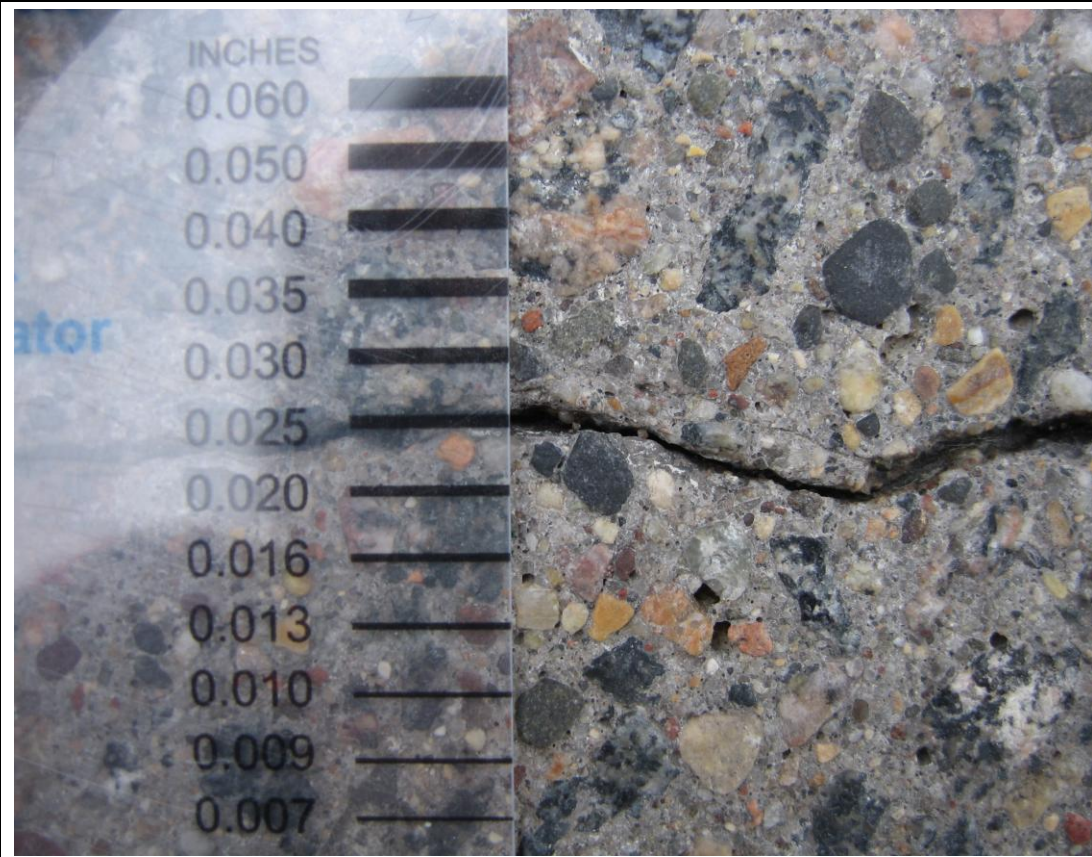
Visual Ranking: **Ineffective**

Photograph #: 30
 Test Information: Test Section 5, Test 12A - TK Products TK-2414 (MMA)
 Surface Prep & Application: Air Hose, Flood, Sand Coat: Yes
 Date: April 8, 2014
 Project BL-09-03973
BRAUN INTERTEC



Photograph #: 31
 Test Information: Test Section 6, Test 12B - CONTROL
 Surface Prep & Application: CONTROL
 Date: May 11, 2012

Project BL-09-03973
BRAUN
 INTERTEC

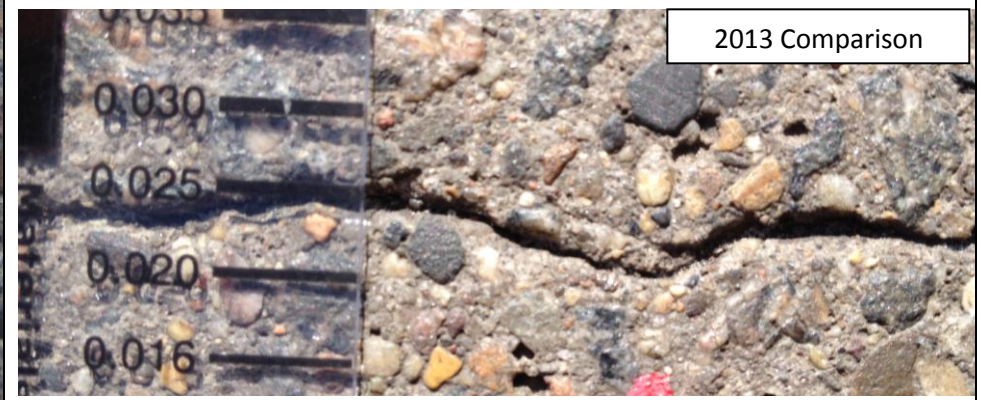


Photograph #: 32
 Test Information: Test Section 6, Test 12B - CONTROL
 Surface Prep & Application: CONTROL
 Date: April 30, 2013

Project BL-09-03973
BRAUN
 INTERTEC



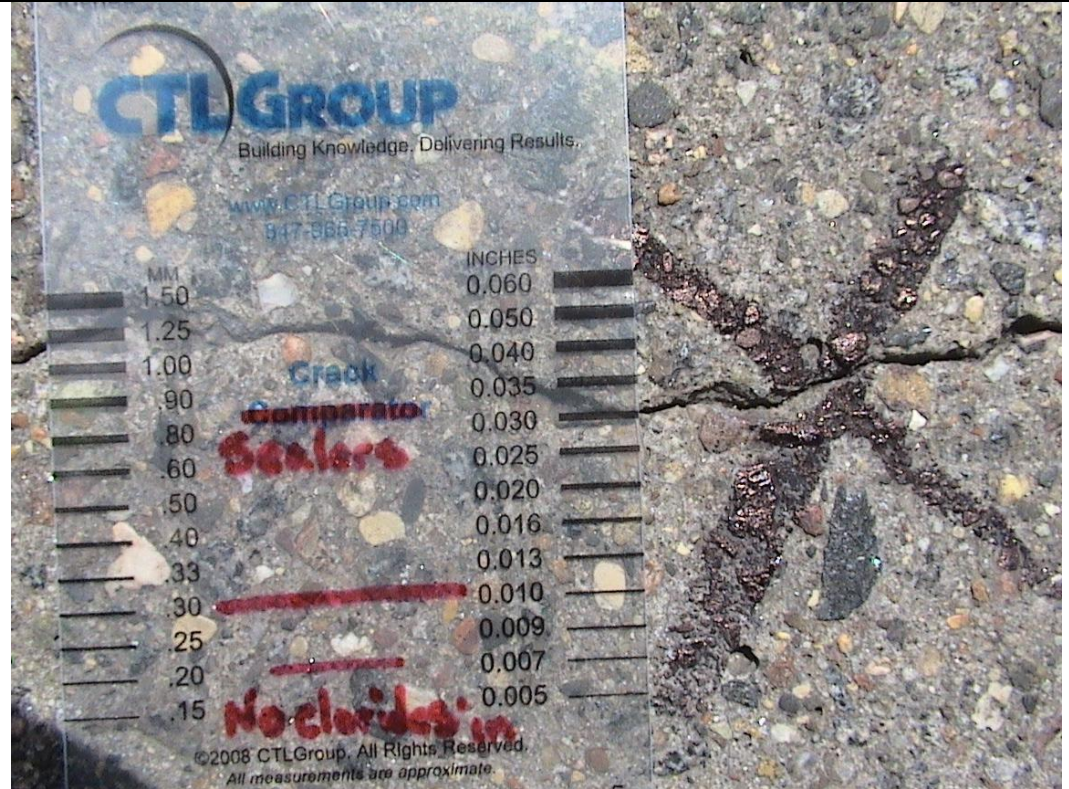
2012 Comparison



2013 Comparison

Photograph #: 33
 Test Information: Test Section 6, Test 12B - CONTROL
 Surface Prep & Application: CONTROL
 Date: April 8, 2014

Project BL-09-03973
BRAUN
 INTERTEC



Photograph #: 34
 Test Information: Test Section 6, Test 15A - CONTROL
 Surface Prep & Application: CONTROL
 Date: May 11, 2012

Project BL-09-03973
BRAUN
 INTERTEC

Not cored/re-surveyed in 2013. No photograph.

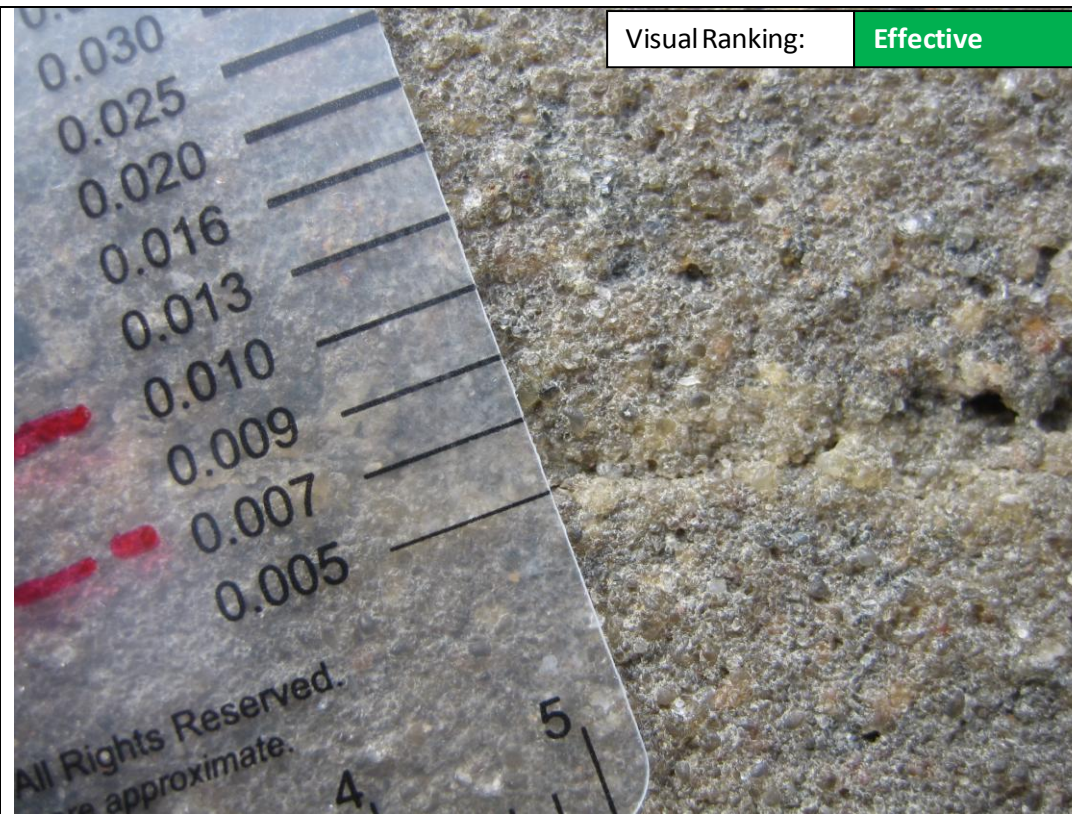
Photograph #: 35
 Test Information: Test Section 6, Test 15A - CONTROL
 Surface Prep & Application: CONTROL
 Date: April 30, 2013

Project BL-09-03973
BRAUN
 INTERTEC



Photograph #: 36
 Test Information: Test Section 6, Test 15A - CONTROL
 Surface Prep & Application: CONTROL
 Date: April 8, 2014

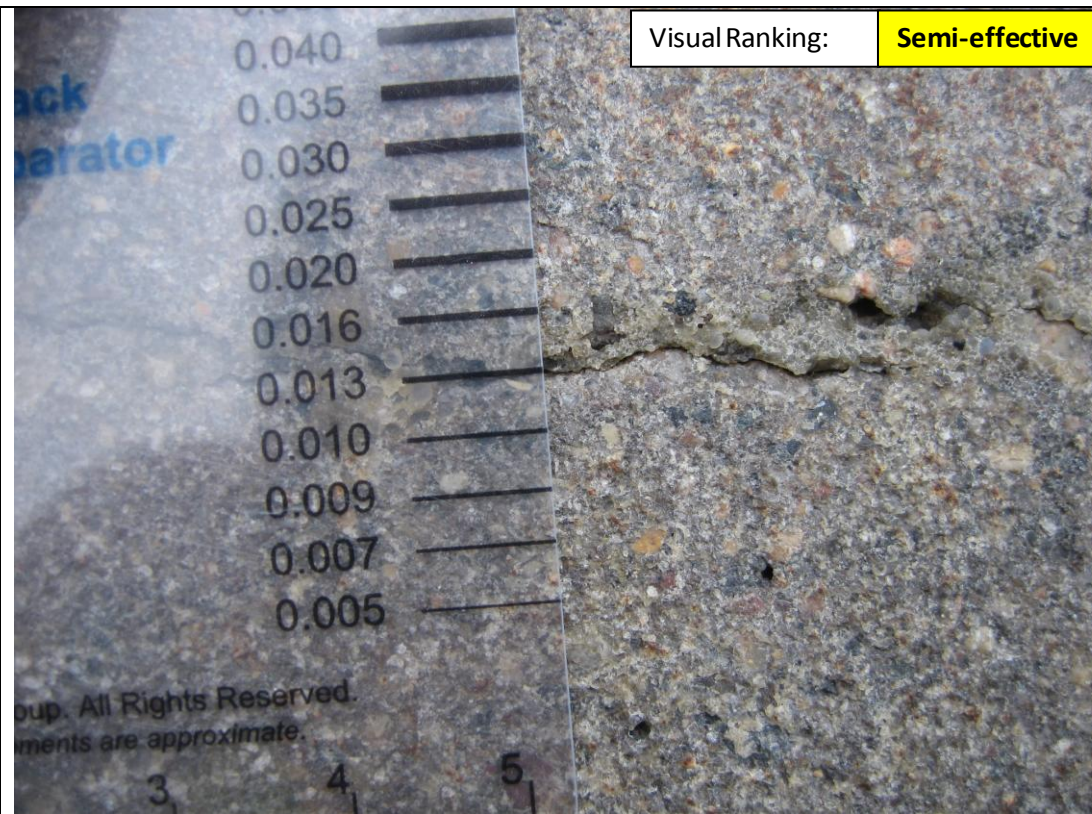
Project BL-09-03973
BRAUN
 INTERTEC



Photograph #: 37
 Test Information: Test Section 7, Test 17A - BASF Epoxeal GS Structural (Epoxy)
 Surface Prep & Application: Air Hose, Flood (cracks), Sand Coat: Yes
 Date: May 11, 2012

Project BL-09-03973

BRAUN
INTERTEC



Photograph #: 38
 Test Information: Test Section 7, Test 17A - BASF Epoxeal GS Structural (Epoxy)
 Surface Prep & Application: Air Hose, Flood (cracks), Sand Coat: Yes
 Date: April 30, 2013

Project BL-09-03973

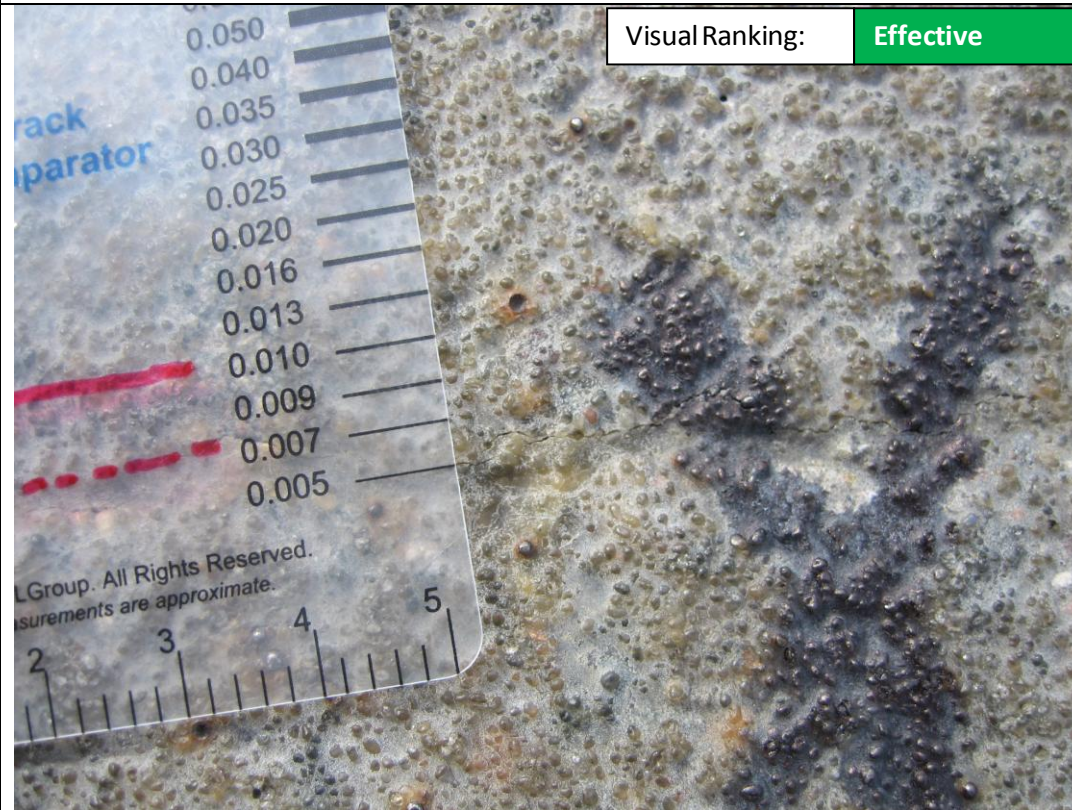
BRAUN
INTERTEC



Photograph #: 39
 Test Information: Test Section 7, Test 17A - BASF Epoxeal GS Structural (Epoxy)
 Surface Prep & Application: Air Hose, Flood (cracks), Sand Coat: Yes
 Date: April 8, 2014

Project BL-09-03973

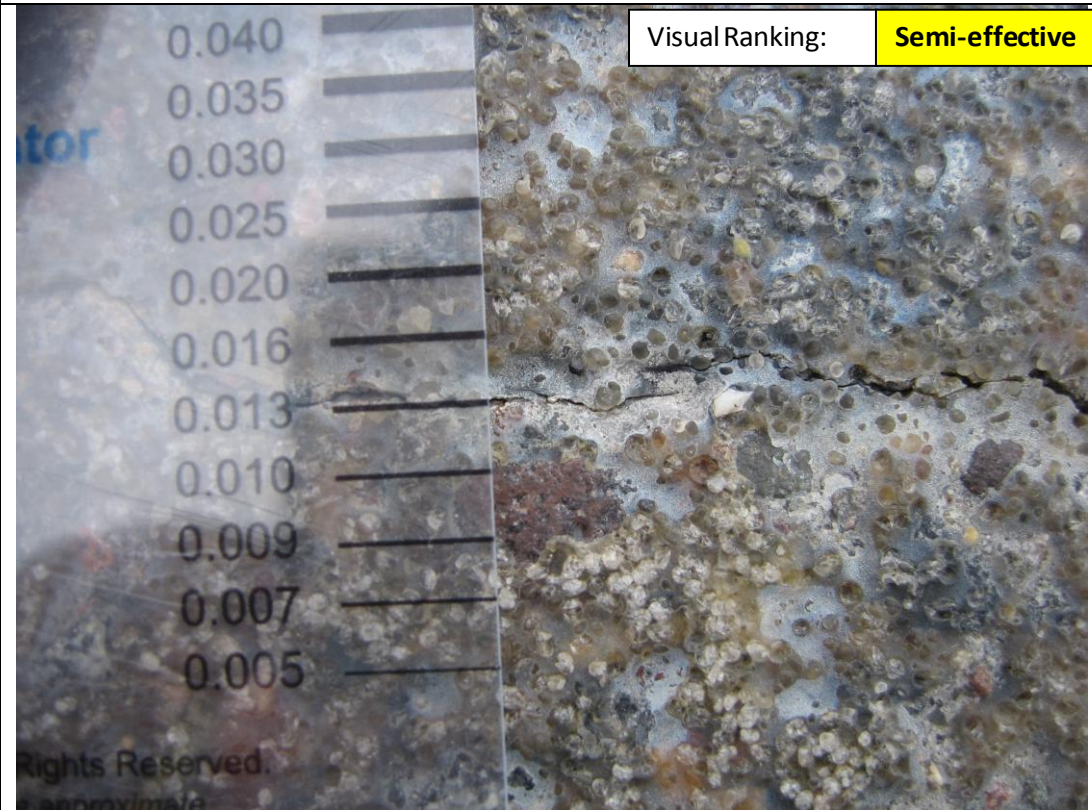
BRAUN
INTERTEC



Photograph #: 40
 Test Information: Test Section 7, Test 19A - BASF Epoxeal GS Structural (Epoxy)
 Surface Prep & Application: Shot Blast, Flood (cracks), Sand Coat: Yes
 Date: May 11, 2012

Project BL-09-03973

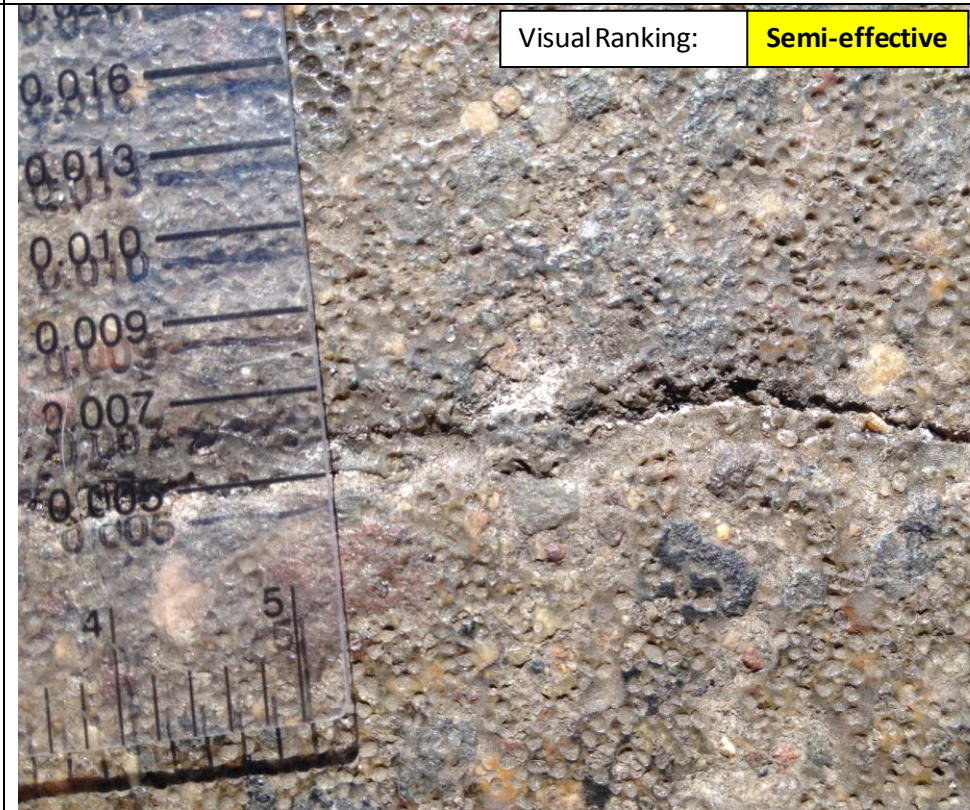
BRAUN
INTERTEC



Photograph #: 41
 Test Information: Test Section 7, Test 19A - BASF Epoxeal GS Structural (Epoxy)
 Surface Prep & Application: Shot Blast, Flood (cracks), Sand Coat: Yes
 Date: April 30, 2013

Project BL-09-03973

BRAUN
INTERTEC



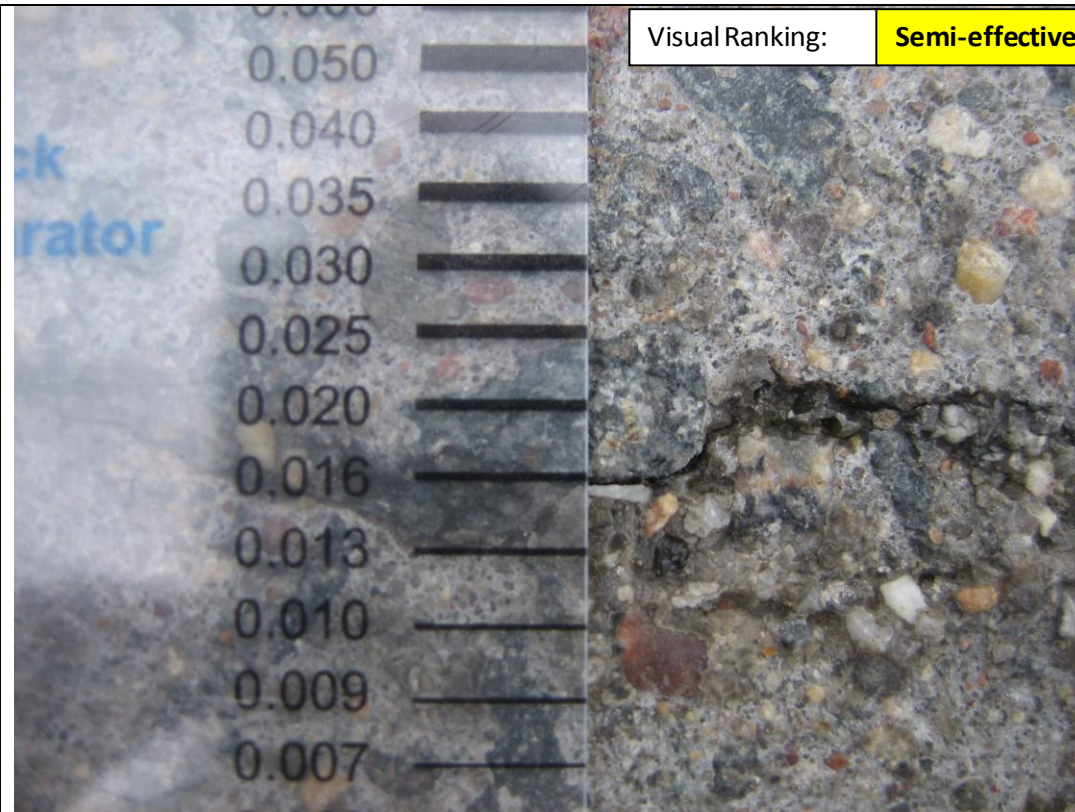
Photograph #: 42
 Test Information: Test Section 7, Test 19A - BASF Epoxeal GS Structural (Epoxy)
 Surface Prep & Application: Shot Blast, Flood (cracks), Sand Coat: Yes
 Date: April 8, 2014

Project BL-09-03973

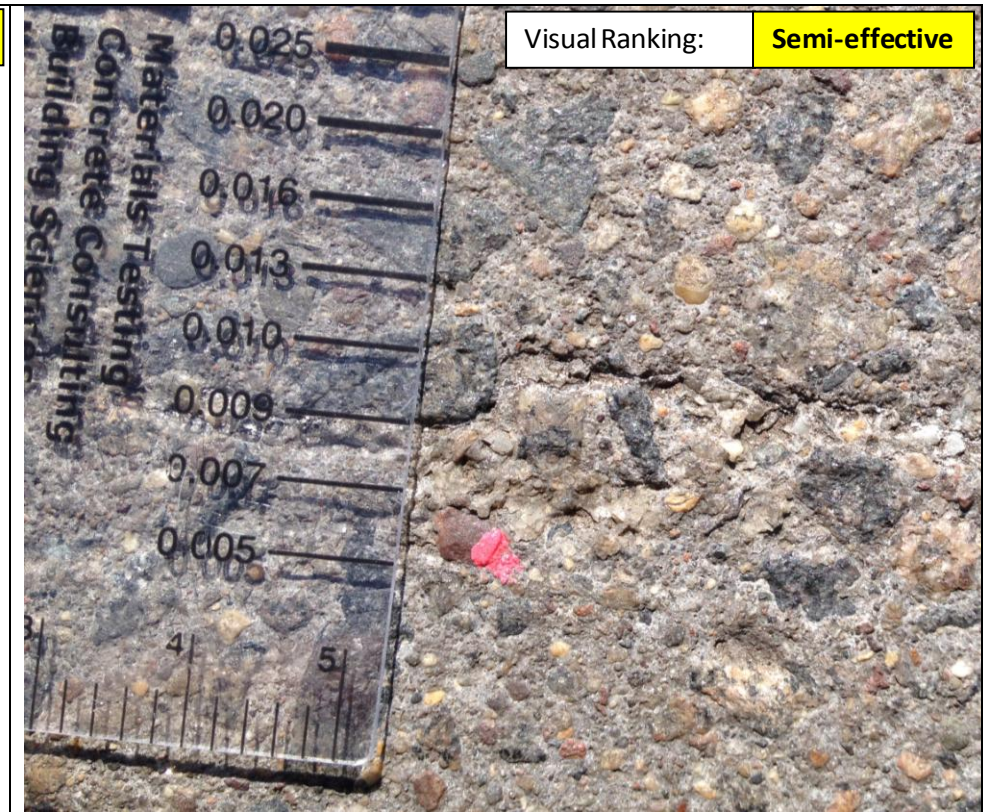
BRAUN
INTERTEC



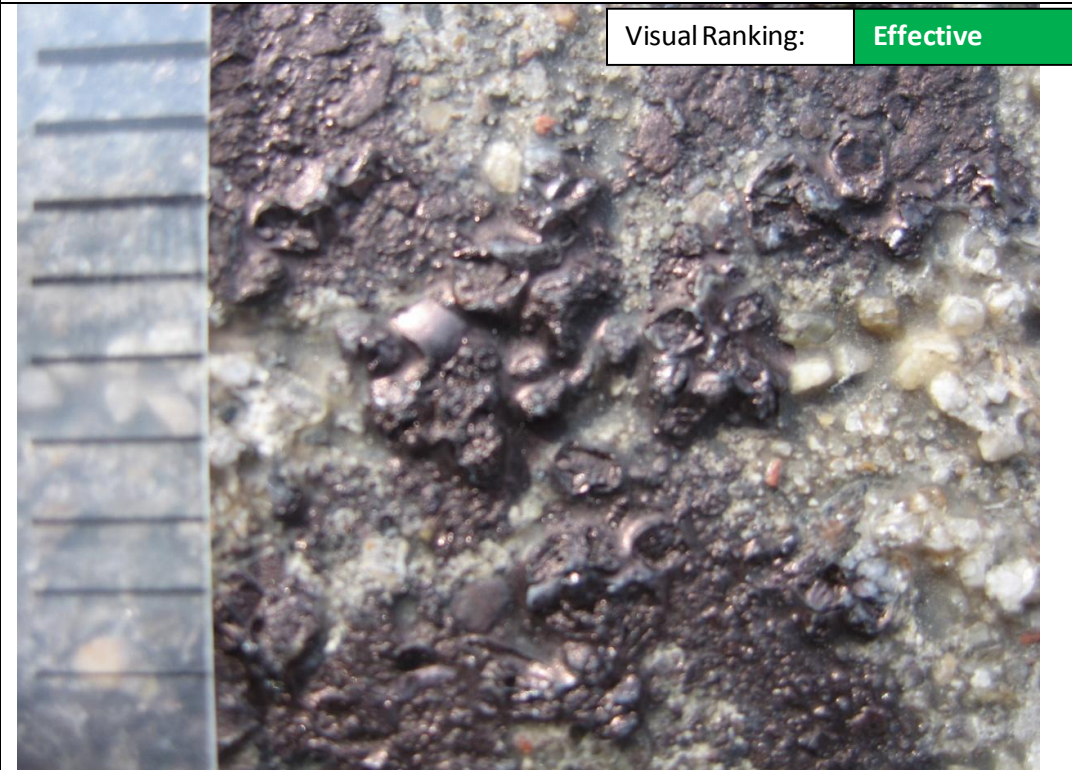
Photograph #: 43
 Test Information: Test Section 8, Test 18A - Kwik Bond KBP 204 P (HMWM)
 Surface Prep & Application: Shot Blast, Flood, Sand Coat: Yes
 Date: May 11, 2012
 Project BL-09-03973
BRAUN INTERTEC



Photograph #: 44
 Test Information: Test Section 8, Test 18A - Kwik Bond KBP 204 P (HMWM)
 Surface Prep & Application: Shot Blast, Flood, Sand Coat: Yes
 Date: April 30, 2013
 Project BL-09-03973
BRAUN INTERTEC



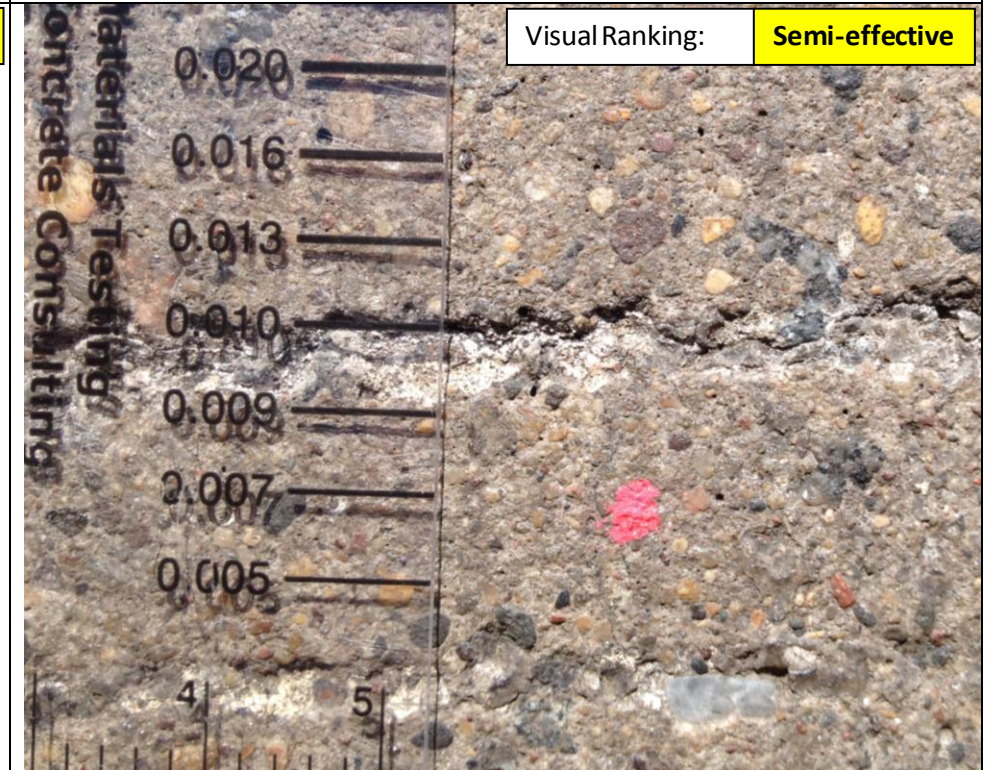
Photograph #: 45
 Test Information: Test Section 8, Test 18A - Kwik Bond KBP 204 P (HMWM)
 Surface Prep & Application: Shot Blast, Flood, Sand Coat: Yes
 Date: April 8, 2014
 Project BL-09-03973
BRAUN INTERTEC



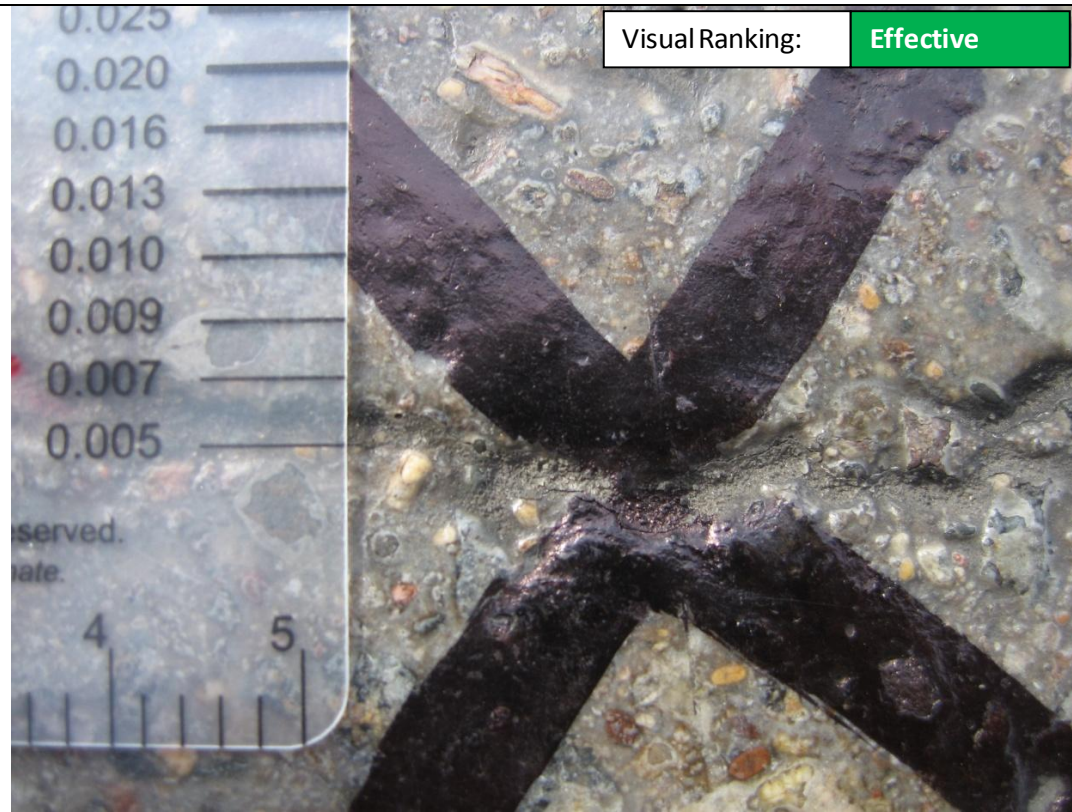
Photograph #: 46
 Test Information: Test Section 8, Test 20A - Kwik Bond KBP 204 P (HMWM)
 Surface Prep & Application: Air Hose, Flood, Sand Coat: Yes
 Date: May 11, 2012
 Project BL-09-03973
BRAUN INTERTEC




Photograph #: 47
 Test Information: Test Section 8, Test 20A - Kwik Bond KBP 204 P (HMWM)
 Surface Prep & Application: Air Hose, Flood, Sand Coat: Yes
 Date: April 30, 2013
 Project BL-09-03973
BRAUN INTERTEC

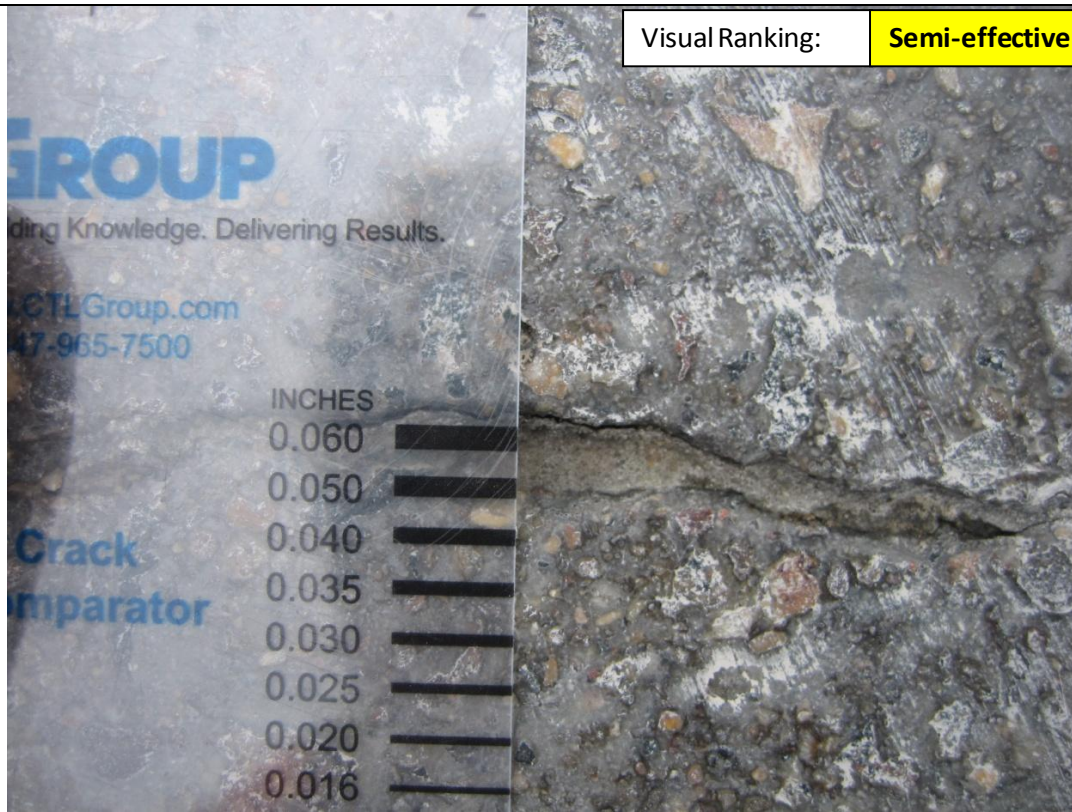


Photograph #: 48
 Test Information: Test Section 8, Test 20A - Kwik Bond KBP 204 P (HMWM)
 Surface Prep & Application: Air Hose, Flood, Sand Coat: Yes
 Date: April 8, 2014
 Project BL-09-03973
BRAUN INTERTEC




Photograph #: 49
 Test Information: Test Section 9, Test 21A - BASF Degadeck Crack Sealer Plus (MMA)
 Surface Prep & Application: Air Hose, Pretreat, Flood, Sand Coat: Yes
 Date: May 11, 2012

Project BL-09-03973





Photograph #: 50
 Test Information: Test Section 9, Test 21A - BASF Degadeck Crack Sealer Plus (MMA)
 Surface Prep & Application: Air Hose, Pretreat, Flood, Sand Coat: Yes
 Date: April 30, 2013

Project BL-09-03973





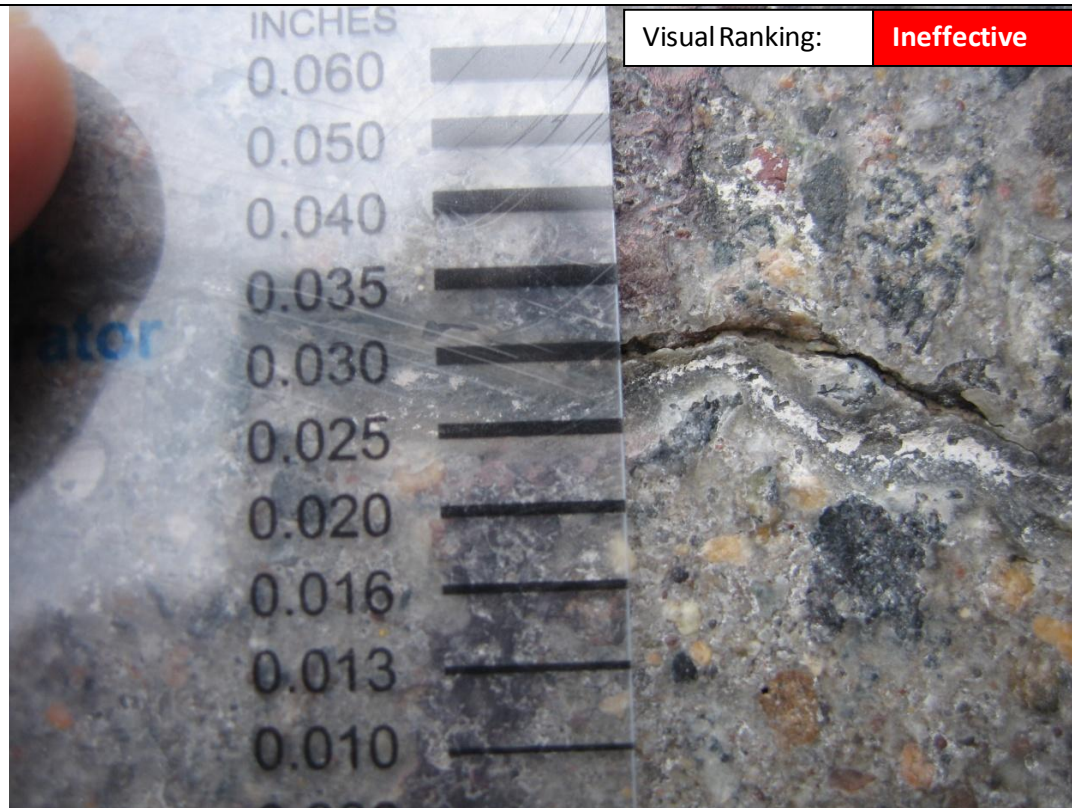
Photograph #: 51
 Test Information: Test Section 9, Test 21A - BASF Degadeck Crack Sealer Plus (MMA)
 Surface Prep & Application: Air Hose, Pretreat, Flood, Sand Coat: Yes
 Date: April 8, 2014

Project BL-09-03973





Photograph #: 52
 Test Information: Test Section 9, Test 21B - BASF Degadeck Crack Sealer Plus (MMA)
 Surface Prep & Application: Shot Blast, Pretreat, Flood, Sand Coat: Yes
 Date: May 11, 2012

Project BL-09-03973





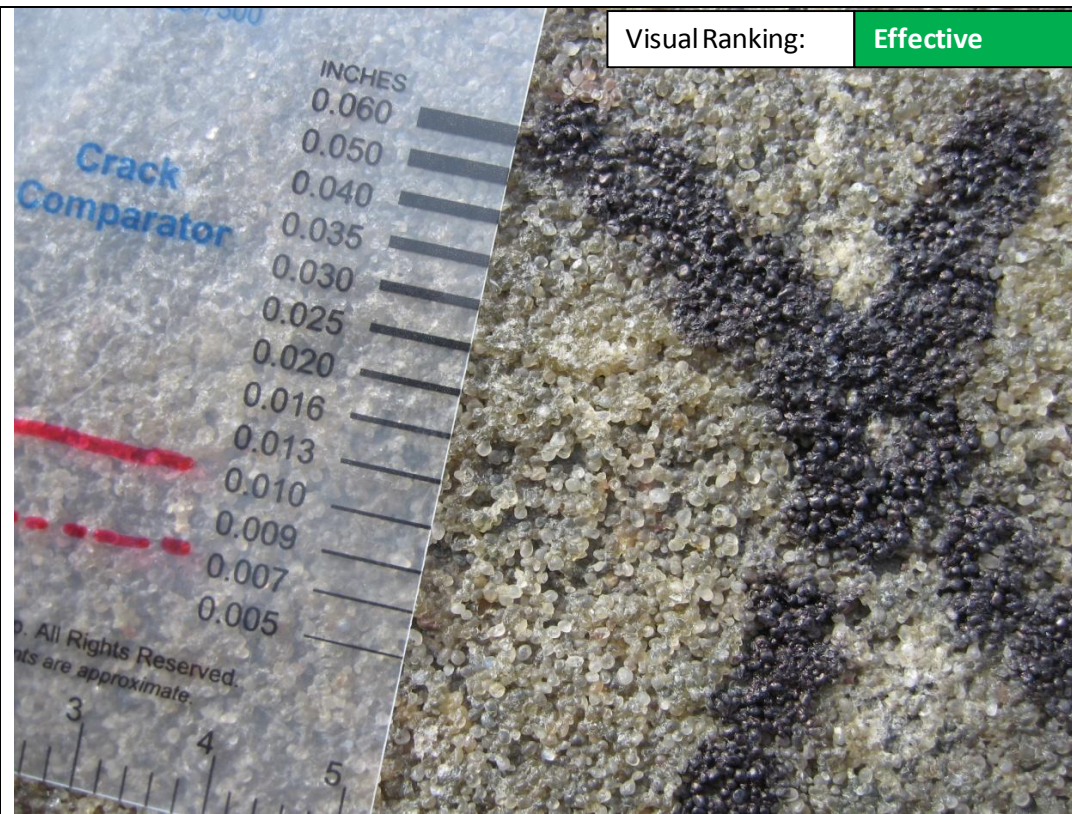
Photograph #: 53
 Test Information: Test Section 9, Test 21B - BASF Degadeck Crack Sealer Plus (MMA)
 Surface Prep & Application: Shot Blast, Pretreat, Flood, Sand Coat: Yes
 Date: April 30, 2013

Project BL-09-03973


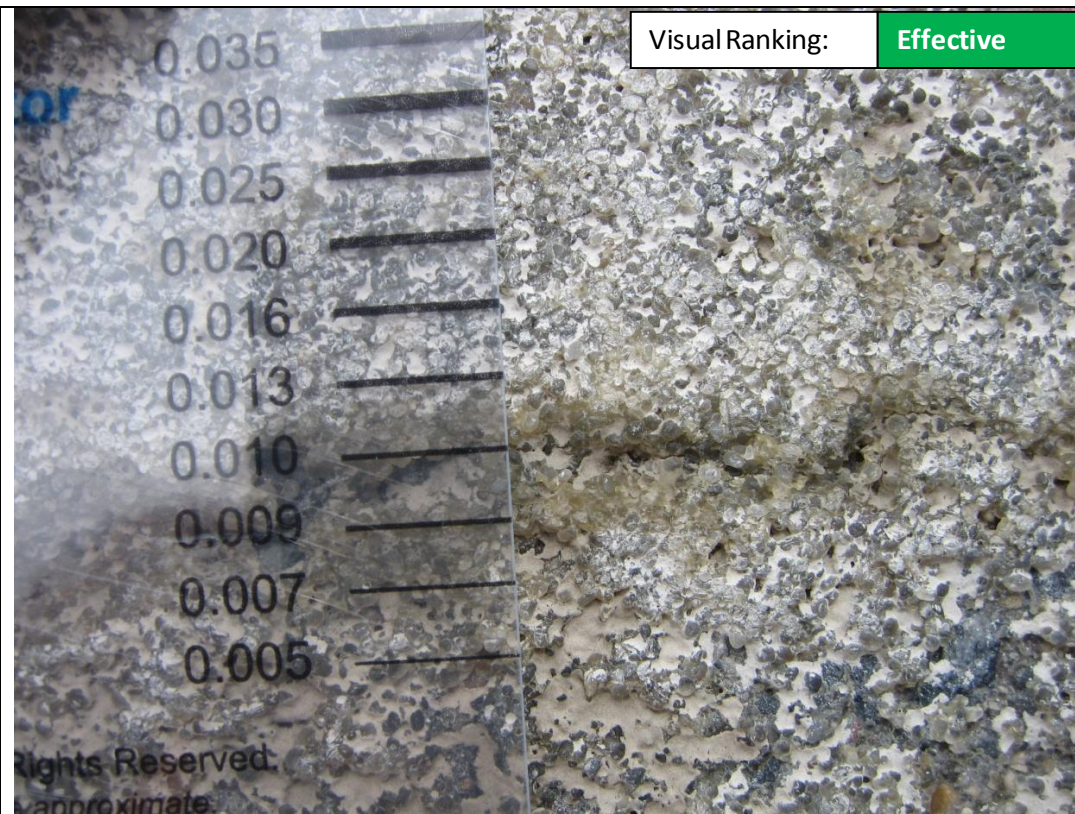


Photograph #: 54
 Test Information: Test Section 9, Test 21B - BASF Degadeck Crack Sealer Plus (MMA)
 Surface Prep & Application: Shot Blast, Pretreat, Flood, Sand Coat: Yes
 Date: April 8, 2014

Project BL-09-03973




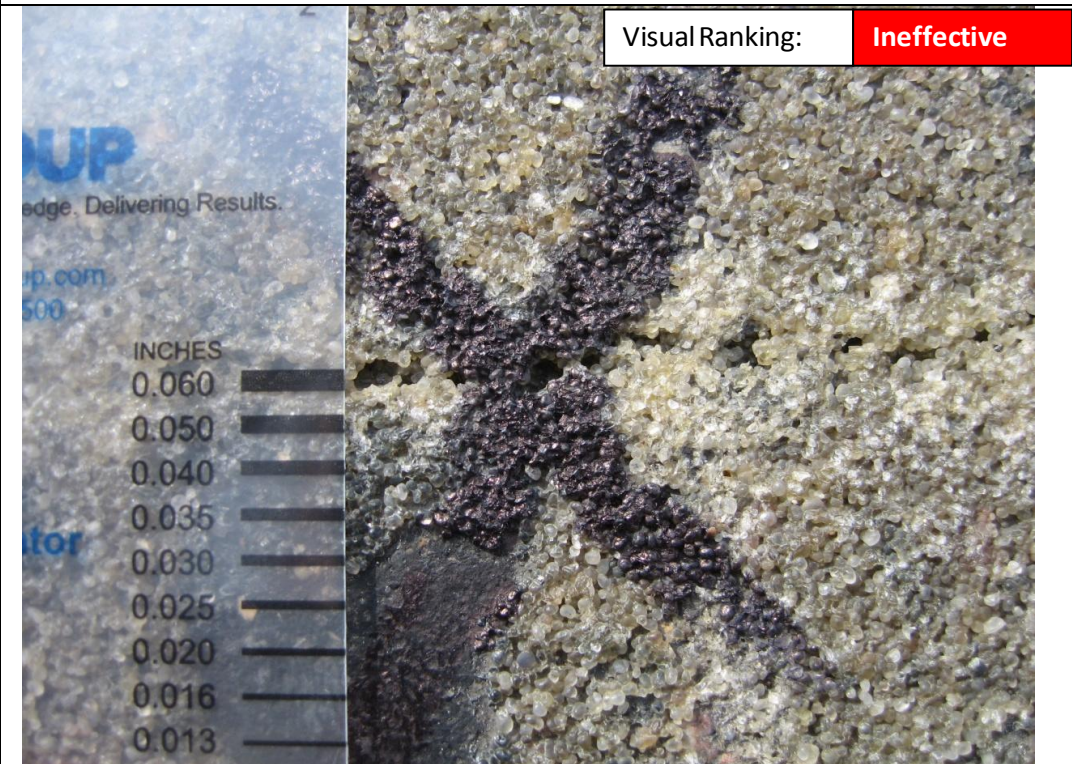
Photograph #: 55
 Test Information: Test Section 10, Test 22A - Sika Corp Sikadur 55 SLV (Epoxy)
 Surface Prep & Application: Air Hose, Route, Pump (squeegee), Sand Coat: Yes
 Date: May 11, 2012
 Project BL-09-03973
BRAUN INTERTEC



Photograph #: 56
 Test Information: Test Section 10, Test 22A - Sika Corp Sikadur 55 SLV (Epoxy)
 Surface Prep & Application: Air Hose, Route, Pump (squeegee), Sand Coat: Yes
 Date: April 30, 2013
 Project BL-09-03973
BRAUN INTERTEC



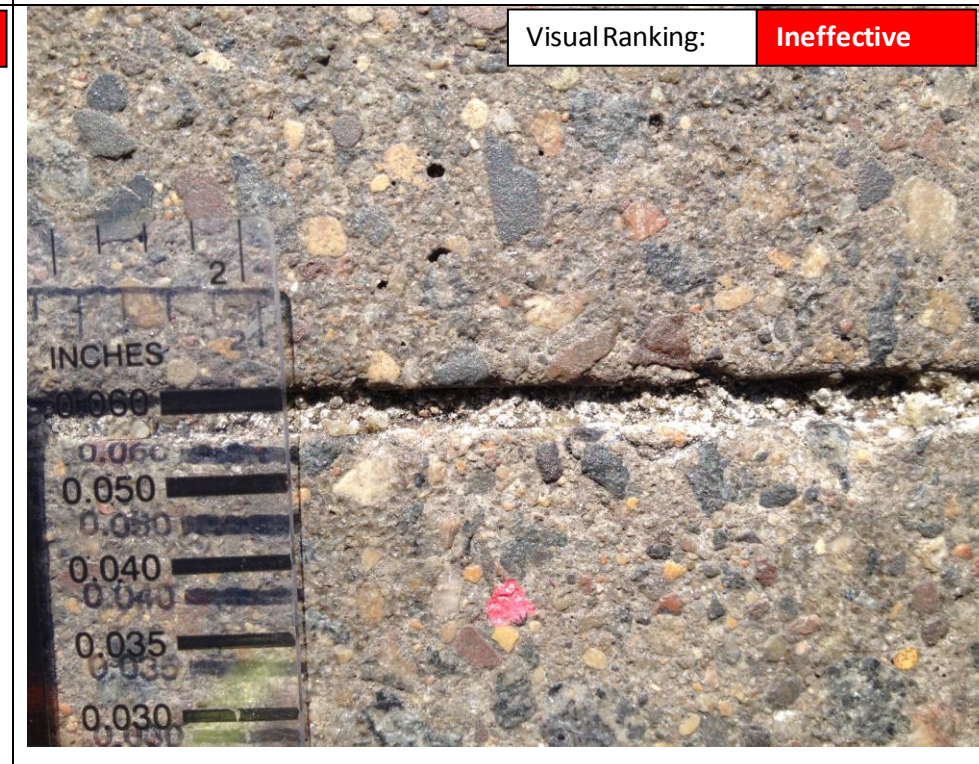
Photograph #: 57
 Test Information: Test Section 10, Test 22A - Sika Corp Sikadur 55 SLV (Epoxy)
 Surface Prep & Application: Air, Route, Pump (squeegee), Sand: Yes
 Date: April 8, 2014
 Project BL-09-03973
BRAUN INTERTEC



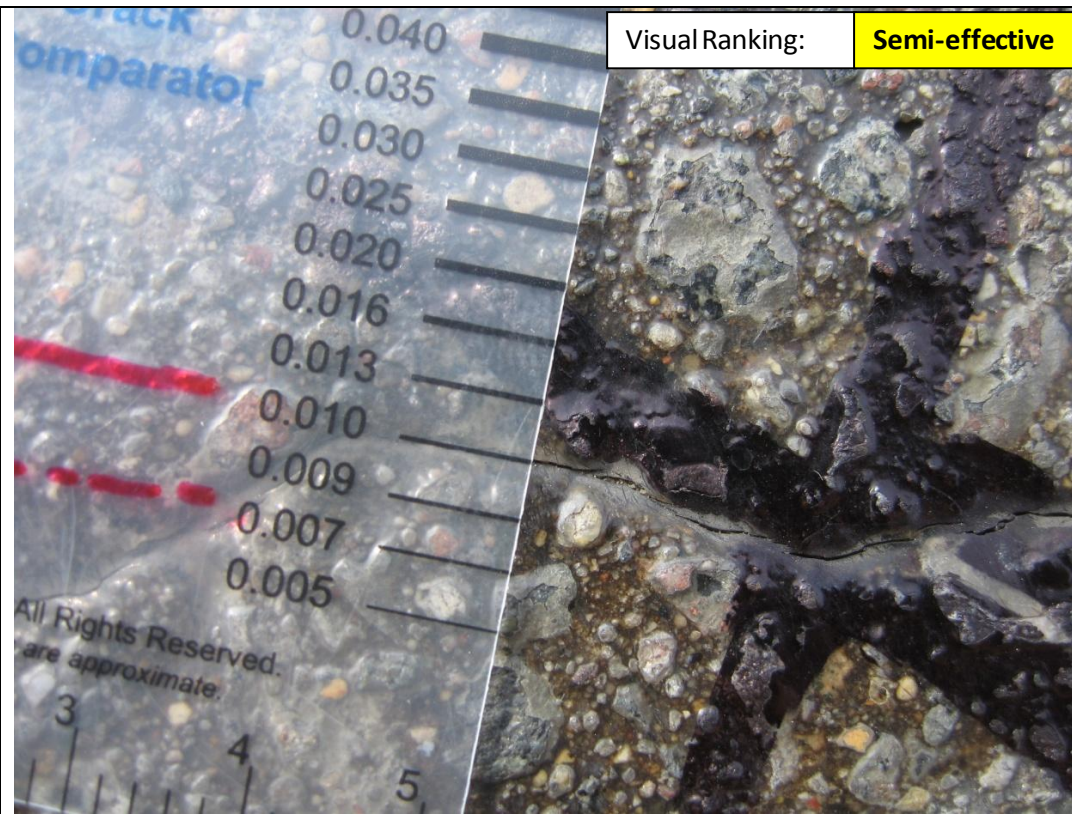
Photograph #: 58
 Test Information: Test Section 10, Test 23A - Sika Corp Sikadur 55 SLV (Epoxy)
 Surface Prep & Application: Air Hose, Route, Pump (squeegee), Sand Coat: Yes
 Date: May 11, 2012
 Project BL-09-03973
BRAUN INTERTEC



Photograph #: 59
 Test Information: Test Section 10, Test 23A - Sika Corp Sikadur 55 SLV (Epoxy)
 Surface Prep & Application: Air Hose, Route, Pump (squeegee), Sand Coat: Yes
 Date: April 30, 2013
 Project BL-09-03973
BRAUN INTERTEC

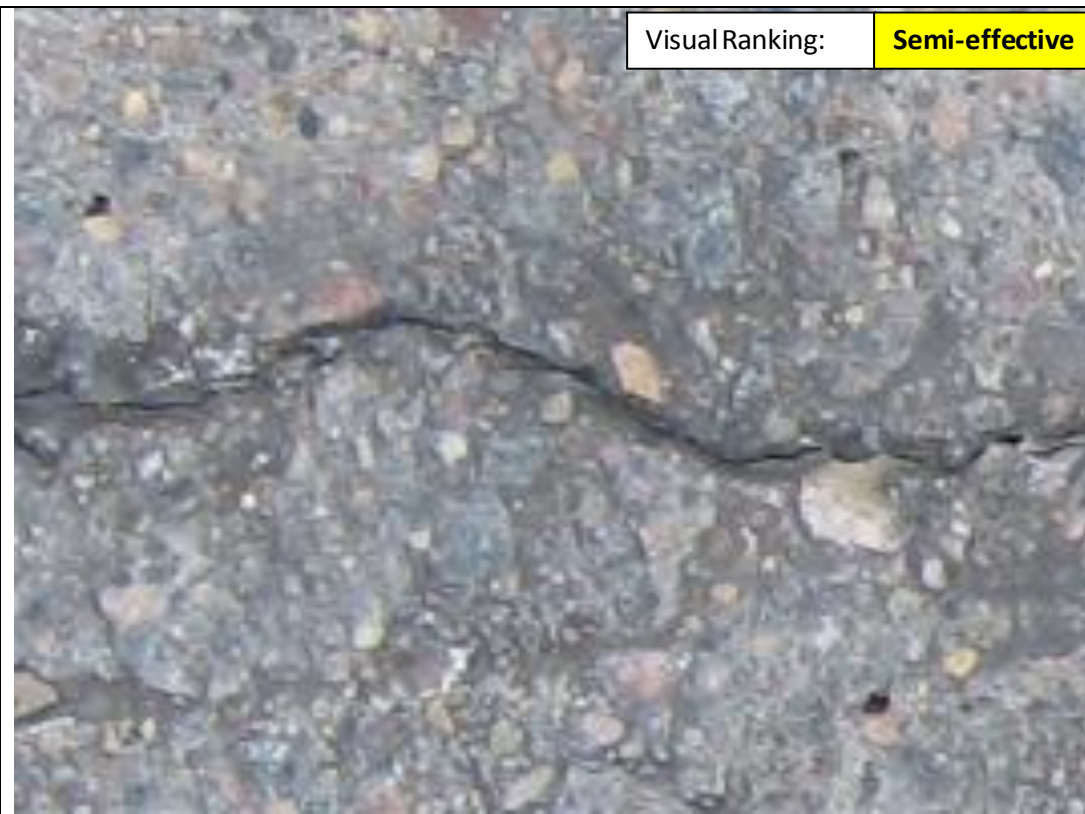


Photograph #: 60
 Test Information: Test Section 10, Test 23A - Sika Corp Sikadur 55 SLV (Epoxy)
 Surface Prep & Application: Air, Route, Pump (squeegee), Sand: Yes
 Date: April 8, 2014
 Project BL-09-03973
BRAUN INTERTEC



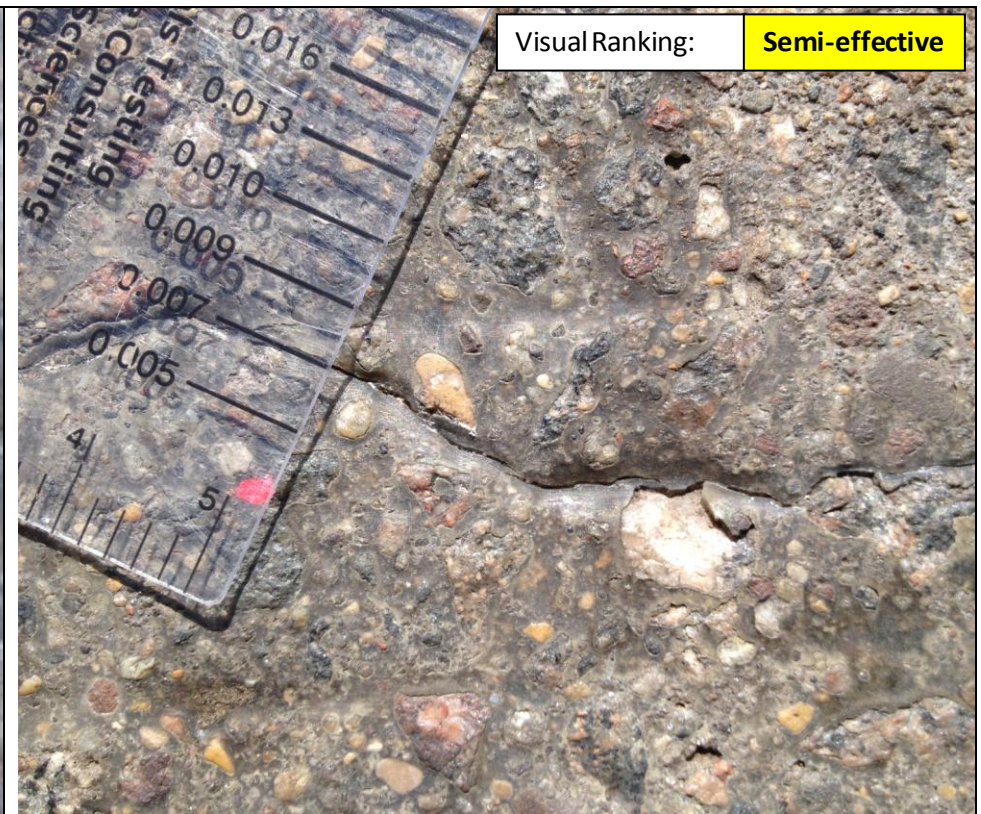
Visual Ranking:

Semi-effective



Visual Ranking:

Semi-effective



Visual Ranking:

Semi-effective

Photograph #: 61
 Test Information: Test Section 11, Test 22B - Viking Paints, Inc. Paulco TE 3008-1 (Epoxy)
 Surface Prep & Application: Air Hose, Bottle, Sand Coat: No
 Date: May 11, 2012

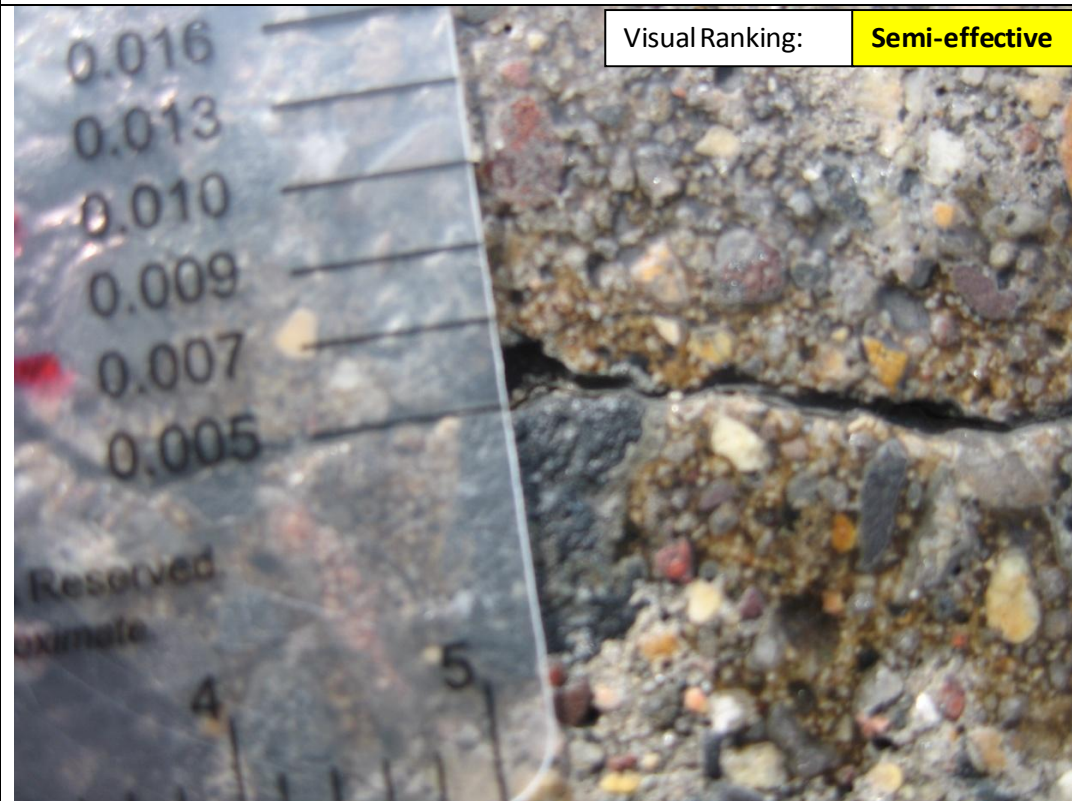
Project BL-09-03973

Photograph #: 62
 Test Information: Test Section 11, Test 22B - Viking Paints, Inc. Paulco TE 3008-1 (Epoxy)
 Surface Prep & Application: Air Hose, Bottle, Sand Coat: No
 Date: April 30, 2013

Project BL-09-03973

Photograph #: 63
 Test Information: Test Section 11, Test 22B - Viking Paints, Inc. Paulco TE 3008-1 (Epoxy)
 Surface Prep & Application: Air Hose, Bottle, Sand Coat: No
 Date: April 8, 2014

Project BL-09-03973



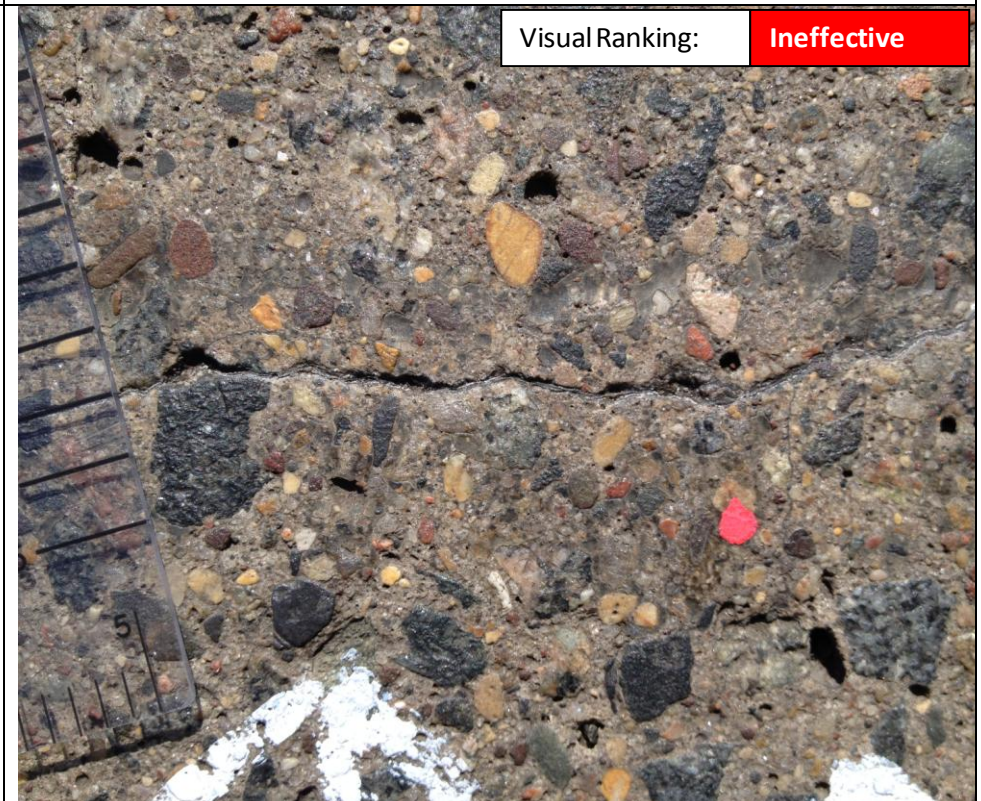
Visual Ranking:

Semi-effective



Visual Ranking:

Semi-effective



Visual Ranking:

Ineffective

Photograph #: 64
 Test Information: Test Section 11, Test 34A - Viking Paints, Inc. Paulco TE 3008-1 (Epoxy)
 Surface Prep & Application: Air Hose, Bottle, Sand Coat: No
 Date: May 11, 2012

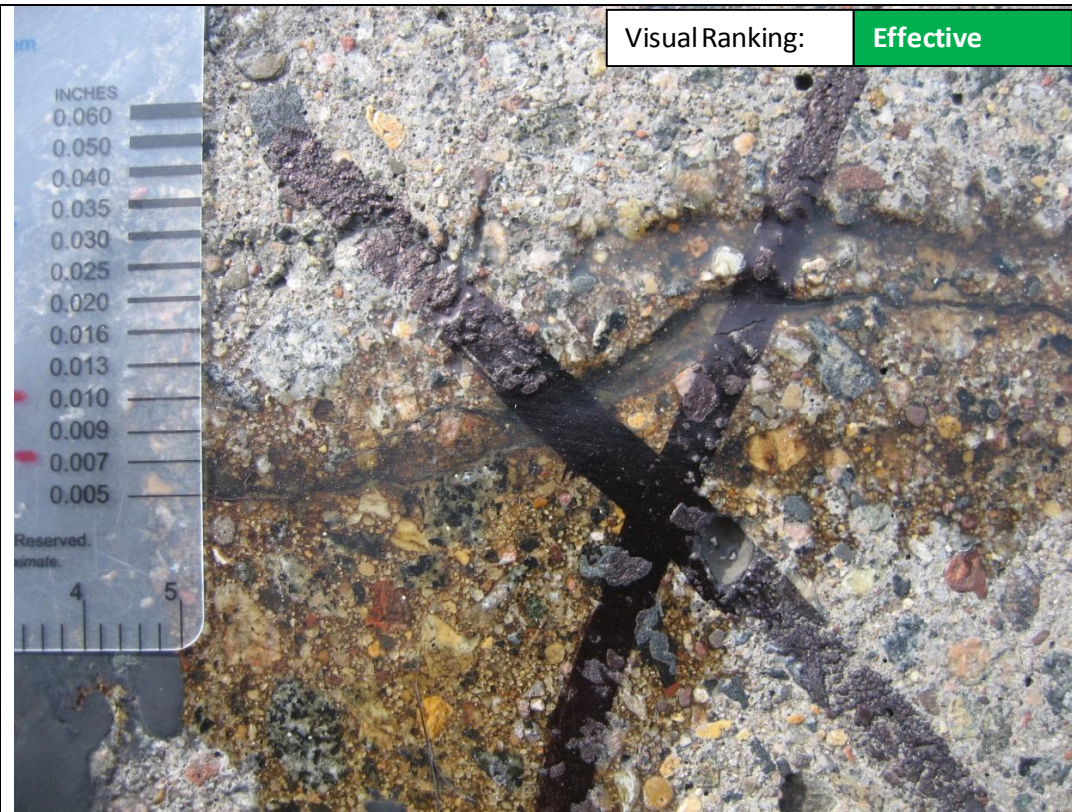
Project BL-09-03973


Photograph #: 65
 Test Information: Test Section 11, Test 34A - Viking Paints, Inc. Paulco TE 3008-1 (Epoxy)
 Surface Prep & Application: Air Hose, Bottle, Sand Coat: No
 Date: April 30, 2013

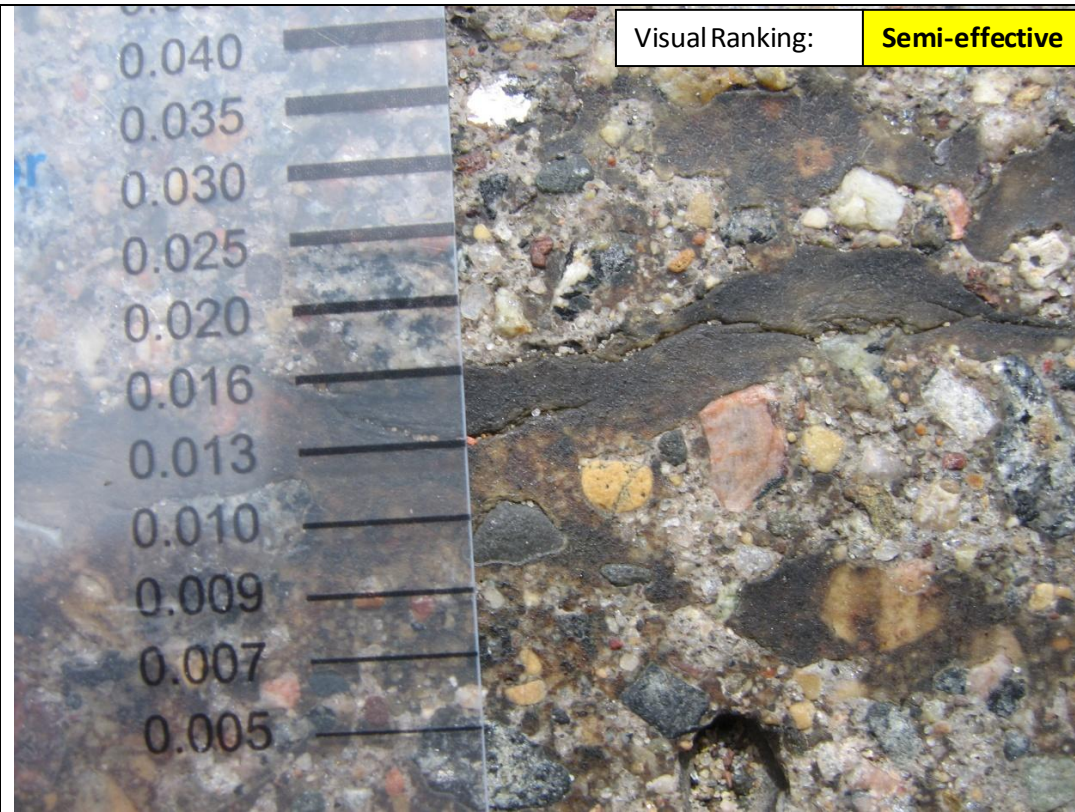
Project BL-09-03973


Photograph #: 66
 Test Information: Test Section 11, Test 34A - Viking Paints, Inc. Paulco TE 3008-1 (Epoxy)
 Surface Prep & Application: Air Hose, Bottle, Sand Coat: No
 Date: April 8, 2014

Project BL-09-03973




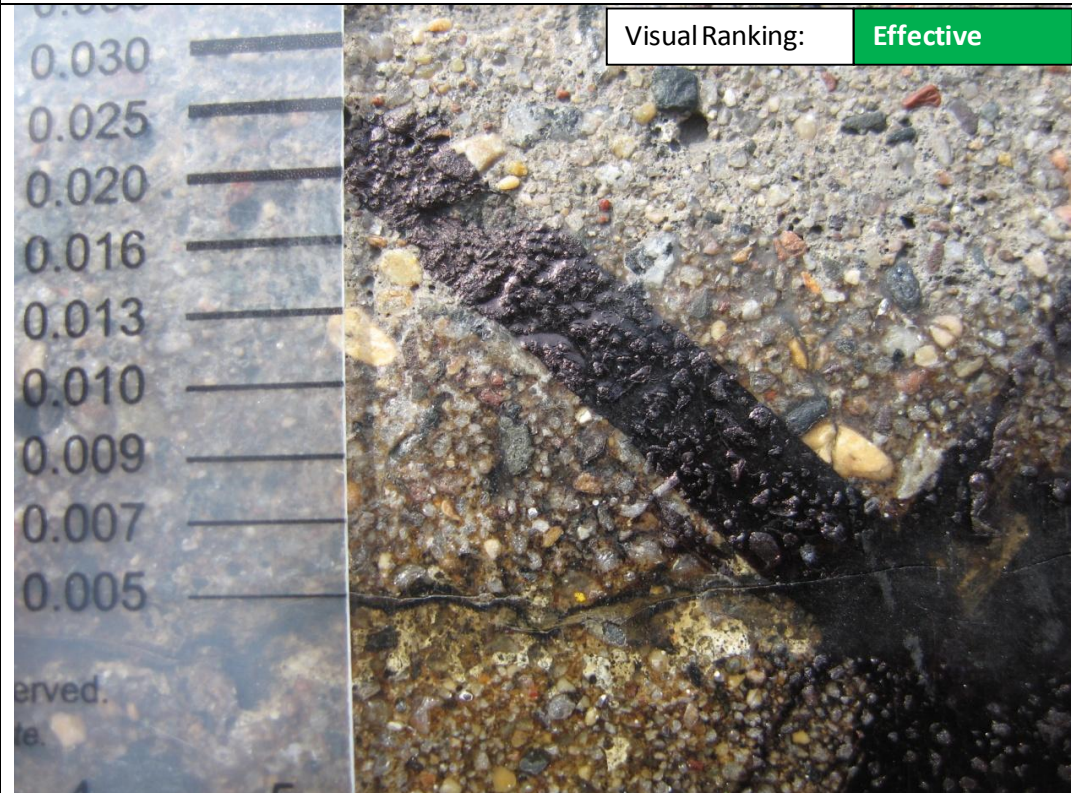
Photograph #: 67
 Test Information: Test Section 12, Test 35A - Viking Paints, Inc. Paulco TE-2501 (Epoxy)
 Surface Prep & Application: Air Hose, Bottle, Sand Coat: No
 Date: May 11, 2012
 Project BL-09-03973





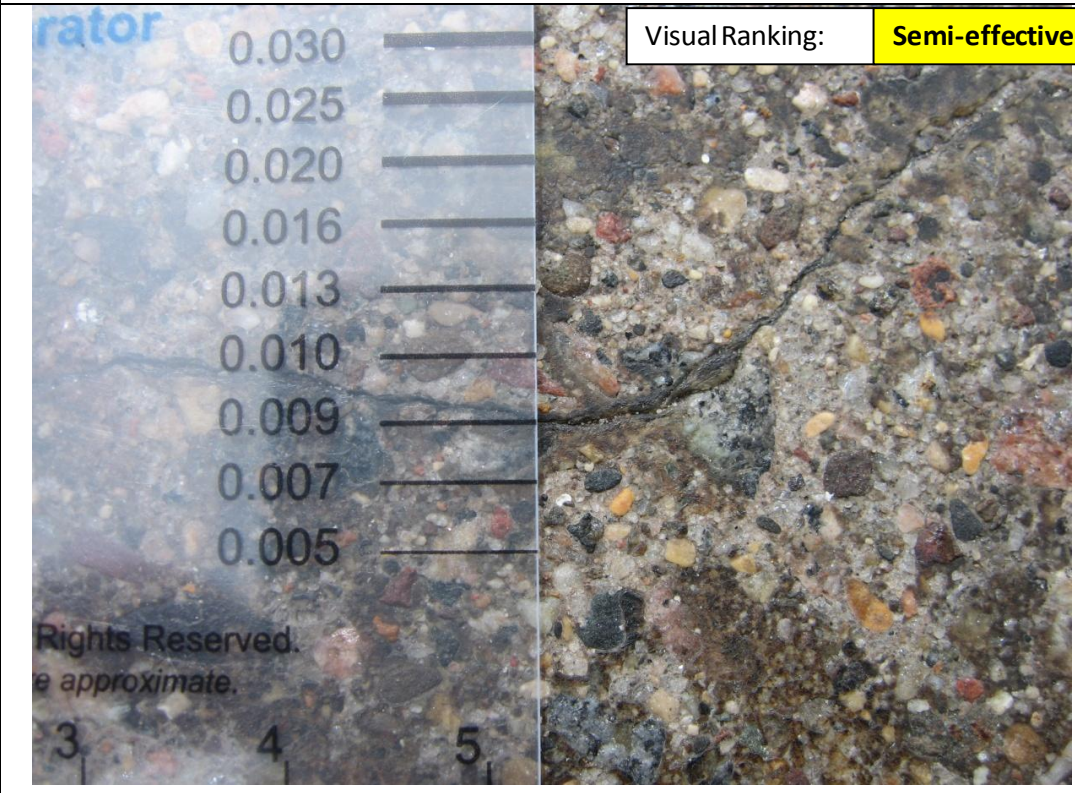
Photograph #: 68
 Test Information: Test Section 12, Test 35A - Viking Paints, Inc. Paulco TE-2501 (Epoxy)
 Surface Prep & Application: Air Hose, Bottle, Sand Coat: No
 Date: April 30, 2013
 Project BL-09-03973





Photograph #: 69
 Test Information: Test Section 12, Test 35A - Viking Paints, Inc. Paulco TE-2501 (Epoxy)
 Surface Prep & Application: Air Hose, Bottle, Sand Coat: No
 Date: April 8, 2014
 Project BL-09-03973





Photograph #: 70
 Test Information: Test Section 12, Test 24A - Viking Paints, Inc. Paulco TE-2501 (Epoxy)
 Surface Prep & Application: Air Hose, Bottle, Sand Coat: No
 Date: May 11, 2012
 Project BL-09-03973




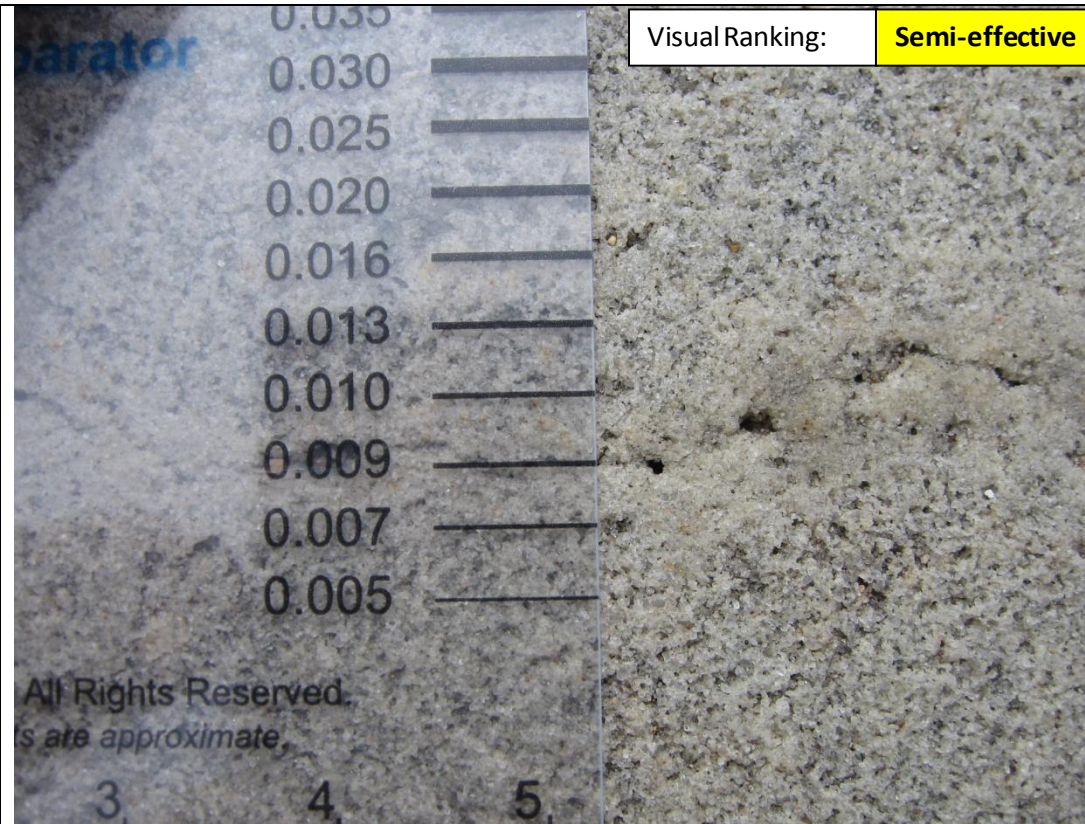
Photograph #: 71
 Test Information: Test Section 12, Test 24A - Viking Paints, Inc. Paulco TE-2501 (Epoxy)
 Surface Prep & Application: Air Hose, Bottle, Sand Coat: No
 Date: April 30, 2013
 Project BL-09-03973




Photograph #: 72
 Test Information: Test Section 12, Test 24A - Viking Paints, Inc. Paulco TE-2501 (Epoxy)
 Surface Prep & Application: Air Hose, Bottle, Sand Coat: No
 Date: April 8, 2014
 Project BL-09-03973




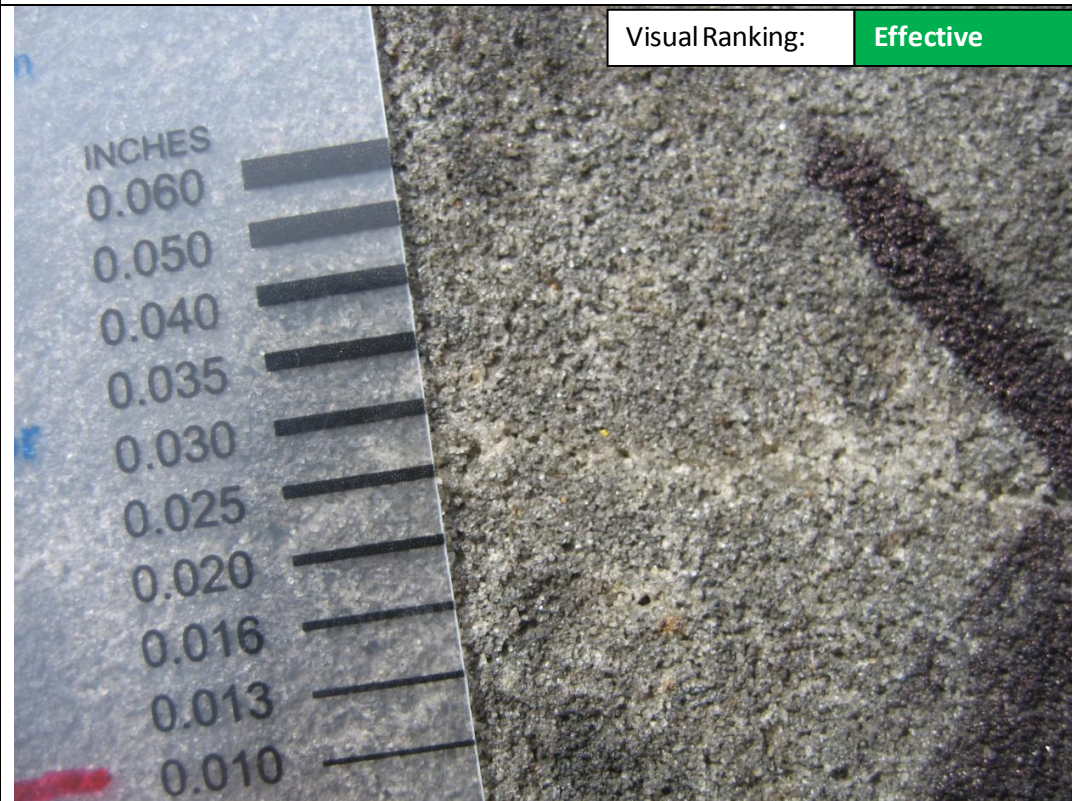
Photograph #: 73
 Test Information: Test Section 13, Test 25A - Euclid Chemical Dural LM 50 (Epoxy)
 Surface Prep & Application: Air Hose, Pretreat, Bottle (squeegee), Sand: Yes
 Date: May 11, 2012
 Project BL-09-03973
BRAUN INTERTEC



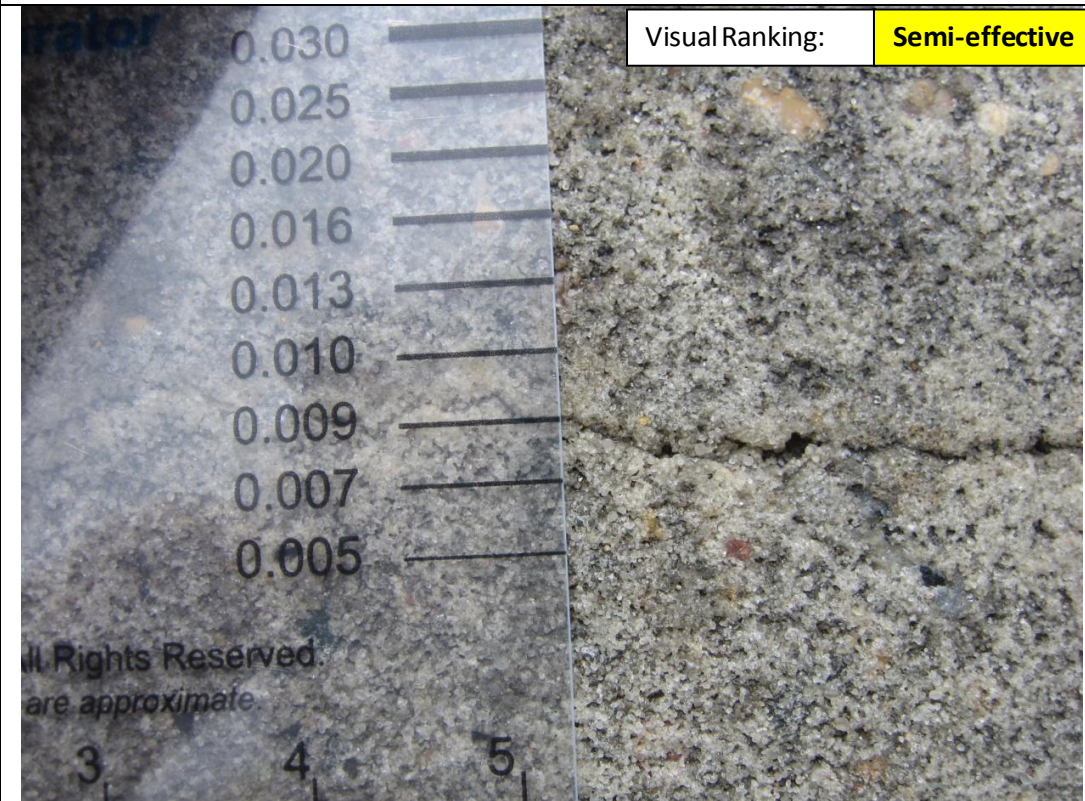
Photograph #: 74
 Test Information: Test Section 13, Test 25A - Euclid Chemical Dural LM 50 (Epoxy)
 Surface Prep & Application: Air Hose, Pretreat, Bottle (squeegee), Sand: Yes
 Date: April 30, 2013
 Project BL-09-03973
BRAUN INTERTEC



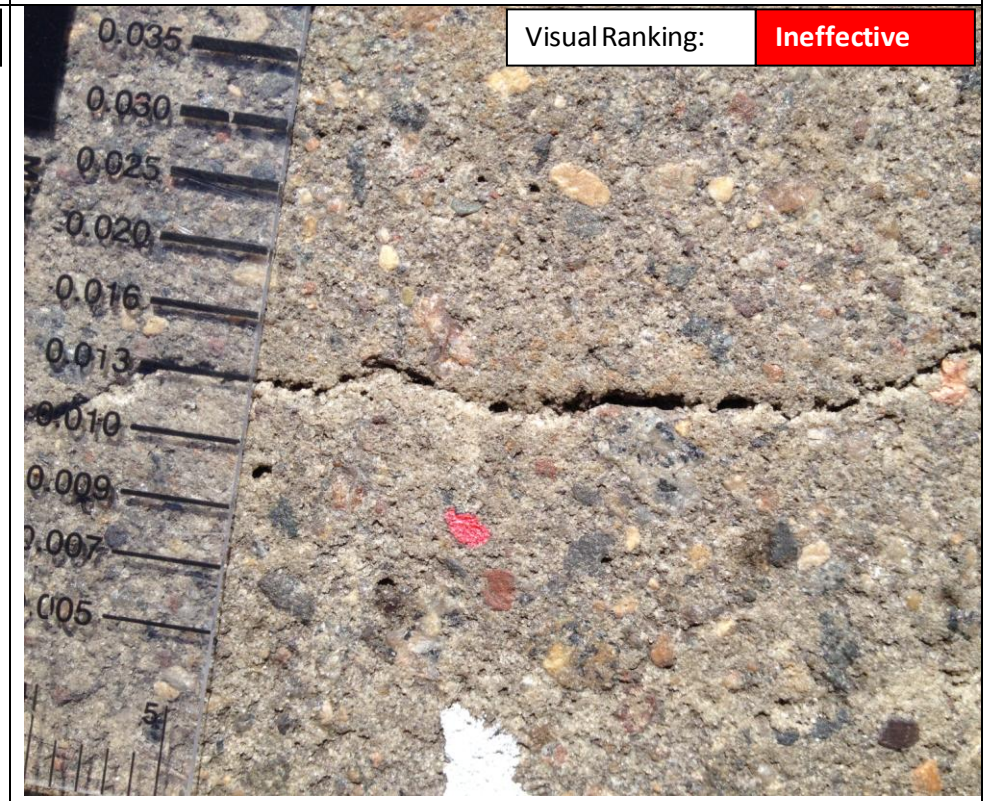
Photograph #: 75
 Test Information: Test Section 13, Test 25A - Euclid Chemical Dural LM 50 (Epoxy)
 Surface Prep & Application: Air, Pretreat, Bottle (squeegee), Sand: Yes
 Date: April 8, 2014
 Project BL-09-03973
BRAUN INTERTEC



Photograph #: 76
 Test Information: Test Section 13, Test 26A - Euclid Chemical Dural LM 50 (Epoxy)
 Surface Prep & Application: Shot Blast, Pretreat, Flood, Sand Coat: Yes
 Date: May 11, 2012
 Project BL-09-03973
BRAUN INTERTEC



Photograph #: 77
 Test Information: Test Section 13, Test 26A - Euclid Chemical Dural LM 50 (Epoxy)
 Surface Prep & Application: Shot Blast, Pretreat, Flood, Sand Coat: Yes
 Date: April 30, 2013
 Project BL-09-03973
BRAUN INTERTEC

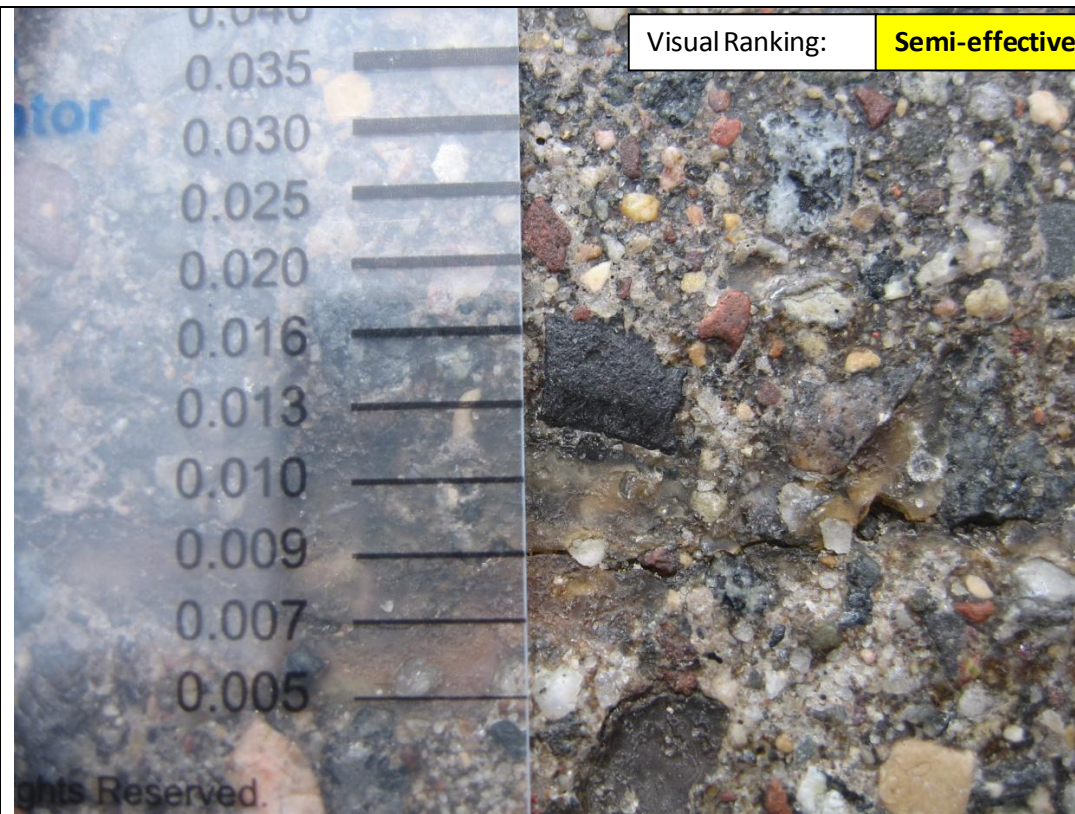


Photograph #: 78
 Test Information: Test Section 13, Test 26A - Euclid Chemical Dural LM 50 (Epoxy)
 Surface Prep & Application: Shot Blast, Pretreat, Flood, Sand Coat: Yes
 Date: April 8, 2014
 Project BL-09-03973
BRAUN INTERTEC



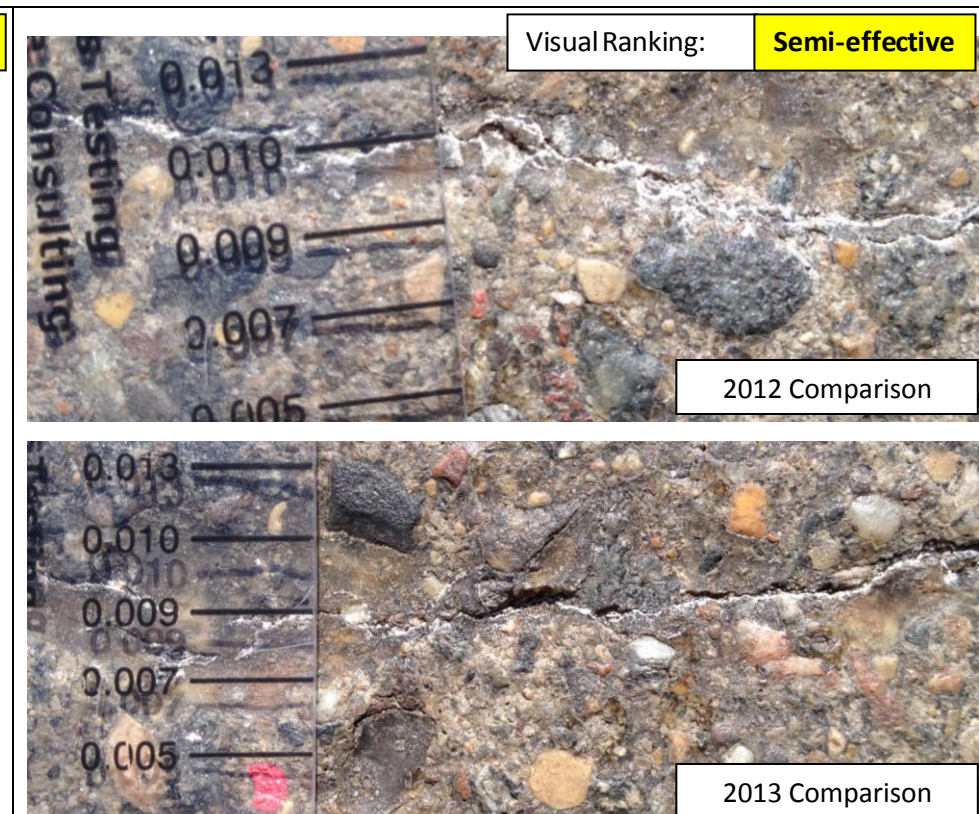
Photograph #: 79
 Test Information: Test Section 14, Test 27A - Transpo Industries T70-MX-30 (HMWM)
 Surface Prep & Application: Air Hose, Flood, Sand Coat: Yes
 Date: May 11, 2012

Project BL-09-03973
BRAUN
 INTERTEC



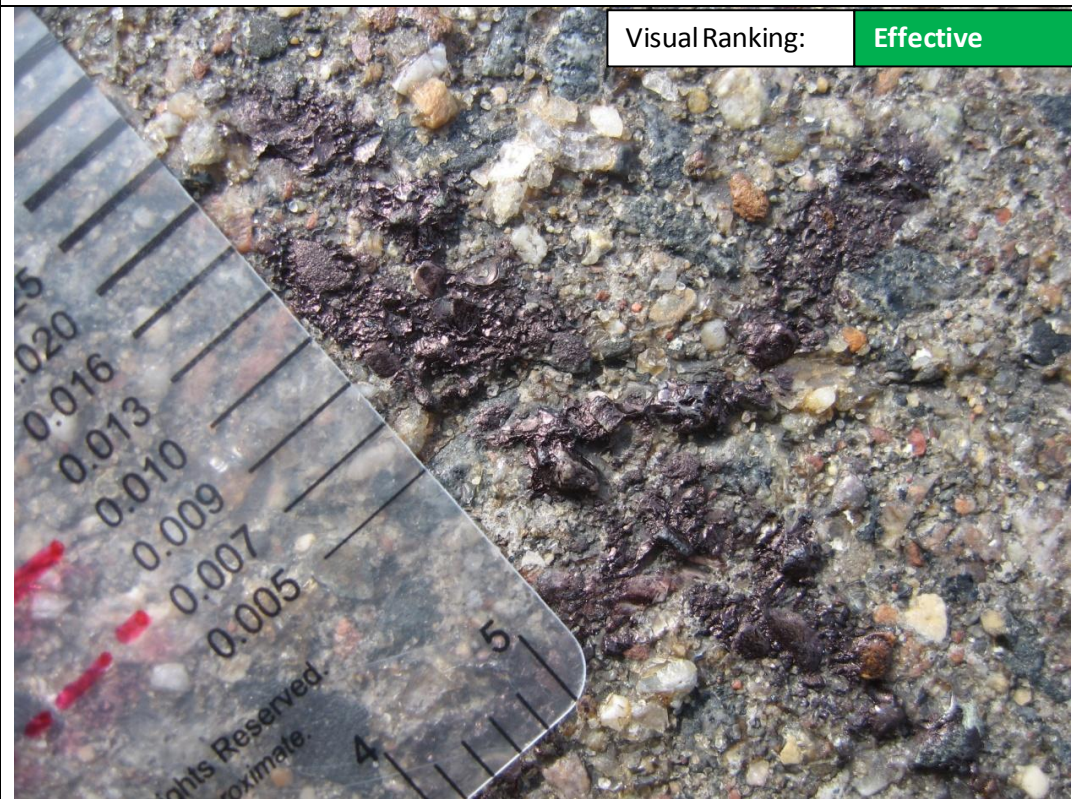
Photograph #: 80
 Test Information: Test Section 14, Test 27A - Transpo Industries T70-MX-30 (HMWM)
 Surface Prep & Application: Air Hose, Flood, Sand Coat: Yes
 Date: April 30, 2013

Project BL-09-03973
BRAUN
 INTERTEC



Photograph #: 81
 Test Information: Test Section 14, Test 27A - Transpo Industries T70-MX-30 (HMWM)
 Surface Prep & Application: Air Hose, Flood, Sand Coat: Yes
 Date: April 8, 2014

Project BL-09-03973
BRAUN
 INTERTEC



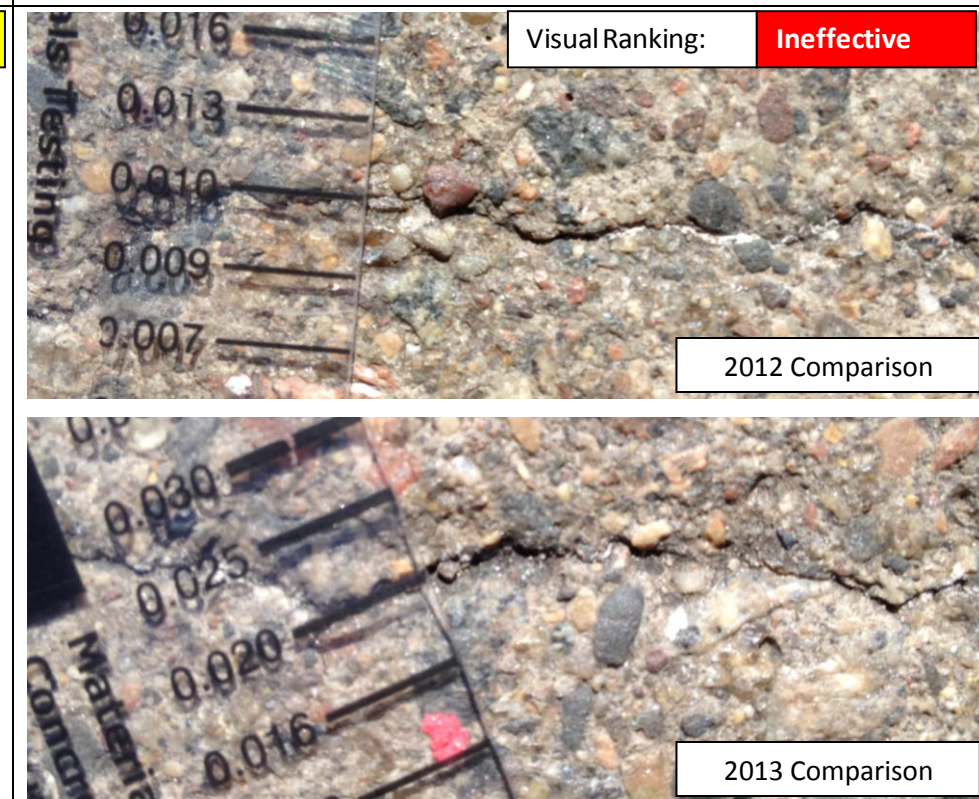
Photograph #: 82
 Test Information: Test Section 14, Test 28A - Transpo Industries T70-MX-30 (HMWM)
 Surface Prep & Application: Air Hose, Flood, Sand Coat: Yes
 Date: May 11, 2012

Project BL-09-03973
BRAUN
 INTERTEC



Photograph #: 83
 Test Information: Test Section 14, Test 28A - Transpo Industries T70-MX-30 (HMWM)
 Surface Prep & Application: Air Hose, Flood, Sand Coat: Yes
 Date: April 30, 2013

Project BL-09-03973
BRAUN
 INTERTEC



Photograph #: 84
 Test Information: Test Section 14, Test 28A - Transpo Industries T70-MX-30 (HMWM)
 Surface Prep & Application: Air Hose, Flood, Sand Coat: Yes
 Date: April 8, 2014

Project BL-09-03973
BRAUN
 INTERTEC



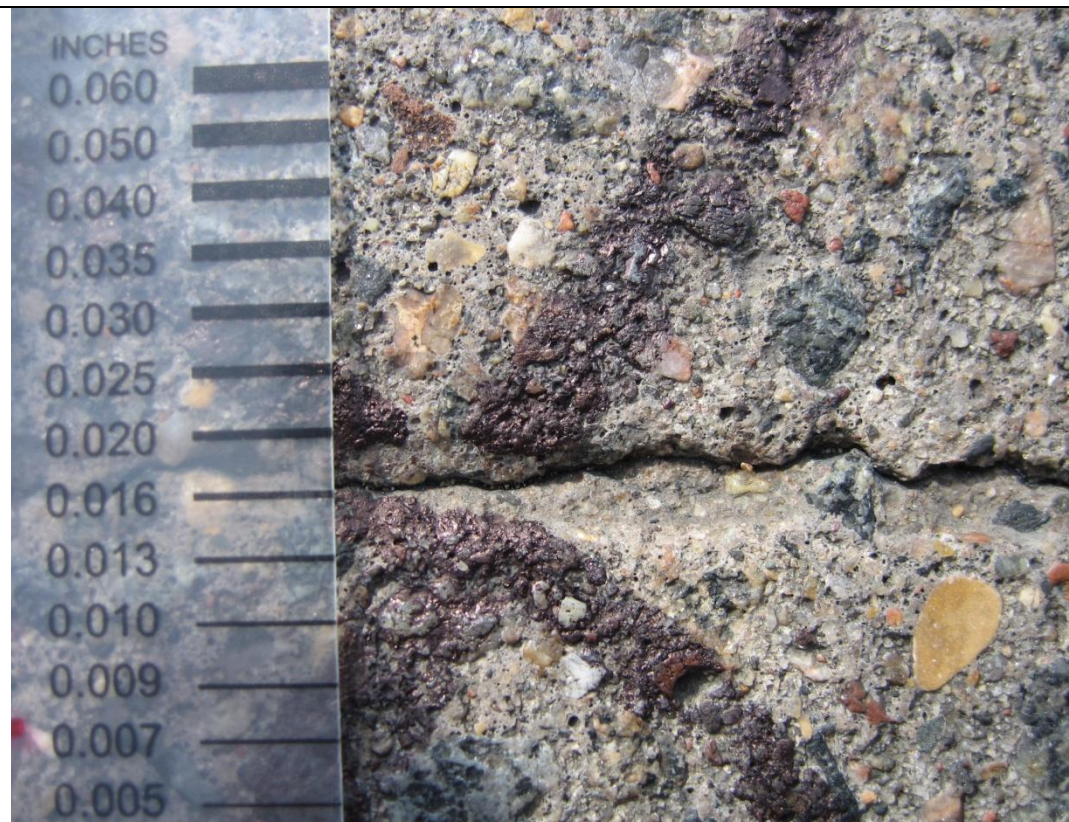
No Photograph



Photograph #: 86
Test Information: Test Section 15, Test 29A - CONTROL
Surface Prep & Application: CONTROL
Date: May 11, 2012
Project BL-09-03973
BRAUN
INTERTEC

Photograph #: 86
Test Information: Test Section 15, Test 29A - CONTROL
Surface Prep & Application: CONTROL
Date: April 30, 2013
Project BL-09-03973
BRAUN
INTERTEC

Photograph #: 87
Test Information: Test Section 15, Test 29A - CONTROL
Surface Prep & Application: CONTROL
Date: April 8, 2014
Project BL-09-03973
BRAUN
INTERTEC



No Photograph



Photograph #: 88
Test Information: Test Section 15, Test 33A - CONTROL
Surface Prep & Application: CONTROL
Date: May 11, 2012
Project BL-09-03973
BRAUN
INTERTEC

Photograph #: 89
Test Information: Test Section 15, Test 33A - CONTROL
Surface Prep & Application: CONTROL
Date: April 30, 2013
Project BL-09-03973
BRAUN
INTERTEC

Photograph #: 90
Test Information: Test Section 15, Test 33A - CONTROL
Surface Prep & Application: CONTROL
Date: April 8, 2014
Project BL-09-03973
BRAUN
INTERTEC

APPENDIX 5 – Product Technical Data Sheets



Gel - Seal Waterproofer

Product: *Gel-Seal Waterproofer (GSW)*

Gel-Seal Waterproofer Description

Gel-Seal is a chemically modified silicate solution that provides long-term waterproofing and durability benefits to concrete. It penetrates deep into concrete and reacts with free calcium and water to form a water-soluble calcium silicate gel complex in cracks, pores and capillaries. This gel creates a sub-surface barrier against the ingress of water and contaminants such as chloride ions.

Gel-Seal Advantage

Gel-Seal remains reactive upon contact with water to provide continuous healing properties to future hairline cracks. Therefore, a single application can deliver a "lifetime" (many years) of concrete waterproofing preventing freeze-thaw degradation and salt ingress. It protects the concrete and reinforcing steel. It offers major cost savings for both new infrastructure work and renovation activities. **Gel-Seal** is suitable for all types of Portland cement concrete mix designs.

- ✓ Will seal existing leaking cracks to 2.0mm
- ✓ Penetrates deep for long-lasting protection
- ✓ Seals against radon gas
- ✓ Eliminates sweating floors
- ✓ Resistant to penetration of grease, oil, acids and salts
- ✓ Meets USDA regulations

Gel-Seal Usage

Gel-Seal is used to penetrate the surface and chemically bond with the concrete. It is not a coating and it does not form a surface film. It has proven effective in:

- ✓ Parking Decks
- ✓ Airport Runways
- ✓ Bridges
- ✓ Tilt-up Construction
- ✓ Water Retaining and Distribution Structures
- ✓ Sports Arenas
- ✓ Distribution Centers
- ✓ Airports & Hangers
- ✓ Schools
- ✓ Pharmaceutical Plants
- ✓ Meat Processing Plants
- ✓ Convention Centers
- ✓ Malls
- ✓ Breweries
- ✓ Sewage Facilities
- ✓ Basement Walls and Floors
- ✓ Pre-cast and cast-in-place concrete structures

Gel-Seal Waterproofer Application

- **Gel-Seal Waterproofer** can be applied to green concrete as soon as you can walk on it, or cured concrete of any age.
- When applied to green concrete, you will get the long-term waterproofing benefits plus it helps prevent curing cracks from developing. It hardens, densifies and dust-proofs the concrete.
- When applied to cured concrete the surface must be clean, dry and dust-free.
- All curing compounds must have degraded or be removed prior to application.
- Any materials that retard penetration must be removed prior to application.
- Where segregation or voids are apparent, chip out or grind, flood with **Gel-Seal Waterproofer** then make good with a quality crack repair material.
- Good concrete practice must be followed such as adequate curing, compaction and vibration
- Do not apply where surface and ambient temperatures are below +40°F or above +90°F, or when the temperature will fall below 35°F within 24 hours after applying.

Application Rates

New Concrete: 150-250 square feet per gallon.

Old Concrete: 100-150 square feet per gallon. Areas with cracking may take two applications.

Application Method

- A.** Locate all cracks and flood with solution first, ensuring they are filled with product.
- B.** Apply the solution to the remaining area at a rate of between 100 and 250 square feet per gallon, ensuring total wetting.
- C.** Spray application with low-pressure (garden-type) sprayer recommended.
- D.** For vertical surfaces start at the bottom, working up.

PRECAUTIONS

Protect glass, aluminum, wood and painted finishes from overspray. Wear impermeable gloves and safety glasses. **DO NOT INGEST.** Wash hands prior to eating.

LIMITATIONS

Gel-Seal is not suitable for sealing working/volatile cracks as a result of structural defects or caused by mechanical damage.



Gel - Seal Waterproofer

Gel-Seal Shelf Life & Storage

No known limit to shelf life in sealed containers. **Keep from freezing** and store between 40°F and 85°F. Keep container sealed and avoid prolonged exposure to direct sunlight. Always agitate drum or container before use.

Packaging	1 gallon Pails
	5 gallon Pails
	55 gallon Drums
	275 gallon Totes

Typical Properties

Diluting		Use as Supplied
Odor		None
Toxicity		None
Flammability		None
Coverage per Gallon		150-250 sf/gal
Environmental Hazards		None
Shelf Life		Infinite
Cleanup		Water & Mild Soap
Water Absorption	ASTM C-642	3.2% in 24 Hours
Depth of Penetration		6mm or more Into Concrete
Compressive Strength	ASTM C-140	3,990 psi Average
Untreated Concrete	ASTM C-140	3,415 psi Average
Water Vapor Transmission		217 grams/sq.ft. 24 hrs

Know your concrete

The **Gel-Seal** reacts with calcium in Portland cement and water. Therefore, the more Portland, the better **Gel-Seal** works. Concrete with Type C fly ash-up to 30% of cement replacement benefits from treatment with **Gel-Seal**. Repeated applications will help. There is no long-term benefit in treating concrete containing more than 5% Type F fly-ash or volcanic ash.

Performance Characteristics

- Permanently seals cracks up to 2.0 mm
- Reseals future hairline cracks up to 0.3 mm
- Reduction of chloride diffusion coefficient by 89%
- Water permeability reduced by 70%
- Increases surface hardness
- Reduces scaling in freeze-thaw environments by 89%
- Allows 84.1% moisture vapor permeability, it breathes
- Suitable for tanking applications (positive hydrostatic pressure) - tested to 400 metres
- Seals against radon gas
- Eliminates sweating floors in basements and garages
- Stops efflorescence and dusting
- Protects against concrete deterioration
- Acts as an adhesion promoter for surface applied coatings/paints (provided that the cured **Gel-Seal** surface is clean, dry and otherwise prepared according to the coating/paint manufacturer's specifications)
- Non-Toxic – suitable for potable water
- Does not change the exterior of the concrete in appearance and the surface will take color stain (acid stain)
- Protects surface coatings and adhesives from capillary rise of moisture and vapor pressure
- Fills voids in air entrained concrete (densifies)
- Neutralizes or stops Alkali Silica Reaction (ASR)

Product Use: All statements, technical information and recommendations contained in this document are based upon tests or experience that Superior Coating Specialists believes are reliable. However, many factors beyond Superior Coating Specialists' control can affect the use and performance of our product in a particular application, including the conditions under which the product is used and the time and environmental conditions in which the product is expected to perform. Since these factors are uniquely within the user's knowledge and control, it is essential that the user evaluate the product to determine whether it is fit for a particular purpose and suitable for the user's method of application.

Warranty and Limited Remedy: Superior Coating Specialists warrants that each product meets the applicable manufacturing specifications at the time the product is shipped. Superior Coating Specialists makes no warranties, expressed or implied, including, but not limited to, any implied warranty of merchantability or fitness for use for a particular purpose or any implied warranty arising out of a course of dealing, customer or usage of trade. The user is responsible for determining whether the Superior Coating Specialists product is fit for a particular purpose and suitable for user's application. If a product is found defective your exclusive remedy and Superior Coating Specialists and seller's sole obligation will be, at Superior Coating Specialists option to replace the product or refund the purchase price. **Limitation of Liability:** Except where prohibited by law, Superior Coating Specialist and seller will not be liable for any loss or damage arising from the Superior Coating Specialists product, whether direct, indirect, special, incidental or consequential, regardless of the legal theory asserted, including warranty, contract, negligence or strict liability.

TK-9030 CRACK REPAIR

LOW VISCOSITY URETHANE/POLYUREA HYBRID



PRODUCTS

Division of Sierra Corporation
ISO 9001:2000 Certified

Technical Data

TK-9030 CRACK REPAIR
Low Viscosity Urethane/Polyurea Hybrid

TK PRODUCTS
7

TK PRODUCTS
7

TK-9030 CRACK REPAIR
Low Viscosity Urethane/Polyurea Hybrid

1. PRODUCT NAME

TK-9030 CRACK REPAIR

2. MANUFACTURER

TK PRODUCTS
DIVISION OF SIERRA CORPORATION
11400 West 47th Street
Minnetonka, MN 55343
952-938-7223
952-938-8084 (FAX)
E-mail: tkproduct@aol.com
Website: www.tkproduct.com

3. PRODUCT DESCRIPTION

TK-9030 CRACK REPAIR is a fast set low viscosity urethane/urea blend. Being low viscosity, TK-9030 can penetrate deep into smaller cracks that other crack repair products can not.

Uses:

With proper preparation, TK-9030 CRACK REPAIR can repair cracks in bridge decks and concrete slabs. Its low viscosity allows it to penetrate deep in smaller cracks.

4. TECHNICAL DATA

Composition:	Polyurea/ Polyurethane
Non-Volatile:	57 - 58%
VOC:	< 450 g/l
Gel Time:	3 - 6 min. at 70°F
Tack Free:	10 minutes at 70°F
Color:	Gray
Tensile Strength: (ASTM D638)	4230 PSI
Tensile Elongation: (ASTM D638)	3.3%
Bond Strength (WDOT Procedure):	4154 psi Hairline Crack

-ASTM C 496: "Splitting Tensile Strength of Cylindrical Concrete Specimens".

-ASTM C 666: "Resistance of Concrete to Rapid Freezing and Thawing". 300 freeze/thaw cycles.

- USDA authorization for use in meat, poultry and food processing plants.

This product is not currently regulated by the 1999 Federal EPA VOC requirements.

5. APPLICATION PROCEDURES AND INSTRUCTIONS

Crack or joint should be clean and dry. All contaminants must be removed before application. TK-9030 CRACK REPAIR is supplied in a two-component tube kit with a static mixer and flow restrictor provided.

Shake cartridge, remove retaining nut and plugs, install flow restrictor, attach static mixer and replace nut. Install cartridge in mix gun. Place mixer tip in area to be filled. Squeeze trigger to start flow. Keep steady pressure to provide proper mixing.

Note: Silica Sand can be used to stop flow in crack and joint.

Dry Time: at 70°F gels 6-10 minutes.
Tack free in 10 minutes.

Coverage Rate:

The coverage rate will vary depending on the size of the crack being filled and waste overfilled. One cartridge kit will contain enough material to fill 36 cubic inches. This would be the equivalent of 12 linear feet for a crack 1/8" wide and 2" deep. For bridge deck crack filling, one cartridge will usually cover 75-100 linear feet.

Clean Up:

Spills of uncured material can be cleaned with xylene. Cured material is very chemically inert and must be scraped. Discard used static mixers, do not attempt to reuse.

Limitations:

Shelf life is approximately 18 months from date of manufacture when stored in unopened containers at room temperature.

Safety Precautions:

-This product contains chemicals that are sensitizers and fire hazards. Care should be taken to minimize exposure and contact. Keep out of reach of children.

-Protective equipment such as safety glasses, gloves and respirators in confined areas are recommended when handling this material.

-Avoid skin contact. If contact accidentally occurs, remove contaminated clothing immediately and wash skin with soap or a lanolized cleaner.

-Avoid eye contact. If contact accidentally occurs, flush eye with large amounts of water and get medical attention immediately.

6. AVAILABILITY

TK-9030 CRACK REPAIR is available through TK Distributors. Contact TK Products for nearest distributor.

Packaging:

-Packaged in 600 ml cartridges, 2-gallon and 10-gallon kits.

-Approximately 20 fluid ounces.

-Boxed in 12 cartridges per case.

7. CONDITIONS OF SALE/ LIMITED WARRANTY

TK Products, division of the Sierra Corporation, warrants that its products conform to the label descriptions, are free from manufacturing defects, and are fit for the ordinary purposes for which such goods are used. Inasmuch as the use of TK Products' product by others and other factors affecting product performance are beyond TK Products' control, TK Products does not guarantee the results to be obtained. There are no warranties except as stated herein, either express or implied, including implied warranties of merchantability or fitness for a particular purpose. **SHOULD ANY TK PRODUCTS' PRODUCT FAIL TO GIVE SATISFACTORY RESULTS, TK PRODUCTS WILL REPLACE THE PRODUCT, OR AT ITS OPTION, REFUND THE PURCHASE PRICE. THIS IS THE SOLE AND EXCLUSIVE REMEDY FOR ANY FAILURE OF TK PRODUCTS'**

PRODUCTS TO PERFORM AS WARRANTED AND SHALL ALSO CONSTITUTE LIQUIDATED DAMAGES IN CASE OF LOSS. UNDER NO CIRCUMSTANCES SHALL THE BUYER BE ENTITLED TO ANY OTHER REMEDY OR DAMAGES. REMEDIES FOR INCIDENTAL AND CONSEQUENTIAL DAMAGES ARE SPECIFICALLY EXCLUDED. TK Products does not authorize any person to assume for it any other liability in connection with the sale or use of its products unless specifically authorized by TK Products in writing.

8. TECHNICAL SERVICES

The TK office offers assistance with specifications, performance test data and field services.

9. FILING SYSTEMS

Information Handling Services
PO Box 1213
Englewood, CO 80150
Information Marketing Services
13271 Northend
Oak Park, MI 48237

TK DISCLAIMER:

Every effort has been made to ensure the accuracy of the above information and to avoid infringement of any patent or copyright. The information is based on field tests by government and private agencies, as well as lab tests, and on technical data from raw material manufacturers. The person(s) specifying or requesting the use of these products is responsible for assuring their suitability for a specific use, as well as the proper application of the products. Where there is any question as to the suitability of a particular product, a small test patch is recommended. See also CONDITIONS OF SALE/ LIMITED WARRANTY (Section 7) above.

FOR INDUSTRIAL USE ONLY

09/09



TK-2110 BRIDGE DECK & CRACK SEALER

Technical Data

Division of Sierra Corporation
ISO 9001:2000 Certified

1. PRODUCT NAME

TK-2110 BRIDGE DECK & CRACK SEALER

-ASTM D638
Tensile Strength: 8563 PSI
Elongation: 2.6%
Youngs Modulus: 769800

2. MANUFACTURER

TK PRODUCTS
DIVISION OF SIERRA CORPORATION
11400 West 47th Street
Minnetonka, MN 55343
952-938-7223
952-938-8084 (FAX)
e-mail: tksales@tkproduct.com
website: <http://www.tkproduct.com>

-ASTM D695
Compressive Strength: 14560 cps
Compressive Modulus: 400,000 PSI

-ASTM D570
Water Absorption: 0.24%

-ASTM D2566
Linear Coefficient of Shrinkage: 0.004%

-ASTM C881
Bond Strength: 2757 PSI

-ASTM 881, Type I, II, IV, Grade 1,
Class B, C & D

5. APPLICATION PROCEDURES AND INSTRUCTIONS

Before using TK-2110 BRIDGE DECK & CRACK SEALER, the Material Safety Data Sheet (MSDS) should be read entirely. Please contact your TK distributor, the TK office or the TK website for this information.

Please note that it is the responsibility of the user to assure proper application by following all preparation, mixing and application guidelines. Jobsite visits by TK representatives are meant as a source of technical recommendation only and do not qualify as project supervision or quality management.

Preparation:

All surfaces must be free from any foreign material. Sandblasting, shot blasting or water blasting methods should be used to remove such materials from existing structures. All cracks should be blown clean by utilizing compressed air. For cracks greater than 1/8" thick, treat individually. Fill wide cracks with a dry silica sand, then apply a small amount of TK-9000 100% EPOXY CRACK FILLER to the crack and disperse with a paint brush.

For best performance, TK-2110 BRIDGE DECK & CRACK SEALER must be applied to a dry surface and in temperatures higher than 50°F. TK-2110 BRIDGE DECK & CRACK SEALER should only be applied to concrete that has been allowed to cure for 14 days or more.

Mixing:

Using a power mechanical mixer, mix part A and part B individually before combining these components together. Pour the entire contents of part B into part A and mix for 2-3 minutes, scraping the sides of the container clean. When mixing multiple kits, mix only the amount of the material that is needed and which will be used within the specified pot life of 30 minutes.

Application:

Immediately pour the entire contents of the **mixed** material onto the surface and distribute with a squeegee or roller; allowing it to pond over cracks. The pot life and working time of the material will be substantially prolonged, up to one hour, by utilizing this application method.

Typical application rate is 100-200 sq. ft. per gallon. This rate can fluctuate depending on the porosity of the substrate, the surface finish, and the amount of cracks in the concrete. Do not over-apply TK-2110 BRIDGE DECK & CRACK SEALER and do not allow tynes in the surface to be filled. Let the material saturate the substrate for 10 minutes. Squeegee the material onto the next surface that is to be sealed and broom any excess material off the surface; sweep any material out of the tynes.

Once this process has been completed for the entire surface area, and before TK-2110 had a chance to cure, broadcast silica sand over the entire area. This top coating of sand over the surface will create a slip resistant finish.

4. TECHNICAL DATA

- 100% solids
- Color: Clear to Amber (mixed)
- Mixed Viscosity: 124 cps
- Pot Life: 36 minutes at 70°F, 60 gram mass
- Flash Point: Greater than 200°F
- VOC: Less than 1 G/L
- Mix Ratio: 4 parts A:1part B by volume (premeasured kits)

TK-2110 BRIDGE DECK & CRACK SEALER
Concrete Bond & Repair Materials

TK
3&9
PRODUCTS



TK
3&9
PRODUCTS

TK-2110 BRIDGE DECK & CRACK SEALER
Concrete Bond & Repair Materials

If needed, recoat the area within 24 hours of the original application of TK-2110 BRIDGE DECK & CRACK SEALER.

Clean Up:

Clean all tools, equipment and spills with Xylene before the material is allowed to dry. Any dried material that may remain may be removed with an epoxy stripper.

Precautions:

Epoxies and their curing agents can be corrosive and can be the cause of sensitization concerns. Consult this product's Material Safety Data Sheet for health, safety and handling information.

Limitations:

Due to abrasion, TK-2110 BRIDGE DECK & CRACK SEALER is a film that will discolor and wear off the surface in time. However, the cracks that were treated will remain sealed and unaffected. Do not use this product if the current air or substrate temperature is, or will fall below, 50°F within 24 hours of application. Do not mix previously catalyzed material with fresh material.

6. AVAILABILITY

TK-2110 BRIDGE DECK & CRACK SEALER is available through TK distributors. Contact TK Products for the nearest distributor.

Packaged in:

-1-Gallon Kit :

- (Part A) Short filled 1-gallon can
- (Part B) Short filled quart

-5-Gallon Kit :

- (Part A) Short filled 5-gallon pail
- (Part B) Short filled 1-gallon can

-50-Gallon Kit :

- (Part A) Short filled 55-gallon drum
- (Part B) 2 5-gallon pails

7. CONDITIONS OF SALE/ LIMITED WARRANTY

TK Products, division of the Sierra Corporation, warrants that its products conform to the label descriptions, are free from manufacturing defects, and are fit for the ordinary purposes for which such goods are used. Inasmuch as the use of TK Products' product by others and other factors affecting product performance are beyond TK Products' control, TK Products does not guarantee the results to be obtained. There are no warranties except as stated herein, either express or implied, including implied warranties of merchantability or fitness for a particular purpose. **SHOULD ANY TK PRODUCTS' PRODUCT FAIL TO GIVE**

SATISFACTORY RESULTS, TK PRODUCTS WILL REPLACE THE PRODUCT, OR AT ITS OPTION, REFUND THE PURCHASE PRICE. THIS IS THE SOLE AND EXCLUSIVE REMEDY FOR ANY FAILURE OF TK PRODUCTS' PRODUCTS TO PERFORM AS WARRANTED AND SHALL ALSO CONSTITUTE LIQUIDATED DAMAGES IN CASE OF LOSS. UNDER NO CIRCUMSTANCES SHALL THE BUYER BE ENTITLED TO ANY OTHER REMEDY OR DAMAGES. REMEDIES FOR INCIDENTAL AND CONSEQUENTIAL DAMAGES ARE SPECIFICALLY EXCLUDED. TK Products does not authorize any person to assume for it any other liability in connection with the sale or use of its products unless specifically authorized by TK Products in writing.

8. TECHNICAL SERVICES

The TK office offers assistance with specifications, performance test data and field services.

9. FILING SYSTEMS

Information Handling Services
PO Box 1213
Englewood, CO 80150
Information Marketing Services
13271 Northend
Oak Park, MI 48237

TK DISCLAIMER:

Every effort has been made to ensure the accuracy of the above information and to avoid infringement of any patent or copyright. The information is based on field tests by government and private agencies, as well as lab tests, and on technical data from raw material manufacturers. The person(s) specifying or requesting the use of these products is responsible for assuring their suitability for a specific use, as well as the proper application of the products. Where there is any question as to the suitability of a particular product, a small test patch is recommended. See also CONDITIONS OF SALE/ LIMITED WARRANTY (Section 7) above.

FOR INDUSTRIAL USE ONLY

09/08



Division of Sierra Corporation
ISO 9001:2008 Certified

1. PRODUCT NAME

TK-2414 MMA BRIDGE DECK & CRACK SEALER

2. MANUFACTURER

TK PRODUCTS
DIVISION OF SIERRA CORPORATION
11400 West 47th Street
Minnetonka, MN 55343
952-938-7223
952-938-8084 (FAX)
e-mail: tksales@tkproduct.com
Website: <http://www.tkproduct.com>

3. PRODUCT DESCRIPTION

TK-2414 MMA BRIDGE DECK & CRACK SEALER is a two-component, clear liquid, low viscosity, low surface tension, solvent-free, rapid curing reactive methacrylate resin that is formulated to penetrate, repair and seal cracks in concrete surfaces.

TK-2414 MMA BRIDGE DECK & CRACK SEALER is UV resistant, protects against intrusion from water and chloride ions and provides resistance against weather and aging. Its fast cure time (1 hour) allows the surface to be reopened to traffic with minimal down time.

BENEFITS:

- Penetrates cracks by gravity
- Fast turn around time
- User-friendly with ease of use installation
- Low viscosity allows easy topical applications and excellent penetration into cracks.
- Shelf life up to 1 year when stored properly
- Prevents premature deterioration of the surface
- May be applied at a wide range of temperatures (from 35° - 104°F), allowing for an extended application season

USES:

- Concrete
- Bridge Decks
- Parking Structures
- Exterior, Horizontal Applications

4. TECHNICAL DATA

Composition:

TK-2414 MMA BRIDGE DECK & CRACK SEALER is a reactive methacrylate resin.

Viscosity, Brookfield RVT:	< 25 cps
Gel Time, ASTM D2471:	25 - 35 min.
Tensile Strength, ASTM D638:	2328 psi
Tensile Elongation, ASTM D638:	30%
Shear Bond Adhesion, ASTM C882:	2188 psi
Tack Free Time, AASHTO T237	30 - 60 min. @ 70°F (21°C)

-A.I.M. Category: Concrete Waterproofing Sealers VOC < 400 g/l
-A.I.M. Definition: A coating that is formulated and recommended for application to a porous substrate for the primary purpose of preventing the penetration of water.

5. APPLICATION PROCEDURES AND INSTRUCTIONS

Surface Preparation:

The surface must be clean, dry and free of dust, dirt, oil, wax, curing compounds, efflorescence, laitance and any other bond-breaking materials. Check the weather forecast to ensure that dry conditions will be present for application and drying. Using a dust-free, mobile shot-blaster or grit-blaster, brush-blast the substrate to expose surface cracking. Do not use wet preparation methods.

Mixing:

TK-2414 MMA BRIDGE DECK & CRACK SEALER (Unit A) is to be mixed with the appropriate amount of Unit B (Initiator) prior to application. The following Mixing Chart is a guide.

Mixing Chart

Temperature (°F)	# Units A (Sealer)	# Units B (Initiator)
40°	1	5
50°	1	4
60°	1	3
70°	1	2
85°	1	1

Add the appropriate amount of Unit B (Initiator), determined from the mixing chart, to the Unit A (Sealer). When calculating the proper amount of Unit B (Initiator) to be used, the temperature of the substrate as well as ambient air temperatures need to be considered. Sift the Unit B (Initiator) into the Unit A (Sealer) while mixing to ensure there are no lumps present. Stir vigorously with a mechanical mixer 1-2 minutes until Unit B (Initiator) is dissolved. The mixed material should be applied immediately as working time is 15-30 minutes. Dumping and spreading the material into a thin film will NOT extend this working time.

Application:

TK-2414 MMA BRIDGE DECK & CRACK SEALER is to be applied as a flood coat in a gravity fed process by broom or roller. The contents of the batch should be immediately poured onto the substrate and worked into the cracks and distributed by squeegee, 1/2" to 3/4" nap solvent grade rollers, or broom. Do not leave ponded material on the surface. TK Products recommends that a 30 mesh dry aggregate be randomly broadcast into the wet, uncured resin at a rate of approximately 4lb./100ft². A second treatment may be required on very porous substrates.

Coverage:

Typical coverage is between 90-150ft²/gallon for crack healing and surface sealing. These rates may vary depending on the porosity and absorption properties of the substrate. Higher porosities will reduce the coverage rate.

Limitations:

- Do not thin as the addition of solvents will prevent proper curing
- Ambient temperature at application must be over 35°F.
- Concrete must be allowed to cure for 21-28 days before application
- Sealed concrete surfaces may appear blotchy due to differential absorption

- Proper application of this product is the responsibility of the user. Visits to the jobsite by TK Products staff are meant as a technical resource only. No supervision of the application processes or quality control will be performed by TK Products.

Clean Up:

Immediately clean tools with xylene, methyl ethyl ketone or similar solvents. In case of spills, collect the material with an absorbent cloth, and dispose of in accordance with all applicable regulations.

Precautions:

Use NIOSH/MSHA approved respiratory protection in accordance with all applicable Federal, state and local regulations. Any person using a respirator must be properly trained in respirator use. Keep away from all sources of ignition including heat and open flame. Use only with adequate ventilation. Avoid contact with the eyes, skin and clothing and wash thoroughly after handling. Do not take internally; avoid inhalation. The use of gloves and eye protective equipment is mandatory. Tyvec suits recommended. Do NOT use in confined areas.

First Aid:

Inhalation: Relocate person to fresh air, give artificial respiration if not breathing. GET MEDICAL HELP.

Eye and Skin Contact: Wash with large quantities of clean water for 15 minutes.

Ingestion: Do not induce vomiting. GET MEDICAL HELP.

Storage:

Store the material in a clean, cool and dry area, away from direct sunlight. Maximum storage temperature is 86°F. Store the material in its original, unopened container.

6. AVAILABILITY

TK-2414 MMA BRIDGE DECK & CRACK SEALER is available through TK distributors. Contact TK Products for the nearest distributor.

Packaged in:

- 5-gallon Unit A (Sealer)
3.41-oz. Unit B** (Initiator)

- 55-gallon Unit A (Sealer)
4.26-lb. Unit B** (Initiator)

**** Temperature at time of application will determine the number of Initiator (Unit B) required. Refer to the "Mixing Chart" (on front) for temperature/unit requirements.**

7. CONDITIONS OF SALE/ LIMITED WARRANTY

TK Products, division of the Sierra Corporation, warrants that its products conform to the label descriptions, are free from manufacturing defects, and are fit for the ordinary purposes for which such goods are used. Inasmuch as the use of TK Products' product by others and other factors affecting product performance are beyond TK Products' control, TK Products does not guarantee the results to be obtained. There are no warranties except as stated herein, either express or implied, including implied warranties of merchantability or fitness for a particular purpose. **SHOULD ANY TK PRODUCTS' PRODUCT FAIL TO GIVE SATISFACTORY RESULTS, TK PRODUCTS WILL REPLACE THE PRODUCT, OR AT ITS OPTION, REFUND THE PURCHASE PRICE. THIS IS THE SOLE AND EXCLUSIVE REMEDY FOR ANY FAILURE OF TK PRODUCTS' PRODUCTS TO PERFORM AS WARRANTED AND SHALL ALSO CONSTITUTE LIQUIDATED DAMAGES IN CASE OF LOSS. UNDER NO CIRCUMSTANCES SHALL THE BUYER BE ENTITLED TO ANY OTHER REMEDY OR DAMAGES. REMEDIES FOR INCIDENTAL AND CONSEQUENTIAL DAMAGES ARE SPECIFICALLY EXCLUDED. TK Products does not authorize any person to assume for it any other liability in connection with the sale or use of its products unless specifically authorized by TK Products in writing.**

8. TECHNICAL SERVICES

The TK office offers assistance with specifications, performance test data and field services.

9. FILING SYSTEMS

Information Handling Services
PO Box 1213
Englewood, CO 80150
Information Marketing Services
13271 Northend
Oak Park, MI 48237

TK DISCLAIMER:

Every effort has been made to ensure the accuracy of the above information and to avoid infringement of any patent or copyright. The information is based on field tests by government and private agencies, as well as lab tests, and on technical data from raw material manufacturers. The person(s) specifying or requesting the use of these products is responsible for assuring their suitability for a specific use, as well as the proper application of the products. Where there is any question as to the suitability of a particular product, a small test patch is recommended. See also CONDITIONS OF SALE/ LIMITED WARRANTY (Section 7) above.

FOR INDUSTRIAL USE ONLY

05/12

PRODUCT DATA

3 03 01 00 **Maintenance of
Concrete****EPOXEAL™ GS STRUCTURAL****Two-component, ultra low viscosity gravity feed or pressure-injected epoxy sealer and structural adhesive****Description**

EpoXeal™ GS Structural is a two-component ultra-low-viscosity epoxy sealer and structural adhesive. Its low-viscosity formula penetrates deeply into concrete to repair damaged structures. It accepts an aggregate broadcast to provide a slip-resistant surface.

Yield

150 ft²/gal (3.8 m²/L) per coat

Coverage will vary depending on porosity and amount of deterioration to substrate.

Packaging

3 gal kits:

Two 1 gal (3.8 L) cans of Part A and
One 1 gal (3.8 L) can Part B

165 gal drum kits:

Two 55 gal drums (208 L) of Part A
and One 55 gal drum (208 L) Part B

Color

Part A: clear amber liquid

Part B: clear liquid

Shelf life

2 years when properly stored

Storage

Store in unopened containers in a cool, clean, dry area.

Features

- Surface sealer
- 2 to 1 mix ratio
- Low viscosity
- Accepts aggregate broadcast

Benefits

- Reduces chloride intrusion and absorption
- Convenient and easy to mix; meets the mix ratio requirements of professional injection equipment
- Penetrates deeply for reliable, complete crack repair
- Produces slip-resistant surface with aggregate concrete

Where to Use

APPLICATION

- Sealing cracks in structural concrete
- Consolidation of partially deteriorated and dusting surfaces
- Bridge decks
- Roadways
- Parking and garage decks
- Floors
- Columns and beams

LOCATION

- Interior and exterior

SUBSTRATE

- Concrete

How to Apply**Surface Preparation**

1. Concrete must be cured a minimum of 14 days before application.
2. Concrete must be mechanically profiled and appropriately cleaned before application. Surfaces must be free from dust, grease, curing compounds, waxes, laitance, loose deteriorated concrete, and other unsound materials.
3. All damaged surfaces must be repaired with appropriate repair material.
4. Optimum penetration is achieved with dry concrete.

Mixing

1. Pre-mix each component thoroughly before mixing together.
2. Place 2 parts by volume of component A with 1 part by volume of component B into a clean mixing container.
3. Mix thoroughly for approximately 3 – 5 minutes using a low-speed (400 – 500 rpm) drill and paddle mixer until uniformly blended.
4. The pot life of EpoXeal™ GS Structural is 45 minutes.

Technical Data

Composition

EpoXeal™ GS Structural features proprietary epoxy resin technology.

Compliances

- ASTM C 881 Type I, II, IV, V, Grade 1, Class B and C
- Meets USDA specifications for use in food processing facilities

Test Data

PROPERTY	RESULTS	SPECIFICATION	TEST METHODS
Viscosity , cps, approximate	95	2,000 maximum	Brookfield
Pot life , min, approximate	45	30 minimum	ASTM C 881
Bond strength , psi (MPa)			ASTM C 882
2 days	2,410 (16.6)	1,000 (6.9)	
14 days	3,450 (23.8)	1,500 (10.3)	
Absorption , %, 24 hour immersion	0.9	1.0 maximum	ASTM D 570
Heat deflection , ° F (° C)	122 (50)	120 (49) minimum	ASTM D 648
Linear coefficient of shrinkage	0.0021	0.005 maximum	ASTM D 2566
Compressive strength , psi (MPa)	10,800 (74.5)	10,000 (69) minimum	ASTM D 695
Compressive modulus , psi (MPa)	310,000 (2,137)	200,000 (1,379)	ASTM D 695
Tensile strength , psi (MPa)	7,100 (49.0)	7,000 (48.3) minimum	ASTM D 638
Flexural strength , psi (MPa)	9,500 (65.5)	None	ASTM D 790
Elongation , %, at break	2.9	1.0 minimum	ASTM D 638

Test results are averages obtained under laboratory conditions. Reasonable variations can be expected.

Application

1. Apply by brush, roller, squeegee, or airless sprayer.
2. Apply material evenly over surface at 150 – 200 ft²/gallon (3.68 – 4.9 m²/L) per coat.
3. Coverage will vary depending on the porosity of the concrete.
4. If injecting cracks, appropriate sealing of cracks and injection ports is necessary. Use appropriately clean and calibrated mechanical injecting equipment.
5. To gravity feed, V-notch the crack, making sure the bottom and sides are sealed. Pour mixed material evenly into crack until full. For cracks greater than 1/8" (3 mm), fill crack with oven dry sand before applying product.
6. If nonslip surface is desired, aggregate broadcast is mandatory. Distribute sand evenly over surface at a rate of 12 – 20 lbs per 100 sq ft (0.59 – 0.98 kg/m²).

Clean Up

Clean equipment with Reducer 990 before material sets. Cured material will require mechanical removal.

For Best Performance

- Do not use when substrate temperature falls below 50° F (10° C).
- Keep from freezing.
- Do not thin; solvents will prevent proper curing.
- Injection cracks should not exceed 1/4" (6 mm) in width.
- Use only high-quality silica quartz aggregate for broadcast.
- Optimum penetration is achieved with dry concrete.
- EpoXeal™ GS Structural will discolor when exposed to UV light.
- Lower temperatures or higher humidity will slow the cure of EpoXeal™ GS Structural.
- Protect EpoXeal™ GS Structural from rain for 24 hours after application at 75° F (24° C).
- Cure time to accept traffic: at 70° F (21° C), 12 hours; at 80° F (27° C), 6 hours.
- Make certain the most current versions of product data sheet and MSDS are being used; call Customer Service (1-800-433-9517) to verify the most current version.

- Proper application is the responsibility of the user. Field visits by BASF personnel are for the purpose of making technical recommendations only and not for supervising or providing quality control on the jobsite.

Health and Safety

EPOXEAL™ GS STRUCTURAL PART A

Warning

EpoXeal™ GS Structural Part A resin contains epoxy resin, 2-ethylhexyl glycidyl ether.

Risks

May cause skin, eye and respiratory irritation. May cause dermatitis and allergic responses. Potential skin and/or respiratory sensitizer. Ingestion may cause irritation.

Precautions

Use only with adequate ventilation. Avoid contact with skin, eyes and clothing. Keep container closed when not in use. Wash thoroughly after handling. DO NOT take internally. Use impervious gloves, eye protection and if the TLV is exceeded or used in a poorly ventilated area, use NIOSH/MSHA approved respiratory protection in accordance with applicable Federal, state and local regulations.

First Aid

In case of eye contact, flush thoroughly with water for at least 15 minutes. In case of skin contact, wash affected areas with soap and water. If irritation persists, SEEK MEDICAL ATTENTION. Remove and wash contaminated clothing. If inhalation causes physical discomfort, remove to fresh air. If discomfort persists or any breathing difficulty occurs or if swallowed, SEEK IMMEDIATE MEDICAL ATTENTION.

Refer to Material Safety Data Sheet (MSDS) for further information.

Proposition 65

This product contains materials listed by the State of California as known to cause cancer, birth defects or other reproductive harm.

VOC Content

0 g/L or 0 lbs/gal less water and exempt solvents when components are mixed and applied per Manufacture's instructions.

EPOXEAL™ GS STRUCTURAL PART B

Danger—Corrosive

EpoXeal™ GS Structural Part B contains 4-nonylphenol; n-aminoethylpiperazine; poly(oxypropylene)diamine; naphthalene; 2,4,6-tris((dimethylamino)methyl)phenol

Risks

Contact with skin or eyes may cause burns. Ingestion may cause irritation and burns of mouth, throat and stomach. Inhalation of vapors may cause irritation. May cause dermatitis and allergic responses. Potential skin and/or respiratory sensitizer. Repeated or prolonged contact with skin may cause sensitization. Suspect cancer hazard. Contains material which may cause cancer. Risk of cancer depends on duration and level of exposure. INTENTIONAL MISUSE BY DELIBERATELY INHALING THE CONTENTS MAY BE HARMFUL OR FATAL.

Precautions

DO NOT get in eyes, on skin or clothing. Wash thoroughly after handling. Keep container closed. DO NOT take internally. Use only with adequate ventilation. DO NOT breathe vapors. Use impervious gloves, eye protection and if the TLV is exceeded or used in a poorly ventilated area, use NIOSH/MSHA approved respiratory protection in accordance with applicable Federal, state and local regulations.

First Aid

In case of eye contact, flush thoroughly with water for at least 15 minutes. In case of skin contact, wash affected areas with soap and water. If irritation persists, SEEK MEDICAL ATTENTION. Remove and wash contaminated clothing. If inhalation causes physical discomfort, remove to fresh air. If discomfort persists or any breathing difficulty occurs or if swallowed, SEEK IMMEDIATE MEDICAL ATTENTION.

Refer to Material Safety Data Sheet (MSDS) for further information.

Proposition 65

This product contains materials listed by the State of California as known to cause cancer, birth defects or other reproductive harm.

VOC Content

0 g/L or 0 lbs/gal less water and exempt solvents when components are mixed and applied per Manufacture's instructions.

For medical emergencies only, call ChemTrec (1-800-424-9300).

BASF Corporation
Building Systems

889 Valley Park Drive
Shakopee, MN, 55379

www.BuildingSystems.BASF.com

Customer Service 800-433-9517
Technical Service 800-243-6739



LIMITED WARRANTY NOTICE Every reasonable effort is made to apply BASF exacting standards both in the manufacture of our products and in the information which we issue concerning these products and their use. We warrant our products to be of good quality and will replace or, at our election, refund the purchase price of any products proved defective. Satisfactory results depend not only upon quality products, but also upon many factors beyond our control. Therefore, except for such replacement or refund, **BASF MAKES NO WARRANTY OR GUARANTEE, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY, RESPECTING ITS PRODUCTS, and BASF shall have no other liability with respect thereto.** Any claim regarding product defect must be received in writing within one (1) year from the date of shipment. No claim will be considered without such written notice or after the specified time interval. User shall determine the suitability of the products for the intended use and assume all risks and liability in connection therewith. Any authorized change in the printed recommendations concerning the use of our products must bear the signature of the BASF Technical Manager.

This information and all further technical advice are based on BASF's present knowledge and experience. However, BASF assumes no liability for providing such information and advice including the extent to which such information and advice may relate to existing third party intellectual property rights, especially patent rights. In particular, BASF disclaims all **CONDITIONS AND WARRANTIES, WHETHER EXPRESS OR IMPLIED, INCLUDING THE IMPLIED WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY. BASF SHALL NOT BE RESPONSIBLE FOR CONSEQUENTIAL, INDIRECT OR INCIDENTAL DAMAGES (INCLUDING LOSS OF PROFITS) OF ANY KIND.** BASF reserves the right to make any changes according to technological progress or further developments. It is the customer's responsibility and obligation to carefully inspect and test any incoming goods. Performance of the product(s) described herein should be verified by testing and carried out only by qualified experts. It is the sole responsibility of the customer to carry out and arrange for any such testing. Reference to trade names used by other companies is neither a recommendation, nor an endorsement of any product and does not imply that similar products could not be used.

For professional use only. Not for sale to or use by the general public.

Form No. 1017959 7/11
Printed on recycled paper including 10% post-consumer fiber.

© 2011 BASF
Printed in U.S.A.

PRODUCT DATA SHEET: KBP 204 P SEAL

PRODUCT DESCRIPTION

KBP 204 P SEAL is a pre-promoted, high molecular weight methacrylate monomer composition that has been developed as a **“healer/sealer”** penetrant for re-bonding and Sealing shrinkage or related cracking in Portland cement concrete, latex modified and/or silica fume (micro silica) concrete. KBP 204 P SEAL has been formulated to conform to published specifications from Cal-Trans, Nevada DOT, Oregon DOT, Virginia DOT, Washington DOT, FHWA, Bureau of Reclamations, and many other specifying authorities.

Formulated high molecular weight methacrylate systems play a distinctly different role than silane, siloxane, or epoxy sealers. KBP 204 P SEAL is a **“100% solids, completely reactive” polymer system**, with low viscosity and surface tension allowing the polymer to wick deep into cracks, pores, etc. After penetrating by gravity the system polymerizes to form a tough plastic seal. The end result is a re-bonded crack that resists the ingress of moisture or other environmental contaminants.

KBP 204 P SEAL is designed to penetrate quickly and allow return to service within a reasonable period. Typically, materials dry to touch within 1-3 hours during sunlight conditions and temperatures ranging from 55 F-100F. Surface dry may be accelerated by mechanical means. Deck temperatures, air temperatures, humidity, U.V. light exposure all play a significant role in penetration and drying characteristics. Due to temperature and humidity variations, a test area should be evaluated under anticipated construction conditions to determine specific catalyst ratios for the expected conditions.

SPECIAL FEATURES

- **Reduced Mixing and Handling Hazard**
- **Very** Low viscosity for rapid surface penetration
- Fast curing properties during daytime, sunlight conditions
- Excellent adhesion to Portland cement concrete, latex modified concrete, silica fume concrete even under damp conditions
- Low overall odor (This product conforms to Cal-Trans specifications limiting volatile organic content to 30% maximum)
- Easy handling, workability, mixing

PHYSICAL PROPERTIES- KBP 204 P SEAL-Typical Values	
Specific Gravity - ASTM D1475	1.06
Viscosity- ASTM D2196 w U/L adaptor, 50 rpm, 25C	< 25 cps
Flash Point (Setaflash) ASTM D3278	>180 °F
Adhesion(Saturated Surface Dry Bond Test, Cal-Trans 551)	> 500 psi
Thin Film Tack Free Time (Cal-Trans Test Method, Cal-Trans 551)*	< 400 minutes
Vapor Pressure, mm Hg (ASTM D 323)	1 mm Hg
ASTM D-695 Compressive Strength-RT Cure (2 hours)	>2000 psi
ASTM D-695 Compressive Strength-RT Cure (24 hours)	>3000 psi
ASTM D-638 Tensile Strength (24 hours)	>2000 psi
ASTM C-882 Adhesion (hardened concrete to hardened concrete) @ 2 days, RT Cure	>2500 psi
Surface Coverage Rate*	60-125 sq.ft./gal.

*Coverage rates for penetrants like KBP 204 P SEAL represent averages only. Field variables such as surface porosity, grooving, tinning, heavy brooming, wide cracks, pop offs, etc. consume proportionately higher amounts of materials.

SEALER APPLICATION

Surface Preparation: As a sealer KBP 204 P SEAL requires minimal surface preparation. On relatively clean decks, free from significant AC deposits, the decks just need to be swept with high-pressure air to remove minor dirt and expose the cracked surface. For decks with higher amounts of contaminants, steel shot-blasting, sandblasting, scarifying or other cleaning processes may be required to provide a surface that will readily absorb the KBP 204 P SEAL materials.

Mixing: KBP 204 P SEAL

Once the deck has been cleaned, catalyze KBP 204 P SEAL using the following starting point formula:

- 1) 4 gallons KBP 204 P SEAL
- 2) 12 fl oz Cumene Hydro Peroxide (CHP)
- 3) 2-15 fl oz Z Cure Accelerator (see temperature chart)

Note: Modifications may be required for working under different temperature conditions or during night time application. For temps above 90 F, night time application should be considered. Reducing CHP levels to 1 fl oz per gallon during elevated temperatures should be evaluated. During cold night time application, both CHP levels and Z Cure accelerator may be increased. (See temperature chart)

Mix the CHP peroxide into the KBP 204 P SEAL monomer first using a variable speed drill motor mixer. Each component, separately, must be stirred into the KBP 204 P SEAL monomer. Always follow the mixing steps outlined above. Take precautions by wearing appropriate protection equipment as well as having a fire extinguisher and plenty of clean water available.

Placement: KBP 204 P SEAL

After proper proportioning and mixing, distribute the KBP 204 P SEAL mixture on the concrete surface as soon as possible. Spread sealer at a rate of 60-120 square feet per gallon, consistent with the listed project specifications (other application rates are acceptable). Use a squeegee, roller, broom, low pressure sprayer, etc. to distribute the material uniformly. Some areas may selectively absorb greater amounts of KBP 204 P SEAL and create dry spots. These areas should receive additional amounts of KBP 204 P SEAL to fill the pores and cracks to the point of refusal to absorb further. Elevated temperatures and UV light significantly increases the reactivity of KBP 204 P SEAL and reduces work time. Cold temperatures greatly retard the surface cure of the KBP 204 P SEAL. Field adjustment of accelerators and/or promoter activators will be required to obtain the proper surface cure within the traffic closure windows. A DEMONSTRATION under EXPECTED JOB CONDITIONS must be conducted PRIOR to actual construction to determine the correct catalyst quantities. Differing levels of catalyst should be evaluated to determine surface cure characteristics obtainable under the prevailing job site conditions. Temperature, humidity, fog, night time versus daylight conditions have an effect on the cure response of the KBP 204 P SEAL system. Normally, traffic may be returned in 1.5-3 hours. **Contact Kwik Bond Polymers technical department for recommendations and suggestions.**

Once the KBP 204 P SEAL monomer mixture has been distributed properly, wait approximately 10-20 minutes and then broadcast a commercial grade of 8 x 20 sand blast sand. The intent of broadcasting sand is to provide initial traction to the treated surface. Commonly available grades of sand blast sand, No. 8, 8 x 12, and 20 mesh have been used successfully. The application rate of the broadcast sand is typically 2 lbs per square yard surface. Sufficient sand should be broadcast to meet the skid resistance requirements of the specification. Any technique may be used to broadcast the sand including hand throwing, fertilizer spreaders, salt spreaders, drop spreaders, etc. Significant quantities of excess loose sand need to be removed from the deck prior to returning traffic.

For night time applications, Sealer cure speeds will be reduced. A thin, oily residue may remain on areas of the Sealed surface under cold, damp conditions. Temperatures should be 50 F and rising during application. Colder temperatures, low fog, dew, etc. will drastically slow cure times. Under these conditions some un-reacted monomer will leave an oily residue on the surface. The oily residue may alter skid resistance properties of the treated surface even though the surface traction sand has been applied and is well bonded. This residual oiliness can be resolved by distributing approximately 5 lb/100 sf of surface area with diatomaceous earth plus mechanically sweeping the area. A skid tester may be utilized to verify bridge deck friction values.

CLEAN UP

Wipe off excess materials with disposable absorbent materials. Solvents like MEK, acetone, lacquer thinner, orange cleaner are excellent cleaners if used before the KBP 204 Sealer hardens. Read and follow the safety and handling recommendations for these materials.

PACKAGING

- Cumene Hydro Peroxide (CHP)- available in 1 gallon containers
- KBP 204 P Seal - 4 gallon pails, 50 gallon drums, 250 gallon Totes.
- Z-Cure is available in 1 gal and 5 gallon pails
- Other packaging may be available

STORAGE

KBP 204 P SEAL and CHP should be stored in a COOL, DRY location and in their original containers at temperatures less than 80 F. Containers need to remain tightly SEALED to prevent contamination. The shelf life for these materials is typically 6-9 months. When stored at elevated temperatures, the KBP 204 P SEAL reactive monomer may gel prematurely. CHP can have reduced activity after a lengthy storage period. Retest all component materials prior to use on a project.

SAFETY

Workers should wear appropriate protective clothing, gloves, and eye protection. For most outdoor applications the use of an organic vapor respirator is not required by OSHA. However, sensitive individuals may desire to wear an organic vapor respirator due to the chemical odors. Additional safety equipment includes a fire extinguisher, fresh water for eye rinse. Workers should have a change of clothing in case of accidental contamination of clothing. All KBP 204 P SEAL monomer components have a very low order of dermal toxicity. However, continued contact with the skin, especially catalyzed material, may lead to redness, swelling, blisters, or other effects. Sensitive workers may react much more rapidly. These effects are typical of other commonly used construction chemicals. All efforts should be made to prevent contact. Read MSDS sheets for additional information and first aid procedures.

The technical data furnished is true and accurate to the best of our knowledge. However, no guarantee of accuracy is given or implied. We suggest that you evaluate these recommendations and suggestions in conjunction with your specific application. Kwik Bond Polymers, LLC warrants its product(s) to be free from manufacturing defects conforming to its most recent material specifications. In the event of defective materials, Kwik Bond Polymers, LLC's liability will be limited to the replacement of material or the material value only at the sole discretion of Kwik Bond Polymers, LLC We assume no responsibility for coverage, suitability of application, performance or injuries resulting from use. 8-15-2011



The Chemical Company

PRODUCT DATA

7 07 18 00

Concrete Rehabilitation

DEGADECK® CSP

Reactive methacrylate resin for sealing cracks and concrete decks

Description

DEGADECK® CSP is a very low viscosity, low surface tension, solvent free, rapid curing reactive methacrylate resin formulated to penetrate, repair and seal cracks in concrete substrates.

POWDER HARDENER is 50% dibenzoyl peroxide (BPO) in granulated powder form to initiate the cure of the DEGADECK® resin.

Yield

100 ft²/gallon (2.5 m²/L), depending on number and volume of cracks as well as porosity of concrete.

Powder Hardener:

See mixing charts for the appropriate products.

Packaging

DEGADECK® CSP is sold by weight and packaged in 38 lb (17.3 kg) pails and 396 lb (180 kg) drums. This is equivalent to 4.7 gallons (17.8 L) and 49 gallons (185.5 L) respectively.

Powder Hardener:

2.5 lb bottle

50 lb box

Color

Clear

Shelf Life

1 year when properly stored

Storage

Store in cool, clean, dry area.

Keep out of direct sunlight. Storage temperature is 60°F – 80°F (15 – 27° C). Store in original and unopened container.

Features

- Fast curing (1 hour)
- UV resistance
- Weather and aging resistant
- 2 component
- Compatible with other DEGADECK® methacrylate systems
- Protects against water and chloride ion ingress
- Can be used at temperatures ranging from 14 to 104° F (-10 to 40° C)

Benefits

- On highway and bridge projects, allows fast return of traffic flow, contributing directly to worker and driver safety
- Exposure to sunlight does not affect product performance
- Provides long-lasting service life
- User friendly; ease of installation; shelf life stable
- Provides complete systems approach to concrete protection
- Prevents premature deterioration
- Extended application season

Where to Use

APPLICATION

- Bridge decks
- Parking structures
- Civil engineering applications
- Penetrating flood coat sealer to prevent moisture and ion ingress into substrate

LOCATION

- Exterior
- Horizontal

SUBSTRATE

- Concrete

How to Apply

Surface Preparation

1. Inspect the concrete substrate before preparation. Note the location of surface cracks and the presence of contaminants. Concrete surfaces must be dry and free of dust, dirt, oil, wax, curing compounds, efflorescence, laitance, and all other bondbreaking materials.
2. Inspect the underside of the deck for signs of leakage due to full depth cracks.
3. Check weather forecast to ensure dry conditions. Wet substrates must be allowed to dry prior to beginning work.
4. Using a dust-free, mobile shotblaster or gritblaster, brush-blast the substrate to expose surface cracking.
5. Do not use wet preparation methods.
6. Perform a second inspection, noting newly-found surface cracks. Mark these for pre-treatment. Clean out cracks and the deck surface with oil-free compressed air.



Technical Data

Composition

DEGADECK® CSP is a reactive methacrylate resin.

Compliances

- DEGADECK® CSP is classified under DOT regulations as Resin Solution, UN 1866, Class 3, PG II.

Test Data

PROPERTY	RESULTS	TEST METHODS
Appearance	Liquid	
Specific gravity	0.97	ASTM D 4669
Viscosity, cP (mPa-sec), at 73° F (23° C)	5-15	ASTM D 2393
Flash point, ° F (° C)	50 (10)	ASTM D 3278
Tensile strength, psi (MPa)	7,775 (54)	ASTM D 638
Compressive, psi (MPa)	12,800 (88.2)	ASTM D 638
Flexural Strength, psi (MPa)	11,900 (82)	ASTM D 638
Elongation at break, %	5	ASTM D 638

Mixing

DEGADECK® CSP must be mixed with the appropriate amount of Powder Hardener just prior to application. Air/substrate temperature determines the amount as follows:

DEGADECK CRACK SEALER (1 GALLON)

TEMPERATURE ° F (° C)	WEIGHT %	VOLUME OUNCES
41 (5)	5	11
50 (10)	4	8.5
59 (15)	3	6.5
68 (20)	2	4
86 (30)	1	2

* Please consult BASF Technical Services for applications outside this temperature range.

At temperatures below 40° F, the DEGADECK® CSP requires the addition of a cold weather additive for proper curing. Below are the instructions for use.

- Add 12 vol. oz. DEGADECK® CW Additive to 1 gallon DEGADECK® CSP. Mix approximately 1 minute.
- Add hardener powder (BPO) to above mixture per ratios below. Quantities are calculated per 1 gallon batch of a (above).

TEMPERATURE ° F	VOLUME OUNCES	CURING TIME (MIN)
40	4	35
32	6.5	40
23	11	60
14	11	90

CAUTION: DO NOT MIX HARDENER POWDER (BPO) INTO DEGADECK® CW ADDITIVE, ONLY ADD PREMIXED BATCH AS IN (a) ABOVE.

Using clean, dry plastic buckets, add Powder Hardener to DEGADECK® CSP and mix until dissolved (approximately 1 minute). Mixed DEGADECK® CSP must be applied immediately. Do not exceed 5-gallon (20 L) batch mixes.

Application

- DEGADECK® CSP is applied as a flood coat in a gravity-fed process by broom or roller.
- The contents of the mixed batch should be immediately poured onto the substrate and worked into cracks by distributing with 1/2" to 3/4" (13 – 20 mm) nap solvent grade rollers or broom. Do not allow material to pond. Application rate is 100 ft²/gal (2.5 m²/L).
- Do not allow the mixed batch to remain in the mixing vessel. It is advisable to randomly broadcast a 30 mesh (600 µm), dry aggregate into the wet, uncured resin at the rate of approximately 4 lb/100 ft² (200 g/m²).
- Working time for Degadeck® CSP is between 10 and 15 minutes once it has been applied to the substrate. Full cure to specification will be between 45 minutes and 1 hour.

Pre-Treat Wide Cracks

Cracks over 1/8" (3 mm) should be treated individually prior to deck application. Full depth cracks may require alternative treatment to prevent runoff of resin. Fill wider cracks with dry, 30 mesh silica sand. Mix a small amount of ® Crack Sealer Plus, pour into cracks and distribute with a paint brush. Squeeze bottles can also be used.

Drying Time

Allow one hour for DEGADECK® CSP to gain full mechanical properties. Check for dry-to-touch condition. End result should be a darker-colored, matte finish with a minimal surface film and some loose broadcast aggregate. Open to traffic.

Clean Up

Clean tools as needed with MMA, acetone, ethyl acetate or similar solvents.

For Best Performance

- Application temperature range of substrate is between 14 and 104° F (-10 and 40° C).
- DEGADECK® CSP is NOT a high molecular weight methacrylate (HMWM).
- DO NOT use for vertical surface treatments.
- DEGADECK® CSP is a sacrificial film that will wear out over time, however the cracks will continue to be protected.
- Periodically inspect the applied material and repair localized areas as needed. Consult a BASF representative for additional information.
- Make certain the most current versions of product data sheet and MSDS are being used; call Customer Service (1-800-433-9517) to verify the most current version.
- Proper application is the responsibility of the user. Field visits by BASF personnel are for the purpose of making technical recommendations only and not for supervising or providing quality control on the jobsite.

Health and Safety

DEGADECK® CSP

Warning

DEGADECK® CSP contains Methyl methacrylate

Risks

FLAMMABLE LIQUID AND VAPOR. MAY CAUSE ALLERGIC SKIN REACTION. MAY CAUSE SKIN AND EYE IRRITATION. INGESTION MAY CAUSE IRRITATION.

Precautions

KEEP AWAY FROM HEAT, FLAME AND SOURCES OF IGNITION. Vapors are heavier than air. Keep container closed. Use only with adequate ventilation. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling. Avoid breathing vapors. DO NOT take internally. Use impervious gloves, eye protection and if the TLV is exceeded or used in a poorly ventilated area, use NIOSH/MSHA approved respiratory protection in accordance with applicable Federal, state and local regulations.

First Aid

In case of eye contact, flush thoroughly with water for at least 15 minutes. SEEK IMMEDIATE MEDICAL ATTENTION. In case of skin contact, wash affected areas with soap and water. If irritation persists, SEEK MEDICAL ATTENTION. Remove and wash contaminated clothing. If inhalation causes physical discomfort, remove to fresh air. If discomfort persists or any breathing difficulty occurs, or if swallowed, SEEK IMMEDIATE MEDICAL ATTENTION. Refer to Material Safety Data Sheet (MSDS) for further information.

VOC Content

70 g/L or 0.59 lbs/gallon, less water and exempt solvents.

POWDER HARDENER

Danger - Organic Peroxide

Powder Hardener contains dibenzoyl peroxide; and dicyclohexyl phthalate.

Risks

May cause skin, eye and respiratory irritation. May cause dermatitis and allergic responses. Repeated or prolonged contact with skin may cause sensitization. May cause dermatitis and allergic responses. Ingestion may cause irritation.

Precautions

KEEP AWAY FROM HEAT, FLAME AND SOURCES OF IGNITION. Use only with adequate ventilation. Avoid contact with skin, eyes and clothing. Keep container closed when not in use. Wash thoroughly after handling. DO NOT take internally. Prevent inhalation of dust. Use impervious gloves, eye protection and if the TLV is exceeded or used in a poorly ventilated area, use NIOSH/MSHA approved respiratory protection in accordance with applicable Federal, state and local regulations. Empty container may contain hazardous residues. All label warnings must be observed until container is commercially cleaned or reconditioned.

First Aid

In case of eye contact, flush thoroughly with water for at least 15 minutes. In case of skin contact, wash affected areas with soap and water. If irritation persists, SEEK MEDICAL ATTENTION. Remove and wash contaminated clothing. If inhalation causes physical discomfort, remove to fresh air. If discomfort persists or any breathing difficulty occurs or if swallowed, SEEK IMMEDIATE MEDICAL ATTENTION.

Refer to Material Safety Data Sheet (MSDS) for further information.

VOC Content

0 g/L or 0 lbs/gallon, less water and exempt solvents when components are mixed and applied per manufacturer's instructions.

DEGADECK® CRACK SEALER PLUS CW

Warning

DEGADECK® Crack Sealer Plus CW contains n,n-Dimethyl-p-toluidine.

Risks

Toxic by inhalation, in contact with skin or by ingestion. May cause skin, eye and respiratory irritation. Prolonged exposure to vapors or repeated skin exposures may effect liver, nervous system and blood-forming system and may cause fatigue, loss of appetite, headache and dizziness. Can be absorbed through skin and may cause loss of oxygen-carrying capacity of blood.

Precautions

Avoid contact with skin, eyes and clothing. Wash thoroughly after handling. DO NOT breathe vapors. Use only with adequate ventilation. Keep container closed. Use impervious gloves, eye protection and if the TLV is exceeded or if used in a poorly ventilated area, use NIOSH/MSHA approved respiratory protection in accordance with applicable Federal, state and local regulations. Empty container may contain hazardous residues.

First Aid

In case of eye contact, flush thoroughly with water for at least 15 minutes. SEEK IMMEDIATE MEDICAL ATTENTION. In case of skin contact, wash affected areas with soap and water. If irritation persists, SEEK MEDICAL ATTENTION. Remove and wash contaminated clothing. If inhalation causes physical discomfort, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, administer oxygen. SEEK IMMEDIATE MEDICAL ATTENTION. If swallowed, SEEK IMMEDIATE MEDICAL ATTENTION. Refer to Material Safety Data Sheet (MSDS) for further information.

VOC Content

0 g/L or 0 lbs/gal less water and exempt solvents.

**For medical emergencies only,
Call ChemTrec (1-800-424-9300).**

® = registered trademark

DEGADECK® = trademark of Evonik Röhm GmbH, Darmstadt / Germany

BASF Corporation Building Systems

889 Valley Park Drive
Shakopee, MN, 55379

www.BuildingSystems.BASF.com

Customer Service 800-433-9517
Technical Service 800-243-6739



LIMITED WARRANTY NOTICE: Every reasonable effort is made to apply BASF exacting standards both in the manufacture of our products and in the information which we issue concerning these products and their use. We warrant our products to be of good quality and will replace or, at our election, refund the purchase price of any products proved defective. Satisfactory results depend not only upon quality products, but also upon many factors beyond our control. Therefore, except for such replacement or refund, BASF MAKES NO WARRANTY OR GUARANTEE, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY, RESPECTING ITS PRODUCTS, and BASF shall have no other liability with respect thereto. Any claim regarding product defect must be received in writing within one (1) year from the date of shipment. No claim will be considered without such written notice or after the specified time interval. User shall determine the suitability of the products for the intended use and assume all risks and liability in connection therewith. Any authorized change in the printed recommendations concerning the use of our products must bear the signature of the BASF Technical Manager.

This information and all further technical advice are based on BASF's present knowledge and experience. However, BASF assumes no liability for providing such information and advice including the extent to which such information and advice may relate to existing third party intellectual property rights, especially patent rights. In particular, BASF disclaims all CONDITIONS AND WARRANTIES, WHETHER EXPRESS OR IMPLIED, INCLUDING THE IMPLIED WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY. BASF SHALL NOT BE RESPONSIBLE FOR CONSEQUENTIAL, INDIRECT OR INCIDENTAL DAMAGES (INCLUDING LOSS OF PROFITS) OF ANY KIND. BASF reserves the right to make any changes according to technological progress or further developments. It is the customer's responsibility and obligation to carefully inspect and test any incoming goods. Performance of the product(s) described herein should be verified by testing and carried out only by qualified experts. It is the sole responsibility of the customer to carry out and arrange for any such testing. Reference to trade names used by other companies is neither a recommendation, nor an endorsement of any product and does not imply that similar products could not be used.

For professional use only. Not for sale to or use by the general public.

Form No. 1031118 03/12

Printed on recycled paper including 10% post-consumer fiber.

© 2012 BASF
Printed in U.S.A.

SIKADUR® 55 SLV

Super Low Viscosity, Moisture Tolerant Epoxy Resin,
Crack Healer / Penetrating Sealer



DESCRIPTION

Sikadur 55 SLV is a patented, 2-component, 100% solids, moisture-tolerant, epoxy crack healer / penetrating sealer, having a fast tack free time to minimize downtime. It is a super low-viscosity, highstrength adhesive formulated specifically for grouting both dry and damp cracks. It conforms to the current ASTM C-881 and AASHTO M-235 specifications.

WHERE TO USE

- Sikadur 55 SLV structurally repairs cracked concrete.
- Seals surface of interior slabs and exterior, above-grade slabs from water, chlorides and chemical attack.
- For horizontal decks, slabs, patios, driveways, parking garages and other structures exposed to foot and pneumatic tire traffic.

ADVANTAGES

- Penetrates cracks by gravity down to 0.004 inches in width (4 mils).
- Structurally improves concrete surface.
- Open to traffic in 6 hours.
- Super low viscosity for easy, topical applications and excellent penetration into cracks.
- High bond strength, even in damp cracks.
- Prolongs life of cracked concrete.
- As a penetrating sealer, Sikadur 55 SLV reduces water absorption and chloride ion intrusion.
- U.S. Patent No. 5,962,602 for ultra low viscosity epoxy healer/sealer to strengthen cracked concrete.

COVERAGE

1 gal. yields 231 cu. in.

Typical coverage is 100-150 sq. ft./gal. for crack healing and surface sealing. Coverage varies with porosity and surface profile of substrate. Higher porosity concrete will reduce coverage.

PACKAGING

3.5-gallon unit. (2.5 gallon 'A' and 1.0 gallon 'B' in 5 gallon pail.)

HOW TO USE

Surface Preparation

Substrate must be clean, sound and free of surface moisture. Remove dust, laitance, grease, oils, curing compounds, waxes, impregnations, foreign particles, coatings and disintegrated materials by mechanical means (i.e. sandblasting). For best results, substrate should be dry. However, a saturated surface dry condition is acceptable.

Typical Data (Material and curing conditions @ 73°F (23°C) and 50% R.H.)			
Shelf Life 2 years in original, unopened containers.			
Storage Conditions Store dry at 40°-95°F (4°-35°C). Condition material to 65°-85°F before using.			
Color Clear, amber			
Mixing Ratio Component 'A' : Component 'B' = 2.5:1 by volume.			
Viscosity (Mixed) Approximately 95 cps.			
Pot Life APPROXIMATELY 25 MINUTES)			
Tack Free Time			
40°F (4°C)	60°F (15°C)	73°F (23°C)	
—	16 hours	6 hours	
Tensile Properties (ASTM D-638)			
	40°F (4°C)	60°F (15°C)	73°F (23°C)
7 day	Tensile Strength	—	5,000 psi (34.4 MPa)
	Elongation at break	—	1.6%
			7,500 psi (51.7 MPa)
			2.3%
Bond Strength (ASTM C-882) Hardened Concrete to Hardened Concrete			
	2 day (moist cure)	Bond Strength	1,400 psi (9.6 MPa)
	14 day (moist cure)	Bond Strength	2,700 psi (18.6 MPa)
Hardened Concrete to Steel			
	2 day (moist cure)	Bond Strength	1,900 psi (13.1 MPa)
	14 day (moist cure)	Bond Strength	2,100 psi (14.5 MPa)
Flexural Properties (ASTM D-790)			
7 days	Flexural strength	9,500 psi (65.5 MPa)	
	Tangent modulus of elasticity	4.8 x 10 ⁵ psi (3,312 MPa)	
Shear Strength (ASTM D-732)			
7 days	Shear Strength	7,600 psi (52.4 MPa)	
Heat Deflection Temperature (ASTM D-648)			
7 days	[fiber stress loading=264 psi (1.8 MPa)]	120°F (49°C)	
Water Absorption (ASTM D-570)			
7 day	(24 hour immersion)	0.61%	
Compressive Properties (ASTM D-695) - Compressive Strength, psi (MPa)			
	40°F* (4°C)	73°F* (23°C)	90°F* (32°C)
1 day	-	250 (1.7)	5,150 (35.5)
3 days	1,200 (8.2)	11,600 (80)	12,900 (88.9)
7 days	7,900 (54.4)	13,700 (94.4)	14,800 (102)
14 days	12,600 (86.8)	14,000 (96.5)	15,300 (105.5)
28 days	13,000 (89.6)	14,000 (96.5)	15,800 (108.9)
Compressive Modulus			
7 days)		3.7 x 10 ⁵ psi (2,553 MPa)	

MIXING

Pre-mix each component.

Proportion 1 part Component 'B' to 2.5 parts Component 'A' by volume into a clean pail. Mix thoroughly for 3 minutes

SIKADUR® 55 SLV

Super Low Viscosity, Moisture Tolerant Epoxy Resin,
Crack Healer / Penetrating Sealer



with Sika Paddle on a low-speed (400-600 rpm) drill until uniformly blended. Mix only that quantity which can be used within its pot life.

DANGER: HEAT AND SMOKE POTENTIAL

Leaving mixture of Component 'A' and 'B' in container longer than 25 minutes (pot life) will allow mixture to begin the curing (hardening) process in container. Spread mixture onto intended surface as soon as properly mixed. Leaving curing product in mixing container can generate excessive heat and may selfcombust. Self combusting materials may generate potentially hazardous smoke. Only mix together the amount of material that can be used and applied in less than the stated pot life. If smoke or excessive heat/flame occurs, ventilate area and cool outside of can with water. DO NOT POUR WATER INTO CAN. DO NOT BREATHE SMOKE.

APPLICATION

To gravity feed cracks:

Sikadur 55 SLV is applied to horizontal surfaces by roller, squeegee or broom. Spread material over area and allow to pond over cracks. Let material penetrate into cracks and substrate; remove excess leaving no visible surface film. For cracks greater than 1/8 in. (3 mm) wide, fill crack with oven-dried sand before applying Sikadur 55 SLV. Seal cracks from underside, when accessible, to prevent leakage.

A second treatment may be required on very porous substrates. Apply second treatment before broadcasting. After treatment, wait at least 20 minutes at 73°F (23°C); cover with light broadcast of a dry 8/20 or similar sand. Distribute evenly over the surface at a rate of 15 to 20 lbs./100 sq. ft. Allow to cure 6 hours at 73°F (23°C). Remove any loose sand and open to traffic. Consult Sika Technical Service for additional information.

To pressure inject cracks: Use automated injection equipment. Set appropriate injection ports. Seal ports and cracks with Sikadur 31, Hi-Mod Gel or Sikadur 33. When the epoxy adhesive has cured, inject Sikadur 55 SLV with steady pressure. Consult Technical Service for additional information.

LIMITATIONS

- Do not thin. Addition of solvents will prevent proper cure.
- Minimum ambient and substrate temperature 40°F (4°C)
- Do not inject cracks greater than 1/4 in. (6 mm) Consult Technical Service.

- Minimum age of concrete is 21-28 days, depending on curing and drying conditions.
- Sealed concrete surface may appear blotchy due to differential absorption.
- Not designed to seal or inject cracks under hydrostatic pressure during application.
- Not to be used as a film forming compound.

CAUTION

Component 'A' - Irritant; Sensitizer - Contains epoxy resin. Can cause skin sensitization after prolonged or repeated contact. Skin and eye irritant. High concentrations of vapor may cause respiratory irritation. Overexposure may cause central nervous system effects. Avoid skin contact. Use only with adequate ventilation. Use of safety goggles and chemical resistant gloves is recommended. In case of exceedance of PELs, use an appropriate, properly fitted NIOSH approved respirator. Remove contaminated clothing.

Component 'B' - Corrosive; Sensitizer - Contains amines. Contact with eyes or skin may cause severe burns. Can cause respiratory irritation. Overexposure may cause central nervous system effects. Avoid skin contact. Use only with adequate ventilation. Use of safety goggles and chemical resistant gloves is recommended. In case of exceedance of PELs, use an appropriate, properly fitted NIOSH approved respirator. Remove contaminated clothing.

FIRST AID

Eyes: Hold eyelids apart and flush thoroughly with water for 15 minutes. **Skin:** Remove contaminated clothing. Wash skin thoroughly for 15 minutes with soap and water. **Inhalation:** Remove person to fresh air. **Ingestion:** Do not induce vomiting. **In all cases, contact a physician immediately if symptoms persist.**

CLEAN UP

In case of spills or leaks, wear suitable protective equipment, contain spill, collect with absorbent material, and transfer to suitable container. Ventilate area. Avoid contact. Dispose of in accordance with current, applicable local, state, and federal regulations.

Warranty

Sika warrants this product for one year from date of installation to be free from manufacturing defects and to meet the technical properties on the current technical data sheet if used as directed within shelf life. User determines suitability of product for intended use and assumes all risks. Buyer's sole remedy shall be limited to the purchase price or replacement of product exclusive of labor or cost of labor.

NO OTHER WARRANTIES EXPRESS OR IMPLIED SHALL APPLY INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. SIKA SHALL NOT BE LIABLE UNDER ANY LEGAL THEORY FOR SPECIAL OR CONSEQUENTIAL DAMAGES.

Viking Paints Product Data Sheet

<u>PRODUCT LINE</u>	PAULCO CONSTRUCTION CHEMICALS
<u>PRODUCT NAME</u>	PAULCO 3008 CONCRETE PRESERVATIVE - TE-3008
<u>MANUFACTURER</u>	Viking Paints, Inc.
<u>DESCRIPTION</u>	PAULCO 3008 is a two-component epoxy resin solution that is cured through the epoxide group by reacting with a specially formulated polyamide. This material has been designed for preventative and remedial treatment of concrete and has been formulated to withstand a range of environments from mild to severely corrosive exposures.
<u>BASIC USES</u>	May be used in a wide variety of applications, but has been designed for use as a sealer to protect concrete surfaces against damage due to chloride penetration, freezing and thawing, chemicals, oils, grease, and other contaminants. This product is recommended for sealing new concrete and also for existing concrete surfaces when applied in conjunction with proper cleaning methods. It has been field tested for many years as a membrane sealer over freshly poured concrete. This promotes moisture retention and hydrating to provide a better concrete cure. PAULCO TE-3008 will seal hairline cracks. To seal wider cracks, use PAULCO TE-2501.
<u>PHYSICAL DATA</u>	N/A

**TECHNICAL
DATA**

COMPONENT A	
Epoxide Equiv. Weight:	Proprietary
Solvent	Proprietary
Solids	38%
Viscosity (CPS)	100 Approximately
Gardner Color Standard	1
Weight/Gallon	8.15 lbs.
Specific Gravity	.977
COMPONENT B	
Amine Hydrogen Equiv.	Proprietary
Solvent	Proprietary
Solids	10%
Viscosity (CPS)	50.75
Gardner Color Standard	1
Weight/Gallon	7.35 lbs.
Specific Gravity	.88
RESISTANCE TO CHEMICALS	
Chemical	Result
Jet Fuel	Unaffected
Gasoline	Unaffected
Salt Solution	Unaffected
Raw Sewage	Unaffected
Oil	Unaffected
Hydraulic Fluid	Unaffected
Ether Glycol	Unaffected
Acetone	Unaffected

<u>SURFACE PREPARATION</u>	The surface should be clean, dry, and free of materials which may act as bond-breakers such as contaminants, curing compounds, other sealers, or membranes. For specific information on cleaning methods contact the distributor.
<u>MIXING INSTRUCTIONS</u>	Mix and agitate components A and B equally by volume for five minutes. Allow the material to induct for one hour. Thorough mixing and induction time are essential to the performance of this product.
<u>BAKING</u>	N/A
<u>APPLICATION</u>	<p>May be applied with conventional spray, airless spray, or roller. Squeegees and brushes are not recommended. Suggested application rates for different types of concrete are as follows: Hardened Concrete 2 coats (400 ft²/gal each coat) Dusted Concrete 3 to 5 coats (400 ft²/gal each coat)</p> <p>NOTES: · Allow at least 24 hours between coats. · Heavily broomed or heavily swirled concrete finishes may require more material. · Concrete must cure for at least 30 days if it is to be etched with muriatic acid. (Etching will dissolve any "fines" which have been forced to the surface.) After etching, surface must be flushed thoroughly with water.</p>
<u>COVERAGE</u>	N/A
<u>CURE SCHEDULE</u>	Will cure at 72° F in 4 to 6 hours; reaches ultimate properties in 72 hours. Surface may be open to light foot traffic as soon as it is tack-free.
<u>COLORS</u>	N/A
<u>AVAILABILITY</u>	Viking Paints, Inc.

	<p>100 W. 78th St. Richfield, MN 55423 Phone: 612-866-1212 Fax: 612-866-5821 E-mail: vikingpaints@earthlink.net Website: http://www.vikingpaints.com/index.htm</p>				
<p><u>WARRANTY</u></p>	<p>The manufacturer warrants all materials to be free from defects and will replace any material proven to be defective when applied according to our specifications -- at no cost - - within a period of one year. No other warranties are implied or intended.</p>				
<p><u>CAUTIONS</u></p>	<p>N/A</p>				
<p><u>THINNING INSTRUCTIONS</u></p>	<p>N/A</p>				
<p><u>LIMITATIONS</u></p>	<p>Application should be avoided at temperatures less than 40° F. Because the product contains flammable solvents, extra precautions should be taken when used in confined areas by providing adequate ventilation. Never allow open flame, sparks, or electrical equipment in areas where the product is in use.</p>				
<p><u>RELATED PRODUCTS</u></p>	<p>TE-3008-1 - SOLIDS BY WT. 47.4% SOLIDS BY VOLUME: 39.7% TE-3008-2 - SOLIDS BY WT. 35.0% SOLIDS BY VOLUME: 28.7%</p>				
<p><u>TEST DATA</u></p>	<table border="1"> <tr> <td data-bbox="548 1629 906 1780"> Freeze-Thaw Deterioration ASTM C666-71: </td> <td data-bbox="906 1629 1170 1780"> None (17 years), No Scaling </td> </tr> <tr> <td data-bbox="548 1780 906 1923"> Salt and Freeze Thaw Deterioration ASTM </td> <td data-bbox="906 1780 1170 1923"> No Scaling </td> </tr> </table>	Freeze-Thaw Deterioration ASTM C666-71:	None (17 years), No Scaling	Salt and Freeze Thaw Deterioration ASTM	No Scaling
Freeze-Thaw Deterioration ASTM C666-71:	None (17 years), No Scaling				
Salt and Freeze Thaw Deterioration ASTM	No Scaling				

	<table border="1"> <tr> <td data-bbox="527 138 909 231">C672:</td> <td data-bbox="909 138 1177 231"></td> </tr> <tr> <td data-bbox="527 231 909 378">Spill Test Evaluating for Concrete D.O.T. Approved:</td> <td data-bbox="909 231 1177 378">Minnesota, Iowa, Ohio</td> </tr> <tr> <td data-bbox="527 378 909 567">Wear Surface Strength ASTM C501, CS-17 1000g:</td> <td data-bbox="909 378 1177 567">Meet or Exceed (18 times better than no coating)</td> </tr> <tr> <td data-bbox="527 567 909 672">Moisture Absorption Barrier ASTM C140:</td> <td data-bbox="909 567 1177 672">Meet or Exceed</td> </tr> <tr> <td data-bbox="527 672 909 928">Moisture Retention ASTM C156-71: AASHTO Design M-148-2: Fed. Spec. TT-C-00800:</td> <td data-bbox="909 672 1177 928">< 0.55g/sq. cm. Meet or Exceed 0.024g at 60% solids</td> </tr> </table>	C672:		Spill Test Evaluating for Concrete D.O.T. Approved:	Minnesota, Iowa, Ohio	Wear Surface Strength ASTM C501, CS-17 1000g:	Meet or Exceed (18 times better than no coating)	Moisture Absorption Barrier ASTM C140:	Meet or Exceed	Moisture Retention ASTM C156-71: AASHTO Design M-148-2: Fed. Spec. TT-C-00800:	< 0.55g/sq. cm. Meet or Exceed 0.024g at 60% solids
C672:											
Spill Test Evaluating for Concrete D.O.T. Approved:	Minnesota, Iowa, Ohio										
Wear Surface Strength ASTM C501, CS-17 1000g:	Meet or Exceed (18 times better than no coating)										
Moisture Absorption Barrier ASTM C140:	Meet or Exceed										
Moisture Retention ASTM C156-71: AASHTO Design M-148-2: Fed. Spec. TT-C-00800:	< 0.55g/sq. cm. Meet or Exceed 0.024g at 60% solids										
<p><u>PACKAGING</u></p>	<p>Available in kits of two one-gallon containers, two five-gallon containers, and two 55-gallon drums.</p>										

Viking Paints Product Data Sheet

<u>PRODUCT LINE</u>	PAULCO CONSTRUCTION CHEMICALS																									
<u>PRODUCT NAME</u>	PAULCO TE-2501																									
<u>MANUFACTURER</u>	Viking Paints, Inc.																									
<u>DESCRIPTION</u>	PAULCO 2501 is a two-component, very high solids epoxy designed for concrete crack filling. The product is low in toxicity, and has excellent resistance against most acids, alkalis, salts, oils, and other chemicals.																									
<u>BASIC USES</u>	Permanent Crack Filler for Concrete Bridge Decks																									
<u>PHYSICAL DATA</u>	N/A																									
<u>TECHNICAL DATA</u>	<table border="1"> <thead> <tr> <th>Component</th> <th>Part A</th> <th>Part B</th> </tr> </thead> <tbody> <tr> <td>Color</td> <td>Gray or Clear</td> <td>Clear</td> </tr> <tr> <td>Percent solids</td> <td>100%</td> <td>85.63%</td> </tr> <tr> <td>Combined solids</td> <td>92.8%</td> <td></td> </tr> <tr> <td>Viscosity</td> <td>Less than 400 cps</td> <td>Less than 300 cps</td> </tr> <tr> <td>Weight/Gallon</td> <td>9.5 lbs.</td> <td>8.06 lbs.</td> </tr> <tr> <td>Pot Life</td> <td>Up to 30 minutes at 72 degrees F</td> <td>85.63%</td> </tr> <tr> <td>Base</td> <td>Epoxy</td> <td></td> </tr> </tbody> </table>		Component	Part A	Part B	Color	Gray or Clear	Clear	Percent solids	100%	85.63%	Combined solids	92.8%		Viscosity	Less than 400 cps	Less than 300 cps	Weight/Gallon	9.5 lbs.	8.06 lbs.	Pot Life	Up to 30 minutes at 72 degrees F	85.63%	Base	Epoxy	
Component	Part A	Part B																								
Color	Gray or Clear	Clear																								
Percent solids	100%	85.63%																								
Combined solids	92.8%																									
Viscosity	Less than 400 cps	Less than 300 cps																								
Weight/Gallon	9.5 lbs.	8.06 lbs.																								
Pot Life	Up to 30 minutes at 72 degrees F	85.63%																								
Base	Epoxy																									
<u>SURFACE PREPARATION</u>	Surfaces to be treated shall be clean, dry, and free of dirt which may later cut loose. Recommend blowing dirt out of cracks before repairing.																									
<u>MIXING INSTRUCTIONS</u>	TE-2501 is a two-component product, mixed equally (one to one parts by volume). The material should be mixed in small amounts to extend the pot life. Premix Part A (if pigmented Gray) with an electric drill for approximately three minutes. Combine Part A with Part B into one container and mix mechanically for approximately three minutes.																									
<u>BAKING</u>	N/A																									
<u>APPLICATION</u>	Usually by squeezing from large size Ketchup bottle container or it can be poured directly into larger cracks.																									
<u>COVERAGE</u>	N/A																									
<u>CURE SCHEDULE</u>	Pot life: Up to 30 minutes. Cure depends on ambient temperature. Hotter = faster cure. Minimum of 4-hrs.																									

	cure time. Dusting of silica sand over repaired cracks after 3-hrs. may then facilitate opening the bridge to traffic.																
<u>COLORS</u>	N/A																
<u>AVAILABILITY</u>	Viking Paints, Inc. 100 W. 78th St. Richfield, MN 55423 Phone: 612-866-1212 Fax: 612-866-5821 E-mail: vikingpaints@earthlink.net Website: http://www.vikingpaints.com																
<u>WARRANTY</u>	The manufacturer warrants all materials to be free from defects and in accordance with testing procedures noted. We will replace any defective material at no cost within a period of one year, when applied according to our specifications. No other warranties are implied or intended. The manufacturer may also provide a written warranty to qualified contractors or an extended warranty when required by a consulting engineer.																
<u>CAUTIONS</u>	N/A																
<u>THINNING INSTRUCTIONS</u>	N/A																
<u>LIMITATIONS</u>	Avoid application at substrate temperatures of less than 50° F.																
<u>RELATED PRODUCTS</u>	N/A																
<u>TEST DATA</u>	<table border="1"> <tr> <td>Elongation</td> <td>20%-30% (28 days @ 77 degrees F)</td> </tr> <tr> <td>Flexural Strength ASTM C-293 Rainhart Beam</td> <td>2000 PSI</td> </tr> <tr> <td>Compressive Strength</td> <td></td> </tr> <tr> <td>Epoxy Mortar</td> <td>15000 PSI</td> </tr> <tr> <td>Seven Days</td> <td>10000 PSI</td> </tr> <tr> <td>Knoop Hardness</td> <td>Exceeds 5000 PSI at 77° F</td> </tr> <tr> <td>Flexibility (1/8" Mandrel)</td> <td>7.5</td> </tr> <tr> <td>Reverse Impact</td> <td>>20 (in/lbs)</td> </tr> </table> <p>(Tested on 2.0 mils dry film thickness applied on 24 gauge Bonderite steel; cured 7 days at 77° F.)</p>	Elongation	20%-30% (28 days @ 77 degrees F)	Flexural Strength ASTM C-293 Rainhart Beam	2000 PSI	Compressive Strength		Epoxy Mortar	15000 PSI	Seven Days	10000 PSI	Knoop Hardness	Exceeds 5000 PSI at 77° F	Flexibility (1/8" Mandrel)	7.5	Reverse Impact	>20 (in/lbs)
Elongation	20%-30% (28 days @ 77 degrees F)																
Flexural Strength ASTM C-293 Rainhart Beam	2000 PSI																
Compressive Strength																	
Epoxy Mortar	15000 PSI																
Seven Days	10000 PSI																
Knoop Hardness	Exceeds 5000 PSI at 77° F																
Flexibility (1/8" Mandrel)	7.5																
Reverse Impact	>20 (in/lbs)																
<u>PACKAGING</u>	Available in kits of two one-gallon containers, two five-gallon containers, and larger sizes.																

DURAL 50 LM

ULTRA LOW VISCOSITY LOW MODULUS EPOXY

DESCRIPTION

DURAL 50 LM is a 100% solids, two component acrylated epoxy resin formulation designed to penetrate concrete and seal it from the ingress of chlorides and water. DURAL 50 LM heals and seals hairline cracks through its penetration.

PRIMARY APPLICATIONS

- Bridge decks
- Parking decks
- Consolidation of porous and dusting surfaces
- Reduces water absorption
- Reduces chloride penetration
- Pressure injection
- Gravity feed hairline cracks

FEATURES/BENEFITS

- Penetrates cracks by gravity
- Deep penetrating
- Heals and seals concrete
- Strengthens concrete surfaces
- Increases wear resistance
- Significantly reduces chloride intrusion
- Low modulus
- Contractor friendly
- Easy mixing
- Does not contain styrene or peroxides
- Non-flammable
- Moisture tolerant

TECHNICAL INFORMATION

Material Properties @ 75°F (24°C) and 50% RH

Mixing Ratio (A:B) by volume.....2:1

Mixed Viscosity, cps.....80 to 120

Gel Time (200 gms), mins.....45

Tack Free, hours.....3 to 5

Tensile Strength, ASTM D 638, psi (MPa).....800 (5.6)

Tensile Elongation, %.....65 %

Slant Shear, ASTM C 882, 14 days, psi (MPa).....> 2000 (13.8)

Reduction in Chloride Ion Penetration, AASHTO T 260, 90 days

 @ ½" depth, % improvement as compared to control 100%

 @ 1" depth, % improvement as compared to control 100%

Water Absorption, ASTM C 413, 7 days, % improvement..... 89.7%

Abrasion Resistance, ASTM C 779, 7 days

 Abrasion depth @ 30 minutes, % improvement 100%

 Abrasion depth @ 45 minutes, % improvement 92.4%

 Abrasion depth @ 60 minutes, % improvement 90.0%

PACKAGING

DURAL 50 LM is packaged in 3 gal (11.3 L), 15 gal (56.8 L) and 150 gal (568 L) units.

SHELF LIFE

2 years in original, unopened package.



The Euclid Chemical Company

19218 Redwood Rd. • Cleveland, OH 44110

Phone: [216] 531-9222 • Toll-free: [800] 321-7628 • Fax: [216] 531-9596

www.euclidchemical.com

An **RPM** Company



COVERAGE

Slab Sealing: 100 to 200 ft²/gal (2.45 to 4.91 m²/L) for the first coat (typical concrete surface). 150 to 300 ft²/gal (3.68 to 7.36 m²/L) for a second coat in cases of extensive cracking or high porosity. **Crack Grouting:** Coverage will be determined by depth and length of cracks.

Note: Coverage rates are approximate and for estimating purposes only. Surface temperature, texture and porosity will determine actual material requirements.

DIRECTIONS FOR USE

Surface Preparation: Concrete must be structurally sound, clean, dry and free of laitance, dust, dirt, oil, coatings, form release agents and other contaminants. The preferred method of surface preparation is mechanical abrasion. Remove defective concrete, honeycombs, cavities, joint crack voids and other defects by routing to sound material. Rebuild areas with suitable patching materials. Smooth, pre-cast and formed concrete surfaces must be cleaned, roughened and made absorptive by mechanical abrasion. Surface profile should be equal to CSP 2-5 in accordance with ICRI Guideline 310.2 at a minimum. Blow debris and residue out of cracks and from the surface with a moisture-free and oil-free air jet. Mask expansion joint sealants to prevent adhesion of DURAL 50 LM to the joint surface. Surfaces and cracks must be completely dry before DURAL 50 LM application to obtain penetration. For further information contact your local Euclid Chemical representative.

Mixing: Premix Part A and Part B. Combine 2 parts by volume of Part A with 1 part by volume of Part B. Mix thoroughly with a slow speed motor and mixing blade. A ½" (13 mm) drill and "Jiffy" mixer is acceptable. Do not aerate mixture.

Application: Sealing concrete slabs: Pour or pump mixed DURAL 50 LM onto the prepared surface in a wave form and spread uniformly with a short nap roller or squeegee to fill voids, cracks and porous areas. Allow resin to penetrate into the surface and reapply to cracks and porous areas if necessary. Before the resin becomes tacky, use a squeegee on a smooth surface and a broom on a textured or tined surface to remove any excess resin that has not penetrated the surface. Broadcast clean, oven-dried silica sand into the still wet resin to provide a skid resistant surface or where subsequent toppings or coating will be applied. Apply the silica sand at an approximate rate of 0.2 to 0.8 lbs/yd² (0.10 to 0.43 kg/m²) and/or until there are no wet spots, not earlier than 20 minutes after application of DURAL 50 LM [at 75°F (24°C)], but before the DURAL 50 LM becomes tack free. Ensure that subsequent coatings or toppings are applied within the recoat window of the DURAL 50 LM [a 24 hour recoat window at 75°F (24°C)]. Before opening to traffic remove any loose aggregate and verify that the skid resistant properties are adequate for the intended purpose of the deck.

Grouting cracks: Gravity feed: Pour neat mixed DURAL 50 LM into vee-notched cracks until completely filled.

Pressure injection: Set appropriate injection ports depending on the system used. Seal around port and surface crack using Duralcrete Gel or Dural Fast Set Epoxy Gel. Inject neat resin using automated or manual injection equipment. Maintain slow steady pressure until the crack is filled with the injection resin.

CLEAN-UP

Clean tools and equipment immediately following use with acetone or methyl ethyl ketone. Clean drips and over spray while still wet with the same solvent. Cured DURAL 50 LM will require mechanical abrasion for removal.

PRECAUTIONS/LIMITATIONS

- Store at temperatures between 50°F to 90°F (10°C to 32°C).
- Protect from moisture.
- Do not store below 50°F (10°C).
- Do not mix or apply DURAL 50 LM at temperatures below 50°F (10°C) or when rain is expected within 12 hours after application.
- Multiple applications of DURAL 50 LM must be within 24 hours of the preceding application.
- DURAL 50 LM is not intended for sealing cracks under hydrostatic pressure.
- Apply only to dry concrete and to concrete which has cured for at least 28 days.
- In all cases, consult the Material Safety Data Sheet before use.

Rev. 05.11

WARRANTY: The Euclid Chemical Company ("Euclid") solely and expressly warrants that its products shall be free from defects in materials and workmanship for one (1) year from the date of purchase. Unless authorized in writing by an officer of Euclid, no other representations or statements made by Euclid or its representatives, in writing or orally, shall alter this warranty. EUCLID MAKES NO WARRANTIES, IMPLIED OR OTHERWISE, AS TO THE MERCHANTABILITY OR FITNESS FOR ORDINARY OR PARTICULAR PURPOSES OF ITS PRODUCTS AND EXCLUDES THE SAME. If any Euclid product fails to conform with this warranty, Euclid will replace the product at no cost to Buyer. Replacement of any product shall be the sole and exclusive remedy available and buyer shall have no claim for incidental or consequential damages. Any warranty claim must be made within one (1) year from the date of the claimed breach. Euclid does not authorize anyone on its behalf to make any written or oral statements which in any way alter Euclid's installation information or instructions in its product literature or on its packaging labels. Any installation of Euclid products which fails to conform with such installation information or instructions shall void this warranty. Product demonstrations, if any, are done for illustrative purposes only and do not constitute a warranty or warranty alteration of any kind. Buyer shall be solely responsible for determining the suitability of Euclid's products for the Buyer's intended purposes.

High Molecular Weight Methacrylate (HMWM) Crack Sealer Sealate™ (T-70 and T-70 MX-30)

Sealate™ is a specially formulated, high molecular weight methacrylate resin system that is highly effective for sealing and filling cracks in concrete structures.

Application Procedure

Surface Preparation: It is strongly recommended that all concrete surfaces that are to receive Sealate™ be thoroughly clean and sound. Remove all surface dirt, grease, paint, rust, and other contaminants by sandblasting, shot-blasting or mechanical abrasion. The concrete surface should be visibly dry and the moisture content in the concrete should be tested according to ASTM D 4263. The temperature of the deck and air should be between 50°F and 100°F prior to resin application.

Mixing: The following table lists the mixing ratios of the two curing agents. Add the appropriate amount of Cobalt Napthenate promoter to Sealate™ resin and stir well. Then add the corresponding amount of CHP initiator, stir again for 1-2 minutes. If machine applied, the resin should be mixed utilizing a two component resin system using promoted resin for one part and initiated resin for the other part. Mixing ratio of promoted/initiated resin should be 1:1. The mixed resin should be applied to the concrete surface within 5 minutes of complete mixing.

Sealate™	Cobalt Napthenate (ml)	CHP (ml)
1 gallon	75	150
5 gallon	375	750

CAUTION: Never mix CHP initiator with Cobalt promoter. Violent reaction will result!

Application: The rate of application of promoted/initiated resin should be approximately 100-150 square feet per gallon. However, this will vary depending on the surface, porosity, size, and quantity of cracks present in the area being treated.

Spray equipment, if used, should be airless, generating sufficient pressure to atomize mixed resins. If hand applied, the concrete surface should be flooded with the resin, allowing sufficient time for penetration into the surface and complete filling of all cracks. Excess material should be redistributed using squeegees or brooms within 15 minutes after application. The quantity of initiated/promoted resin mixed at one time should be limited to 5 gallons for manual application.

Broadcasting of Aggregate: Broadcast sand should be applied to the entire treated area prior to cure, typically at 1-2 pounds per square yard. The sand used should be 12 x 16 mesh, #2 or #3 blasting sand, and should have a maximum moisture content no greater than 0.5%. It should be placed within 15-20 minutes of the resin application and before any setting of monomer occurs. Traffic can be restored once the concrete surface is cured tack-free.

Ambient Temperature	Approximate Cure Time	
	T-70	T-70 MX-30
50° F – 70° F	7 – 12 hrs.	8 – 16 hrs.
70° F – 100° F	4 – 7 hrs.	5 – 8 hrs.

*Cure times are approximate and will vary with ambient and deck temperature, humidity, and sunlight. Structures can be opened to traffic only after complete cure is achieved.

Properties*

Property	Results		Test Method
	T-70	T-70 MX-30	
Appearance	Amber Liquid	Amber Liquid	
Viscosity	15 – 25 cps (MPa-sec)	10 – 25 cps (MPa-sec)	ASTM D2395
Density	8.4 – 8.6 lb/gal (1.01 – 1.03 g/mL)	8.1 – 8.5 lb/gal (0.97 – 1.02 g/mL)	ASTM D1425
Gel Time/Pot Life (@ 70 °F)	35 – 40 min	50 – 60 min	AASHTO T237
Tack Free Time (@ 70 °F)	4 – 7 hrs.	6 – 8 hrs.	AASHTO T237
Flash Point	>210°F (>98.9°C)	>200°F (>93°C)	ASTM D1310/ASTM D93
Solids Content	100%	100%	ASTM D1644
Tensile Strength	1,600 psi (>11.0 MPa)	>500 psi (>3.4 MPa)	ASTM D638
PCC-SSD Bond Strength	>615 psi (>4.2 MPa)	>615 psi (>4.2 MPa)	CA Test 551
Tensile Elongation	1 – 5%	>30%	ASTM D638
Compressive Strength (24 hrs)	>8,150 psi (56.2 MPa)	>3,500 psi (>24.1 MPa)	ASTM C3986/ASTM D695
Volatile Content	24 – 25%	40 – 45%	ASTM D2369
Slant Shear Bond Strength	>1,500 psi (>10.3 MPa)	>1,500 psi (>10.3 MPa)	ASTM C882

Packaging

Sealate™ comes in 1, 5 and 55- gallon containers. The initiator, Cumene Hydroperoxide (CHP) and the Cobalt Napthenate promoter are provided in separate labeled containers and in pre-measured quantities to make scale mixes of Sealate™.

Storage

Sealate™ should be stored in tightly sealed containers in a dry location and at normal room temperatures (50°F - 85°F). The initiator, Cumene Hydroperoxide (CHP) and the Cobalt Napthenate promoter are provided in separate labeled containers, and should be stored in a cool shaded area separately from each other and away from the monomer.

Caution

Direct contact with Sealate™ may produce minor skin irritations to persons prone to such reactions. It is recommended that all persons involved in mixing and application wear protective clothing such as goggles, rubber boots, and rubber gloves. As with all chemicals, read MSDS prior to use.

Warranty

The following warranty is made in lieu of all other warranties, either expressed or implied. This product is manufactured of selected raw materials by skilled technicians. Neither seller nor manufacturer has any knowledge or control concerning the purchaser's use of product and no warranty is made as to the results of any use. The only obligation of either seller or manufacturer shall be to replace any quantity of this product that proves to be defective. Neither seller nor manufacturer assumes any liability for injury, loss or damage resulting from use of this product.

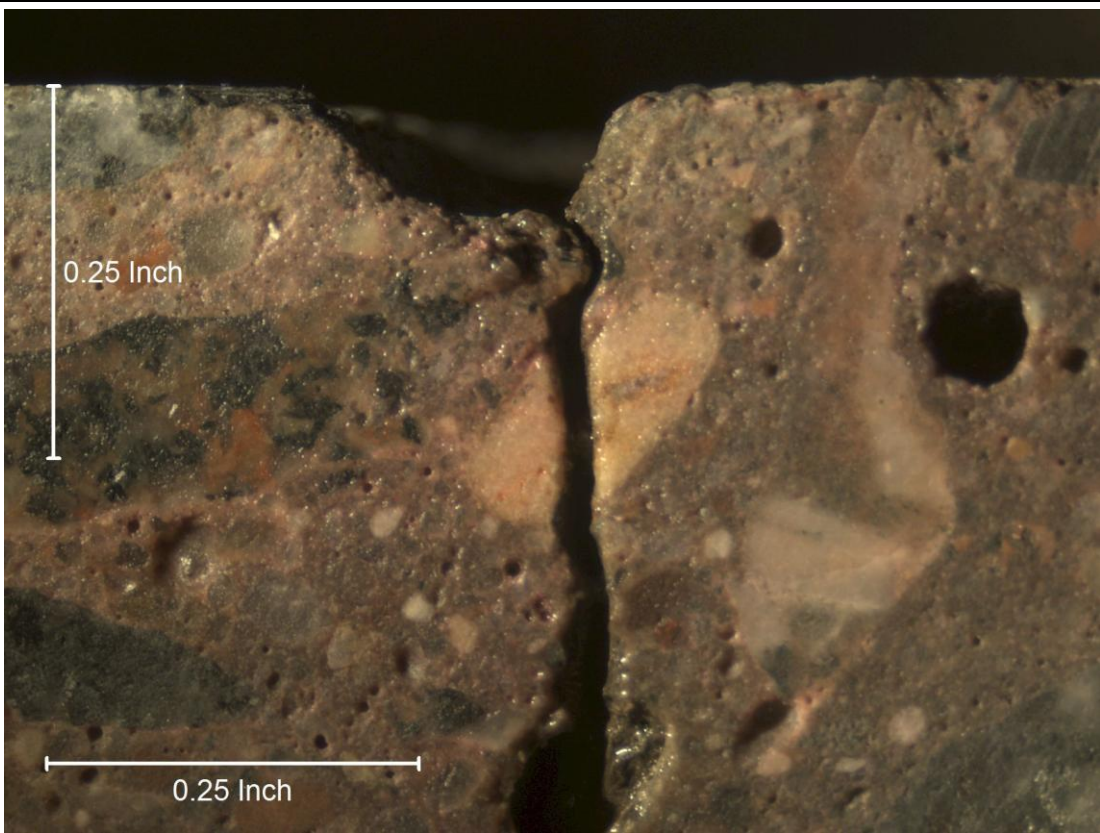
APPENDIX 6 – Petrographic Photo Log



Core #: 1A
Subject: Test Section 1, Test 1A - Accuflex Coatings, Gel Seal
Location: Smith Avenue High Bridge
Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

Project BL-09-03973

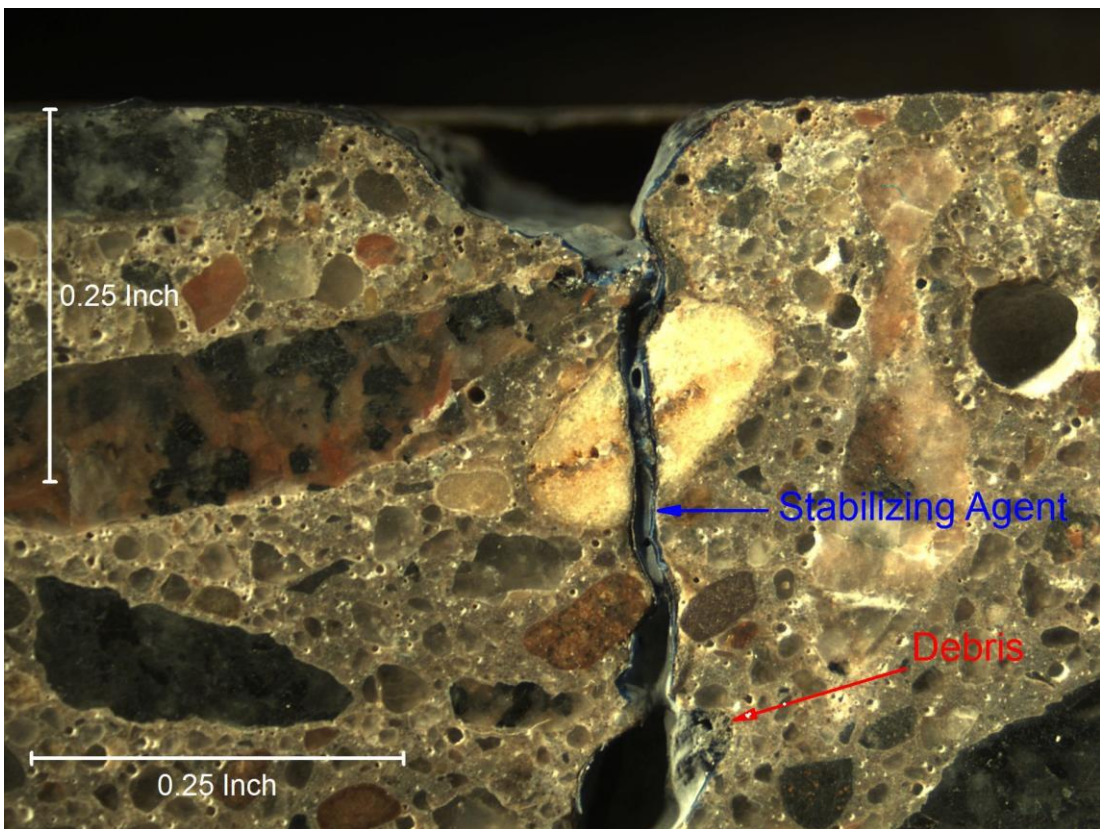
BRAUN
INTERTEC



Core #: 1A
Subject: Test Section 1, Test 1A - Accuflex Coatings, Gel Seal
Notes: Depth of Maximum Penetration is 0.000 in.

Project BL-09-03973

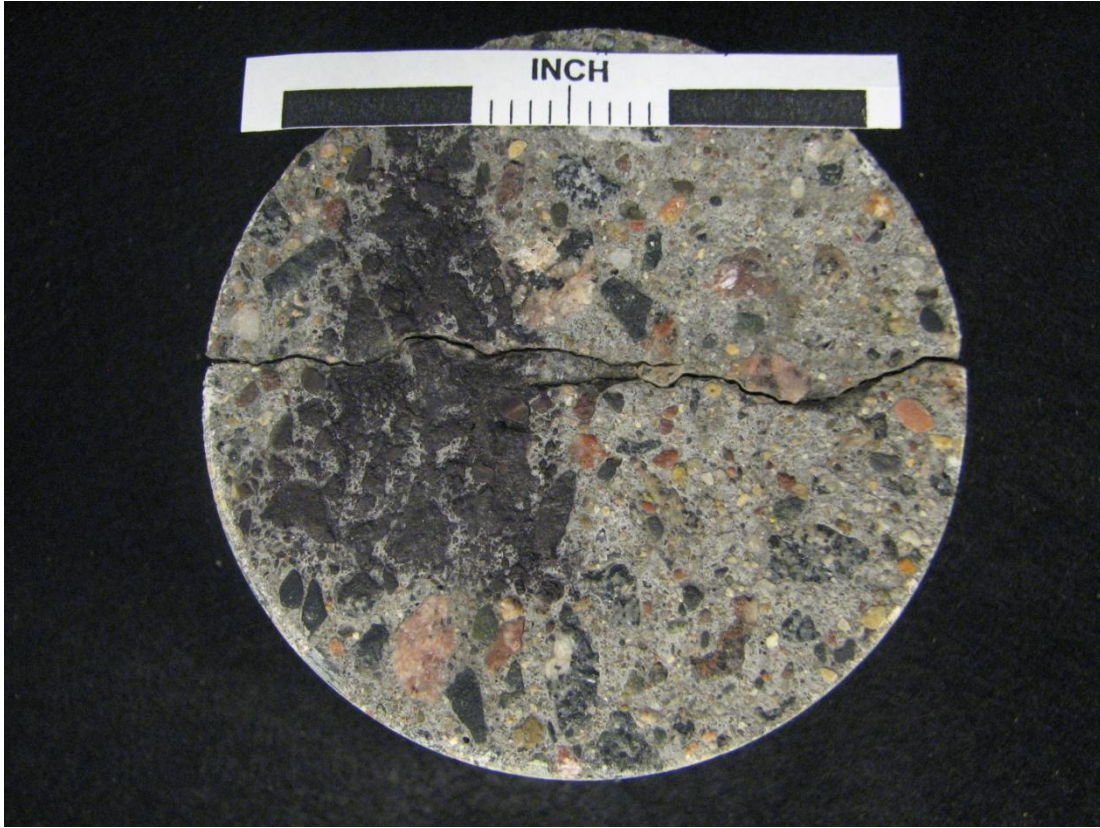
BRAUN
INTERTEC



Core #: 1A
Subject: Test Section 1, Test 2A - Accuflex Coatings, Gel Seal
Comments: Depth of Maximum Penetration is 0.000 in.

Project BL-09-03973

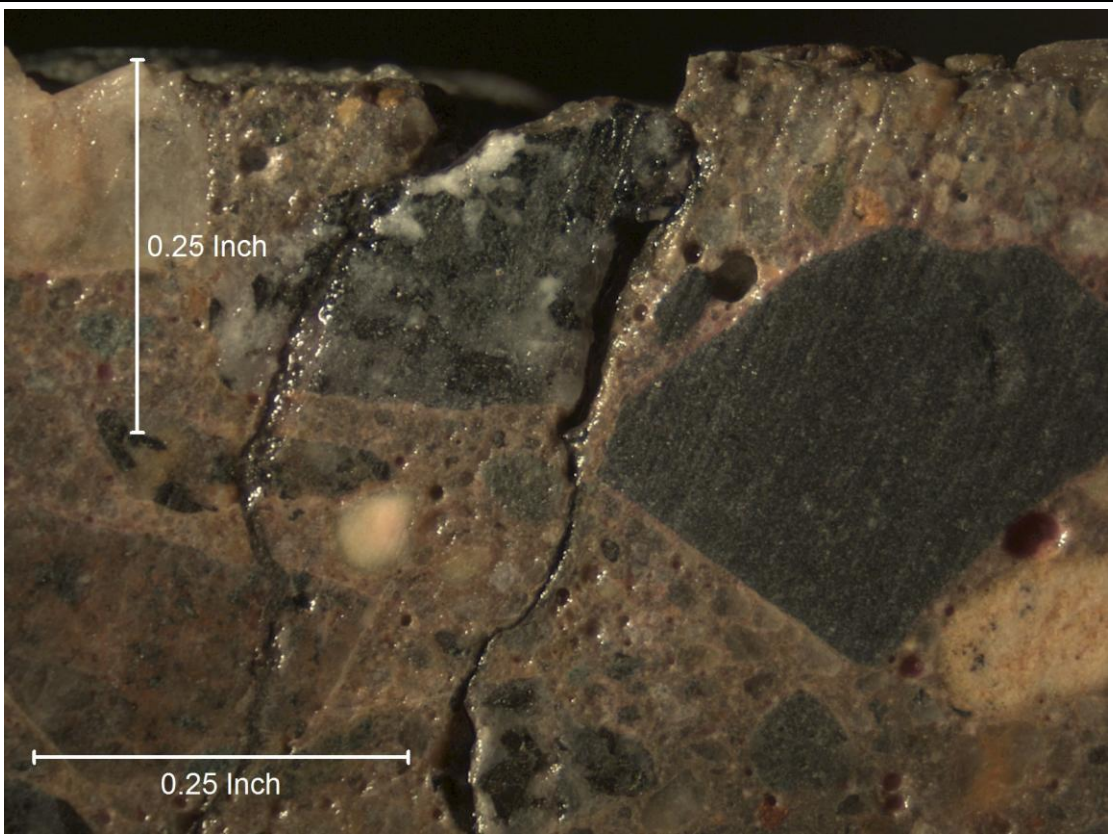
BRAUN
INTERTEC



Core #: 2A
Subject: Test Section 1, Test 2A - Accuflex Coatings, Gel Seal
Location: Smith Avenue High Bridge
Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

Project BL-09-03973

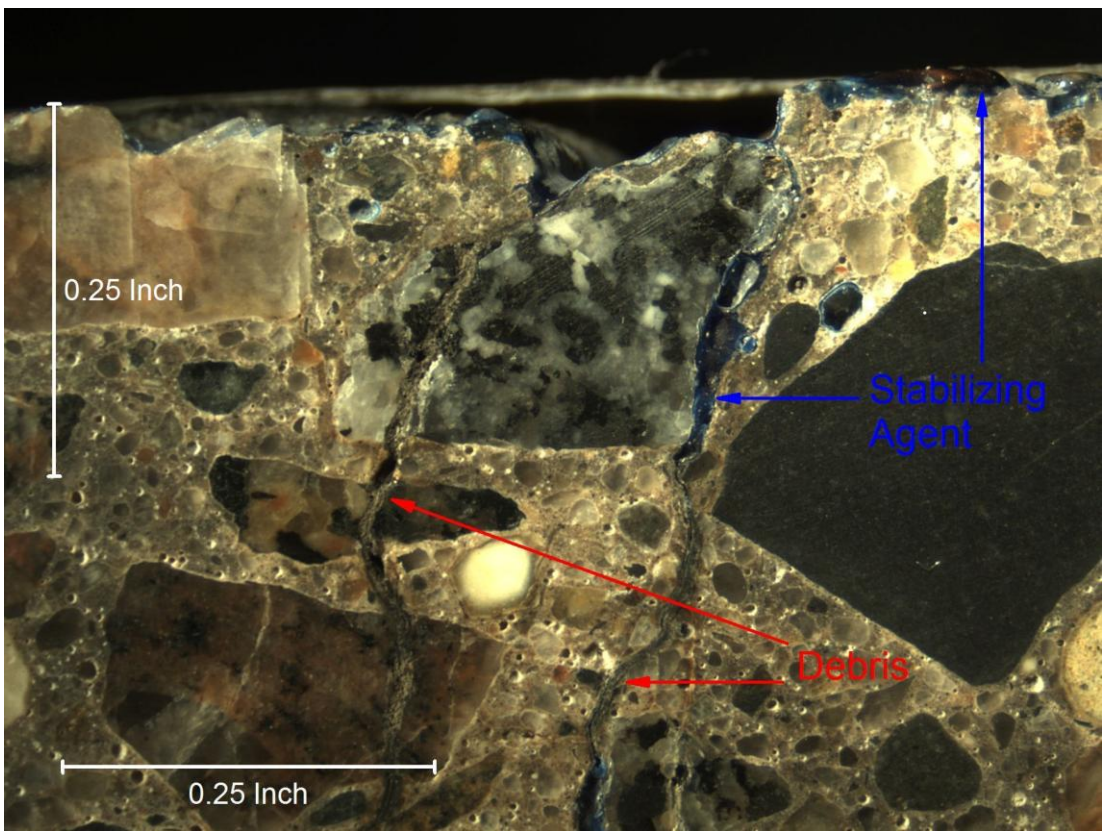
BRAUN
INTERTEC



Core #: 2A
 Subject: Test Section 1, Test 2A - Accuflex Coatings, Gel Seal
 Notes: Depth of Maximum Penetration is 0.000 in.

Project BL-09-03973

BRAUN
 INTERTEC



Core #: 2A
 Subject: Test Section 1, Test 2A - Accuflex Coatings, Gel Seal
 Comments: Depth of Maximum Penetration is 0.000 in.

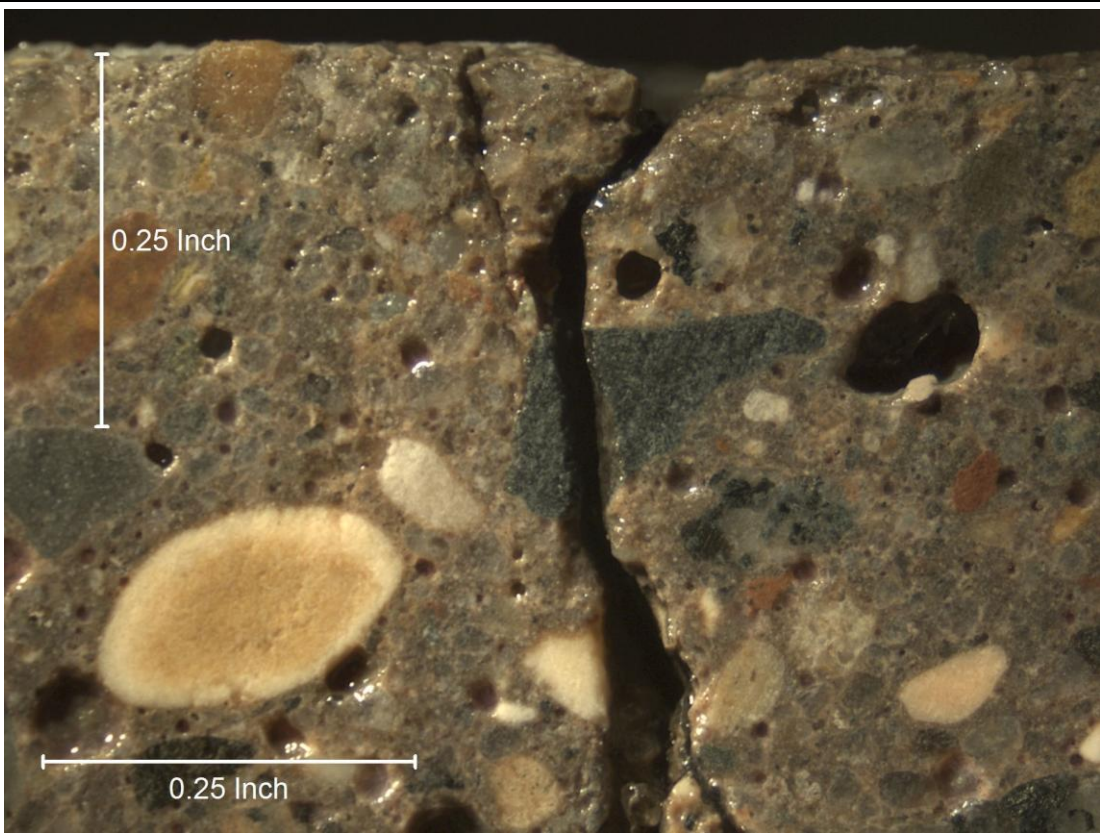
Project BL-09-03973

BRAUN
 INTERTEC



Core #:	4B	Project BL-09-03973
Subject:	Test Section 2, Test 4B – Control	
Location:	Smith Avenue High Bridge	
Notes:	Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.	

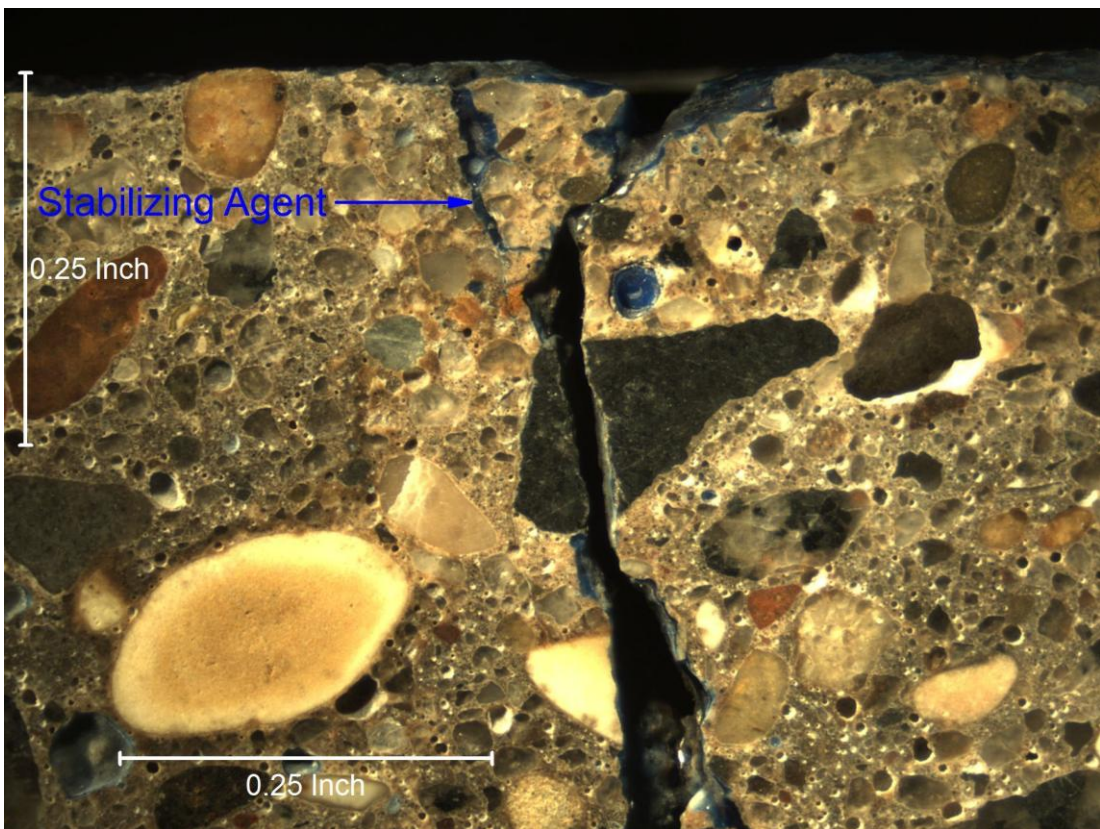




Core #: 4B
Subject: Test Section 2, Test 4B – Control
Notes: Depth of Maximum Penetration is 0.000 in.

Project BL-09-03973

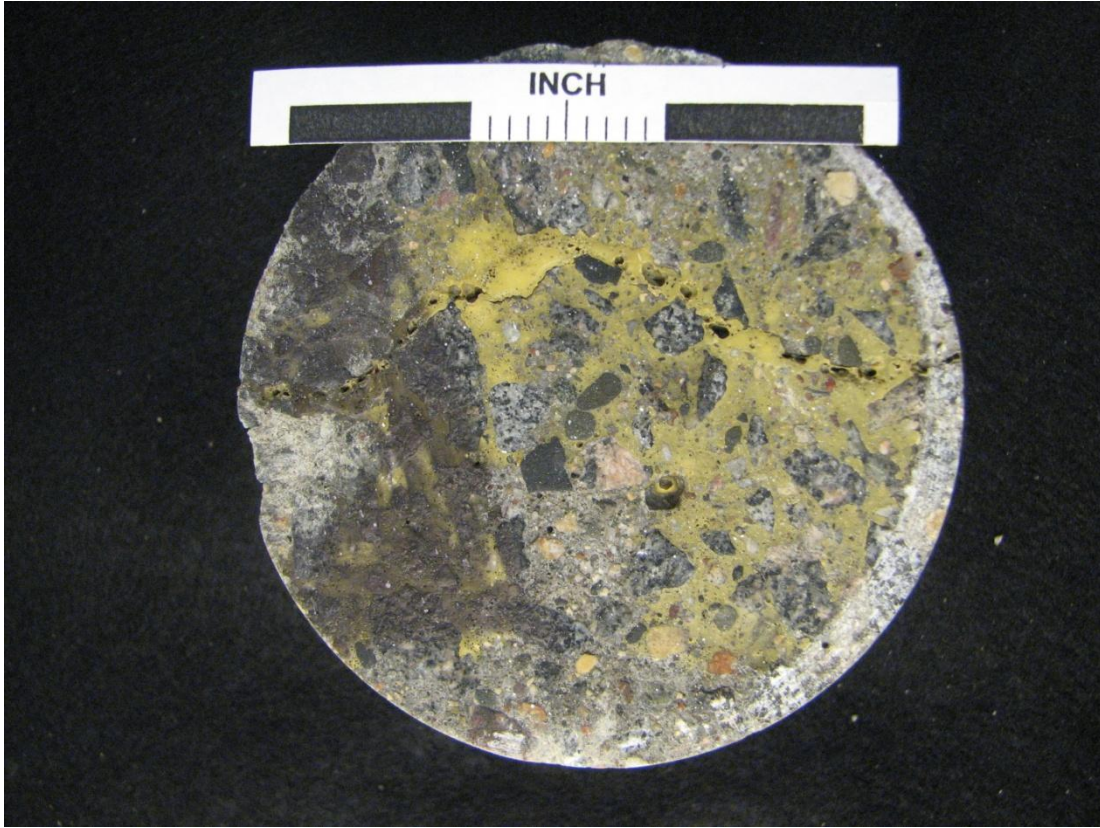
BRAUN
INTERTEC



Core #: 4B
Subject: Test Section 2, Test 4B – Control
Comments: Depth of Maximum Penetration is 0.000 in.

Project BL-09-03973

BRAUN
INTERTEC

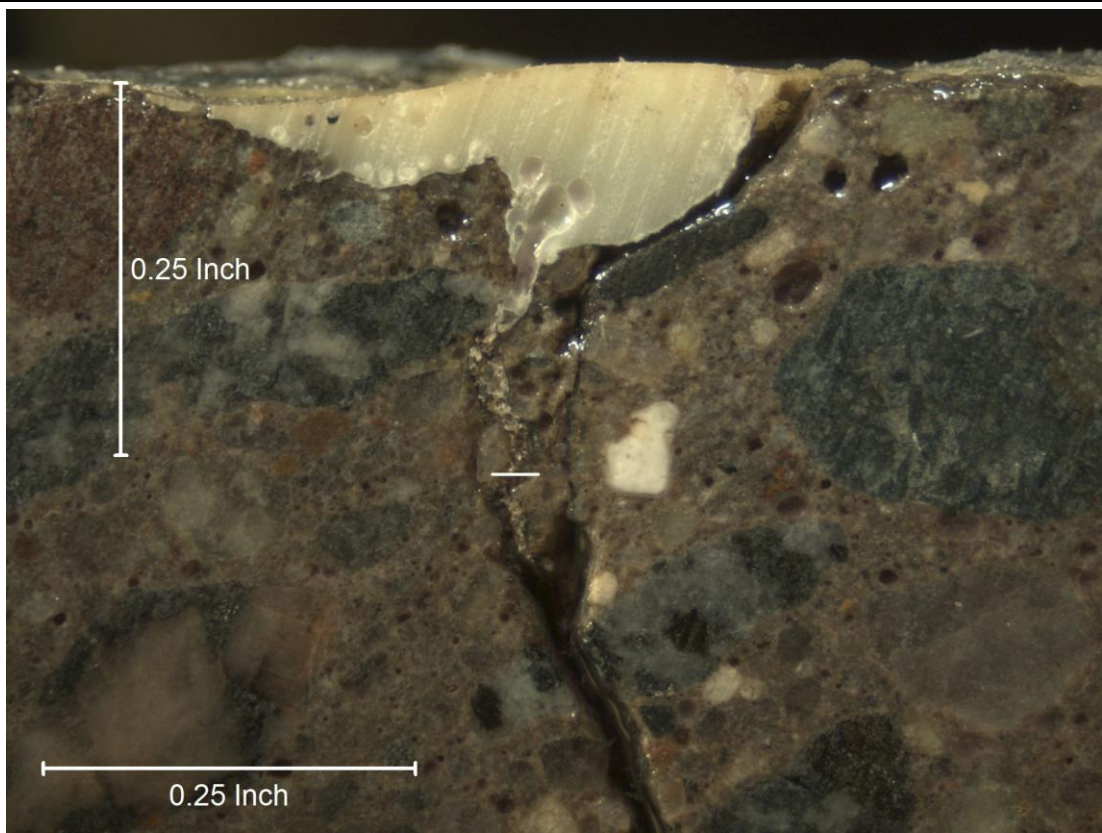


Core #: 7B
Subject: Test Section 3, Test 7B - TK-9030
Location: Smith Avenue High Bridge

Project BL-09-03973

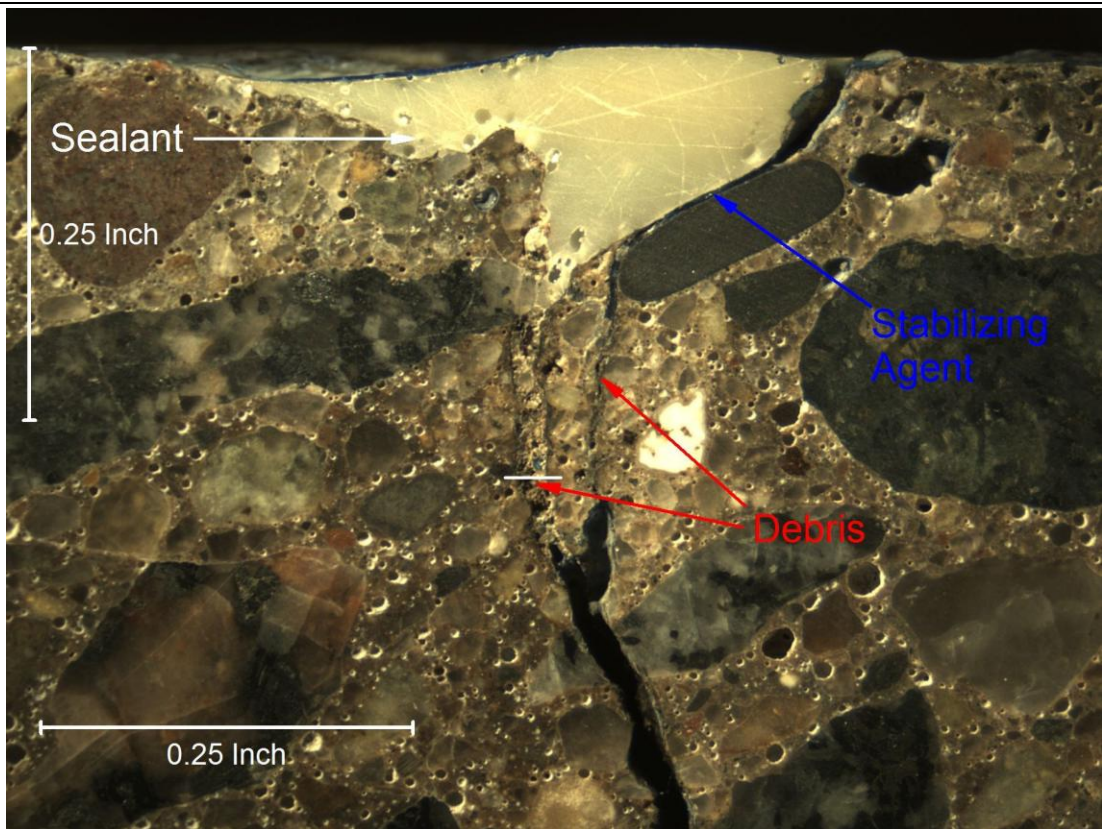
Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

BRAUN
INTERTEC



Core #: 7B
 Subject: Test Section 3, Test 7B - TK-9030
 Notes: Depth of Maximum Penetration is 0.274 in. White horizontal line marks the approx. depth of sealant.

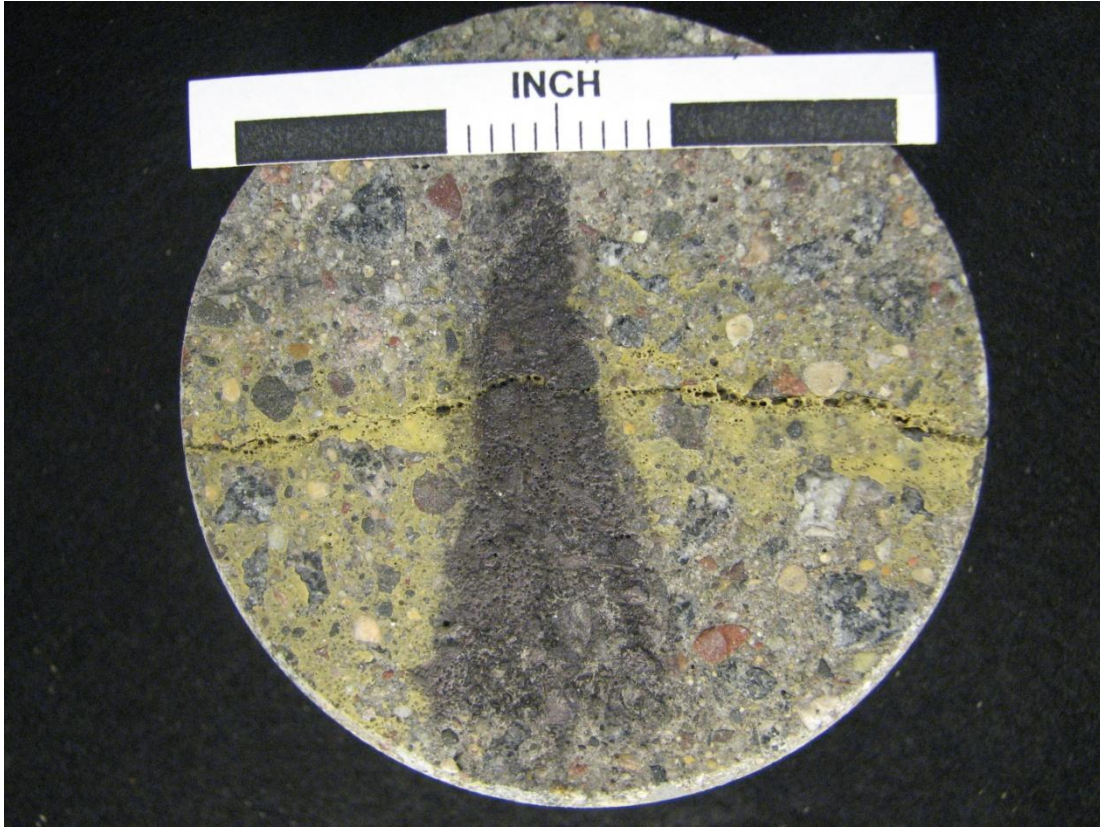
Project BL-09-03973



Core #: 7B
 Subject: Test Section 3, Test 7B - TK-9030
 Comments: Depth of Maximum Penetration is 0.302 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973



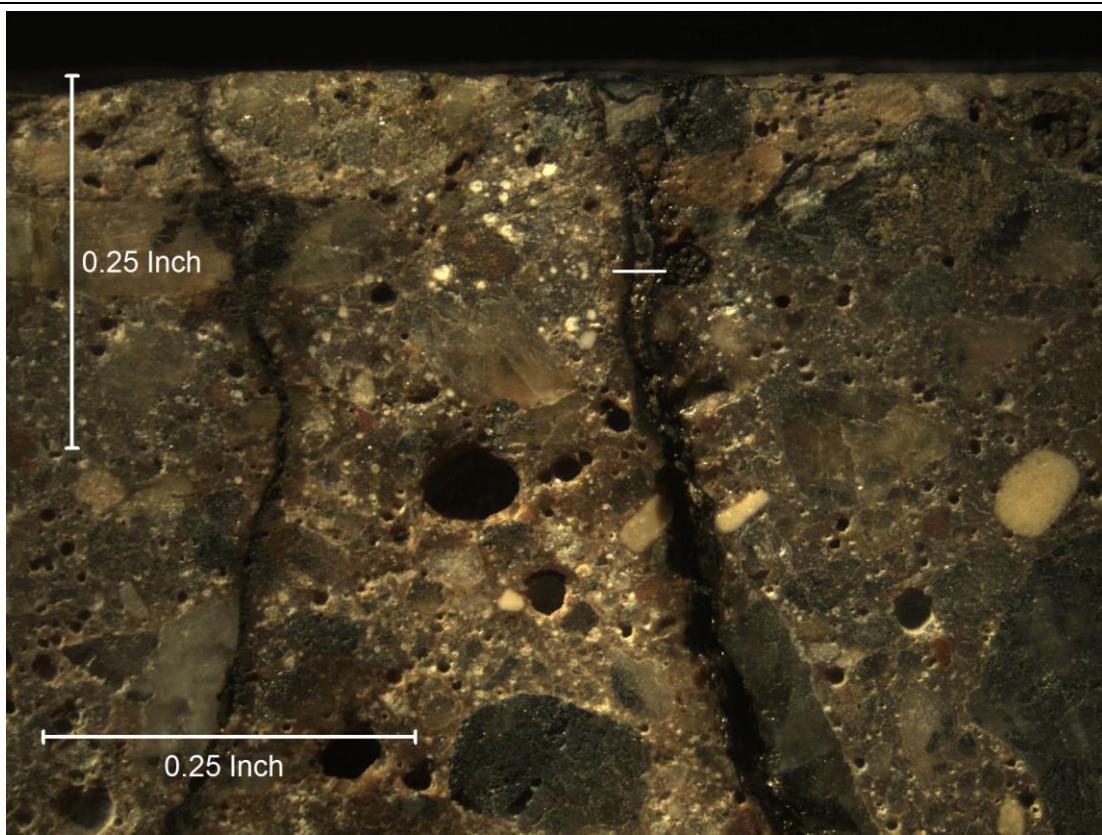


Core #: 8A
Subject: Test Section 3, Test 8A - TK-9030
Location: Smith Avenue High Bridge

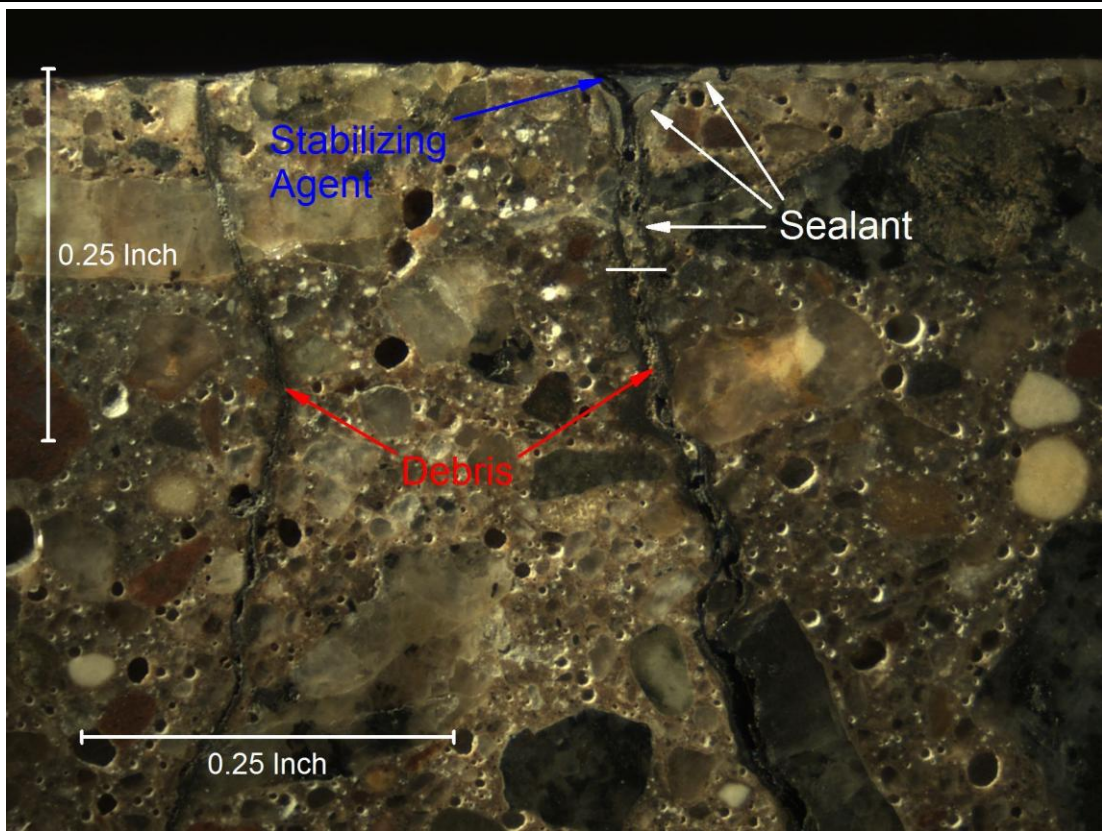
Project BL-09-03973

Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

BRAUN
INTERTEC



Core #: 8A Project BL-09-03973
 Subject: Test Section 3, Test 8A - TK-9030
 Notes: Depth of Maximum Penetration is 0.134 in. White horizontal line marks the approx. depth of sealant.



Core #: 8A Project BL-09-03973
 Subject: Test Section 3, Test 8A - TK-9030
 Comments: Depth of Maximum Penetration is 0.136 in. White horizontal line marks the approx. depth of sealant.





Core #:

9A

Project BL-09-03973

Subject:

Test Section 4, Test 9A - TK-2110

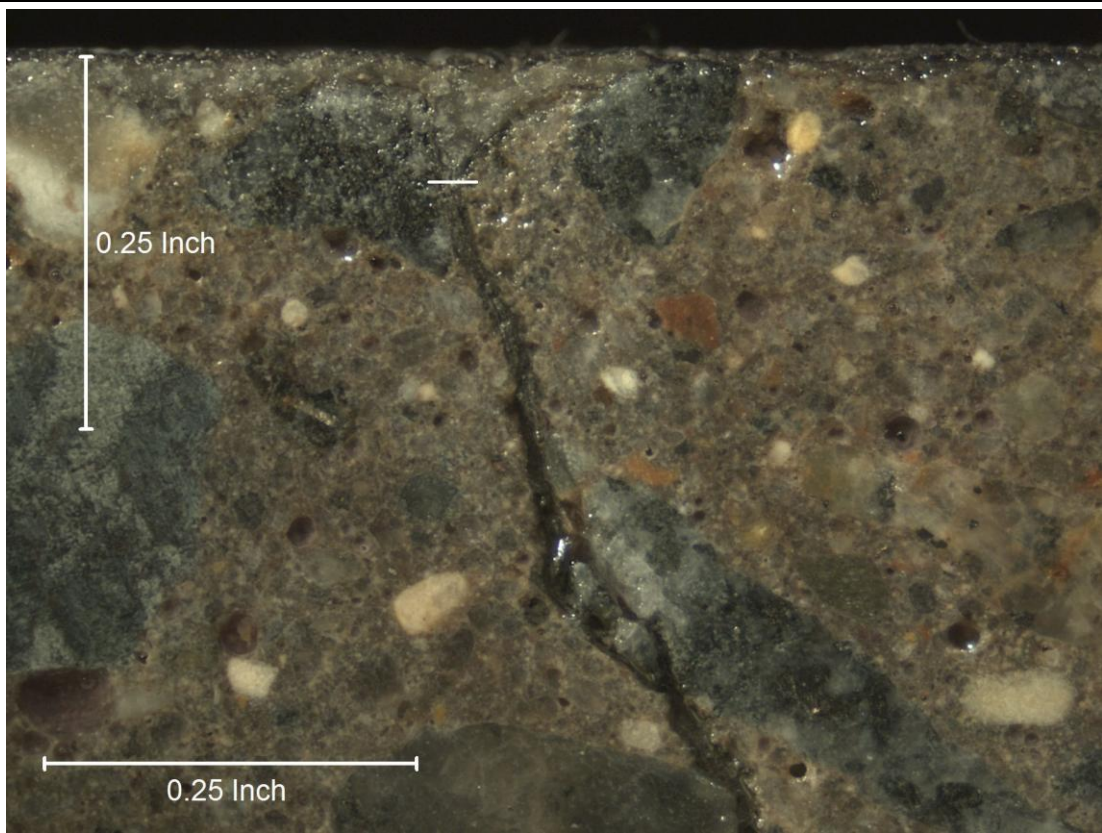
Location:

Smith Avenue High Bridge

Notes:

Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

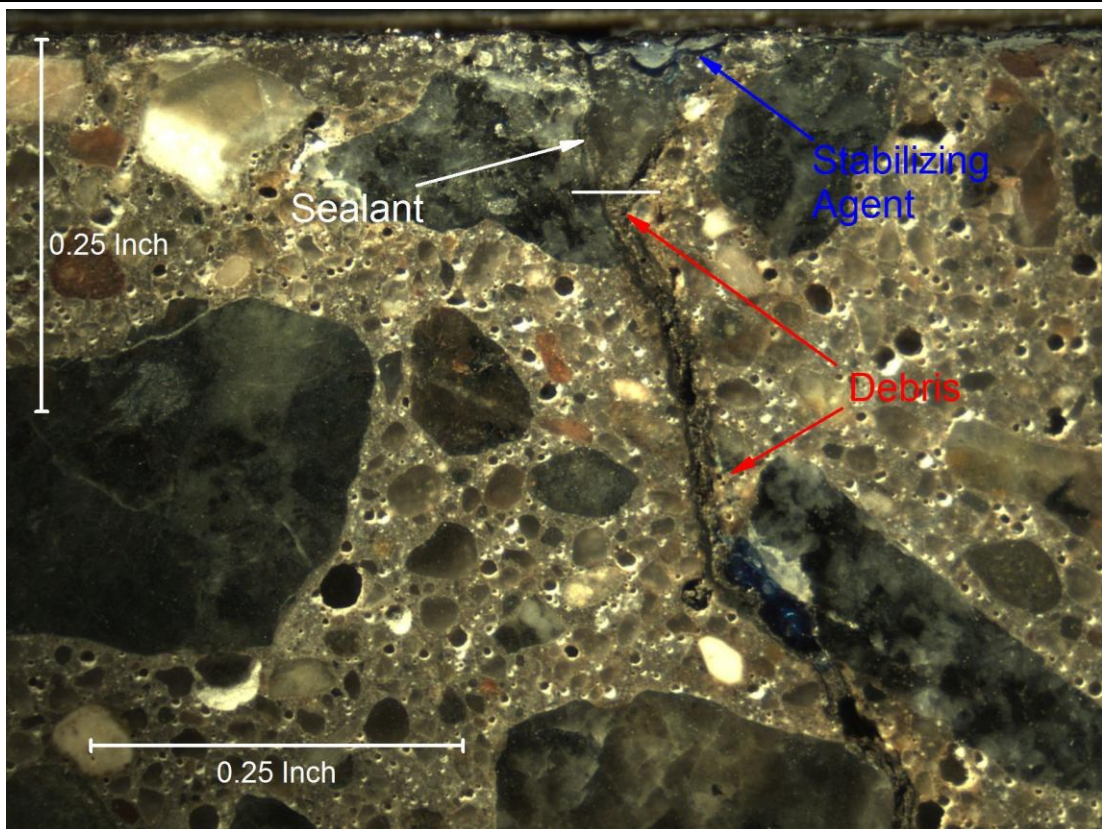
BRAUN
INTERTEC



Core #: 9A
 Subject: Test Section 4, Test 9A - TK-2110
 Notes: Depth of Maximum Penetration is 0.092 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973

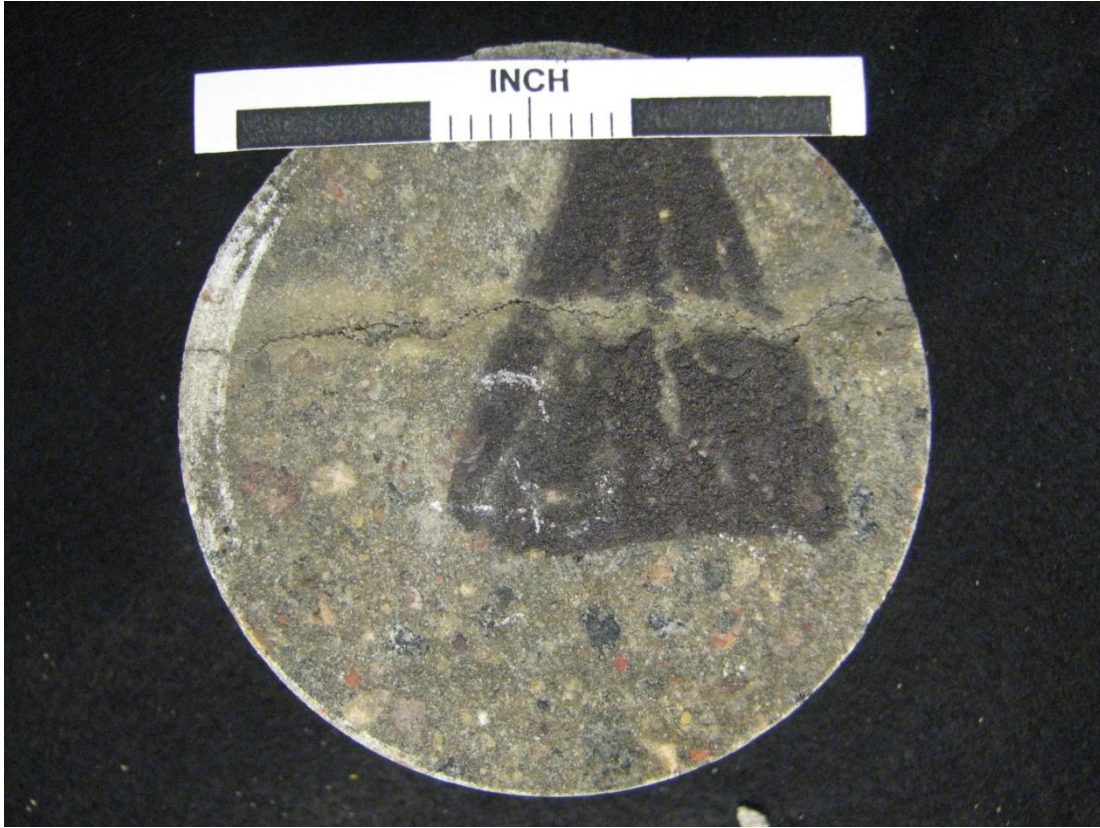
BRAUN
 INTERTEC



Core #: 9A
 Subject: Test Section 4, Test 9A - TK-2110
 Comments: Depth of Maximum Penetration is 0.118 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973

BRAUN
 INTERTEC



Core #: 10B

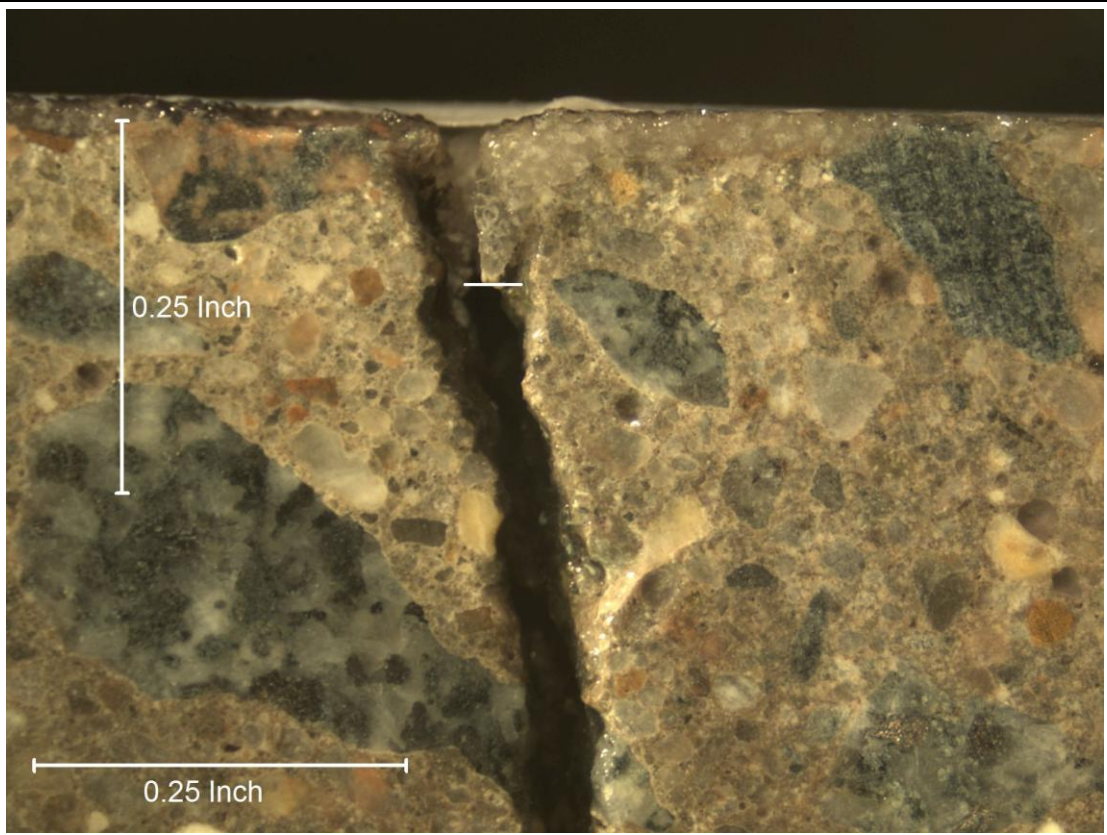
Subject: Test Section 4, Test 10B - TK-2110

Location: Smith Avenue High Bridge

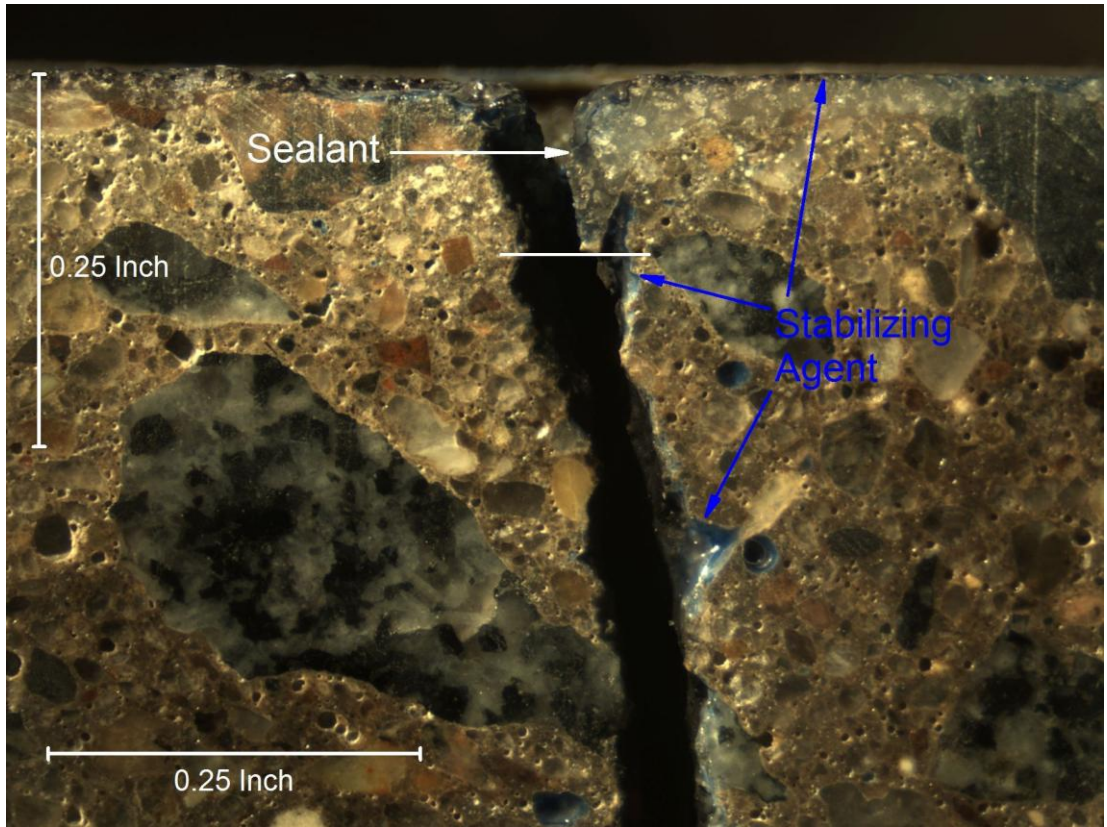
Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

Project BL-09-03973

BRAUN
INTERTEC



Core #:	10B	Project BL-09-03973
Subject:	Test Section 4, Test 10B - TK-2110	BRAUN INTERTEC
Notes:	Depth of Maximum Penetration is 0.117 in. White horizontal line marks the approx. depth of sealant.	



Core #:	10B	Project BL-09-03973
Subject:	Test Section 4, Test 10B - TK-2110	BRAUN INTERTEC
Comments:	Depth of Maximum Penetration is 0.122 in. White horizontal line marks the approx. depth of sealant.	



Core #: 11A

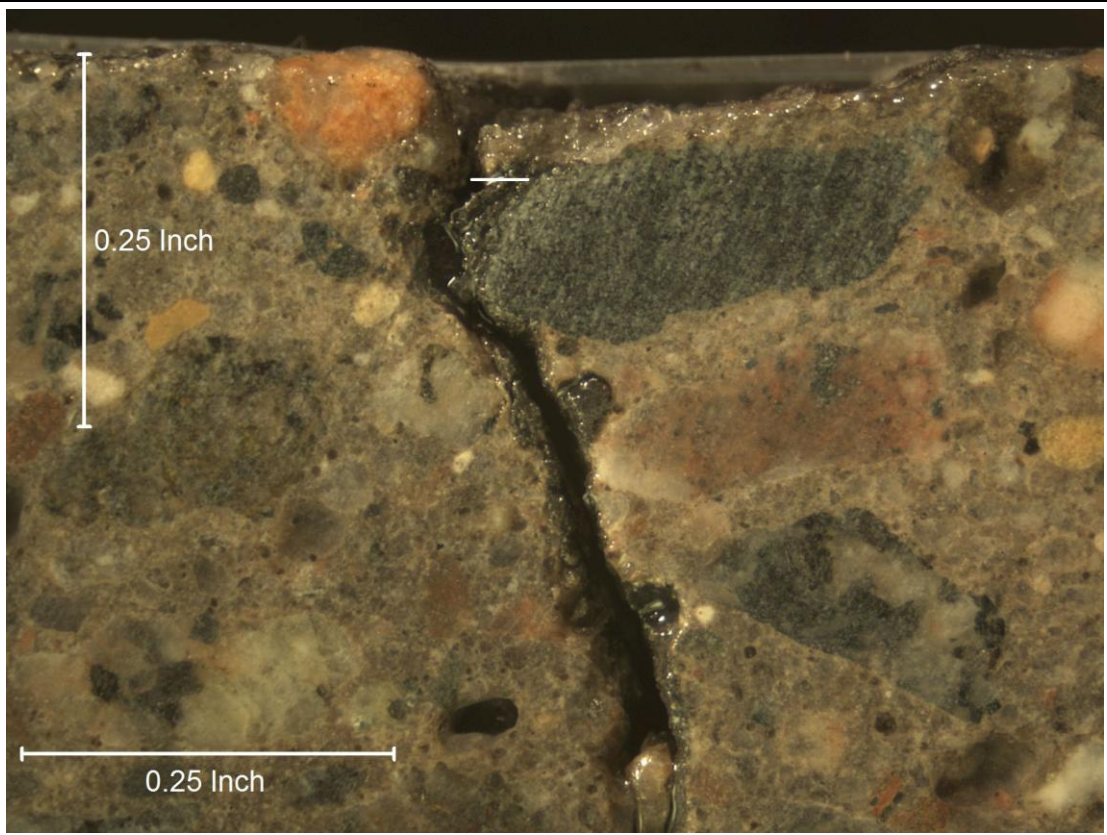
Subject: Test Section 5, Test 11A - TK-2414


Location: Smith Avenue High Bridge

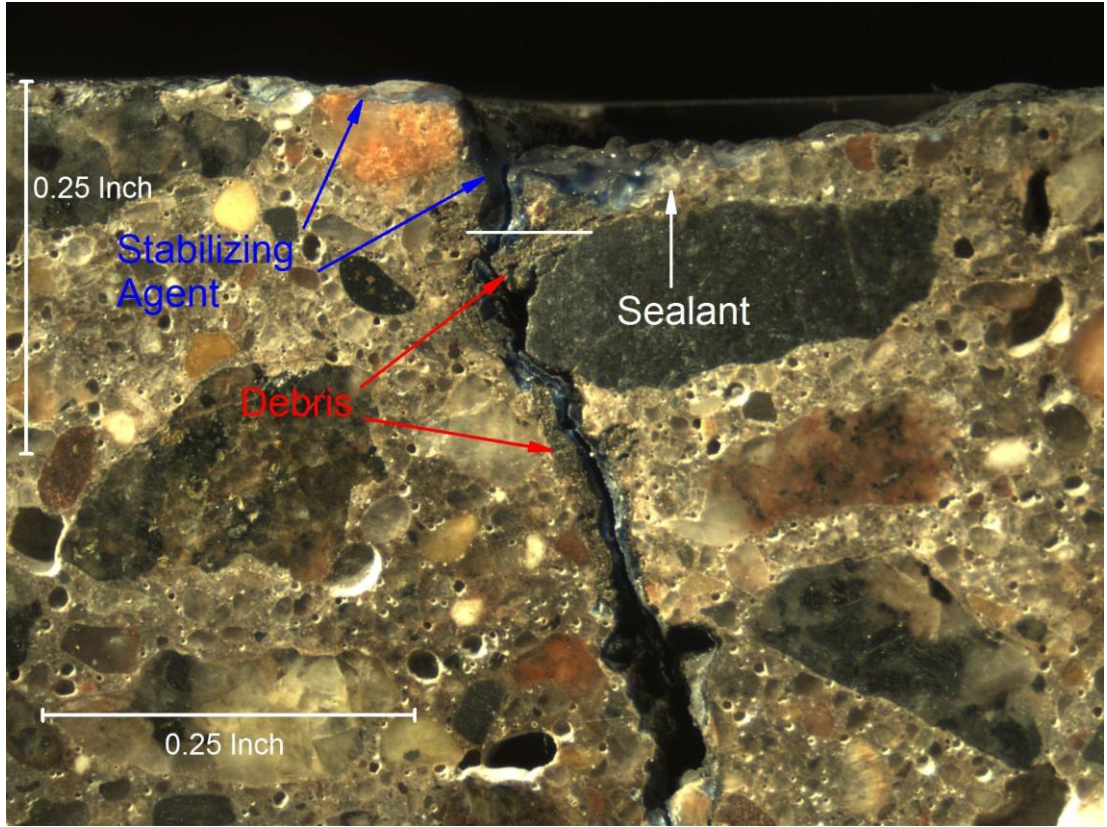
Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.


Project BL-09-03973

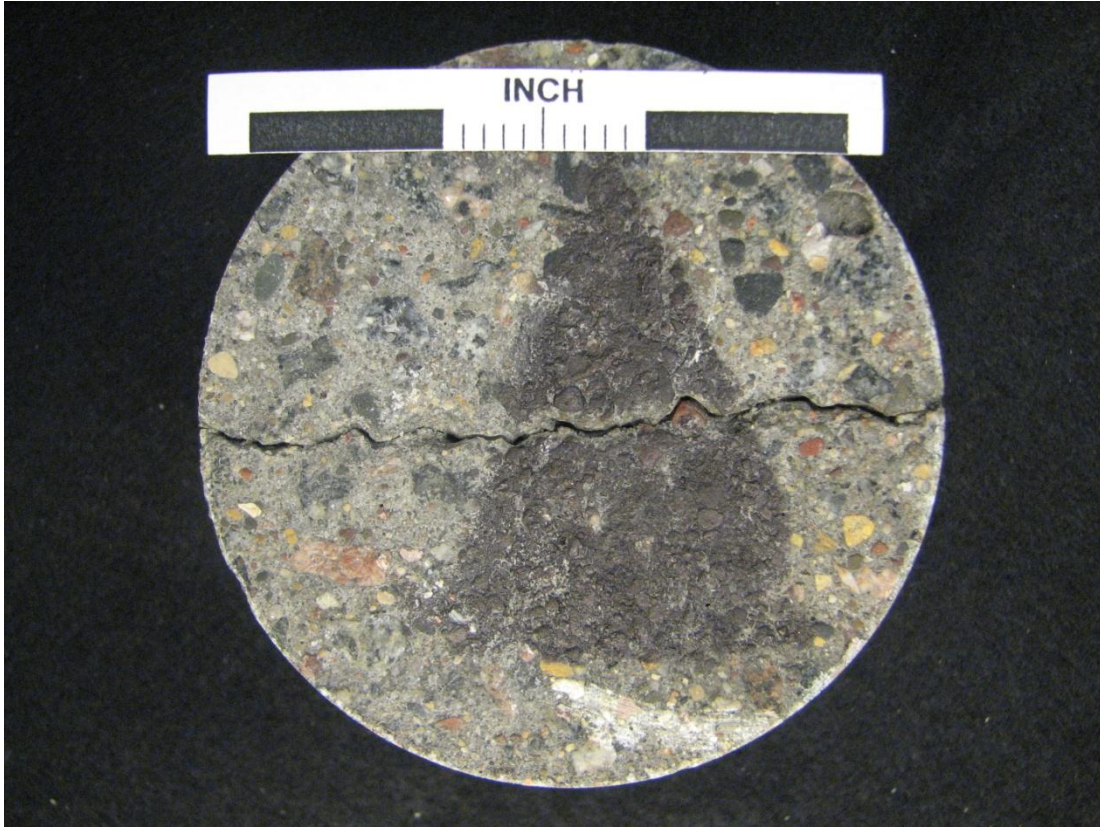
BRAUN
INTERTEC



Core #:	11A	Project BL-09-03973
Subject:	Test Section 5, Test 11A - TK-2414	
Notes:	Depth of Maximum Penetration is 0.088 in. White horizontal line marks the approx. depth of sealant.	



Core #:	11A	Project BL-09-03973
Subject:	Test Section 5, Test 11A - TK-2414	
Comments:	Depth of Maximum Penetration is 0.094 in. White horizontal line marks the approx. depth of sealant.	



Core #: 12A

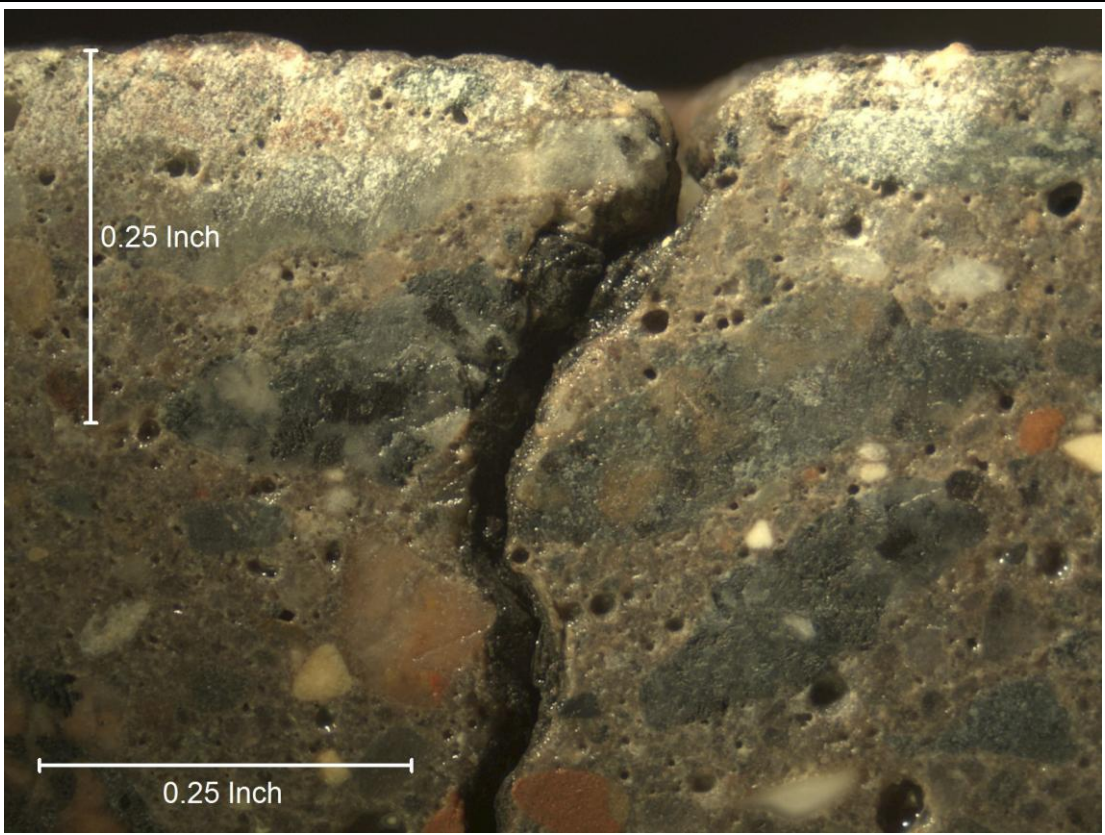
Subject: Test Section 5, Test 12A - TK-2414

Location: Smith Avenue High Bridge

Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

Project BL-09-03973

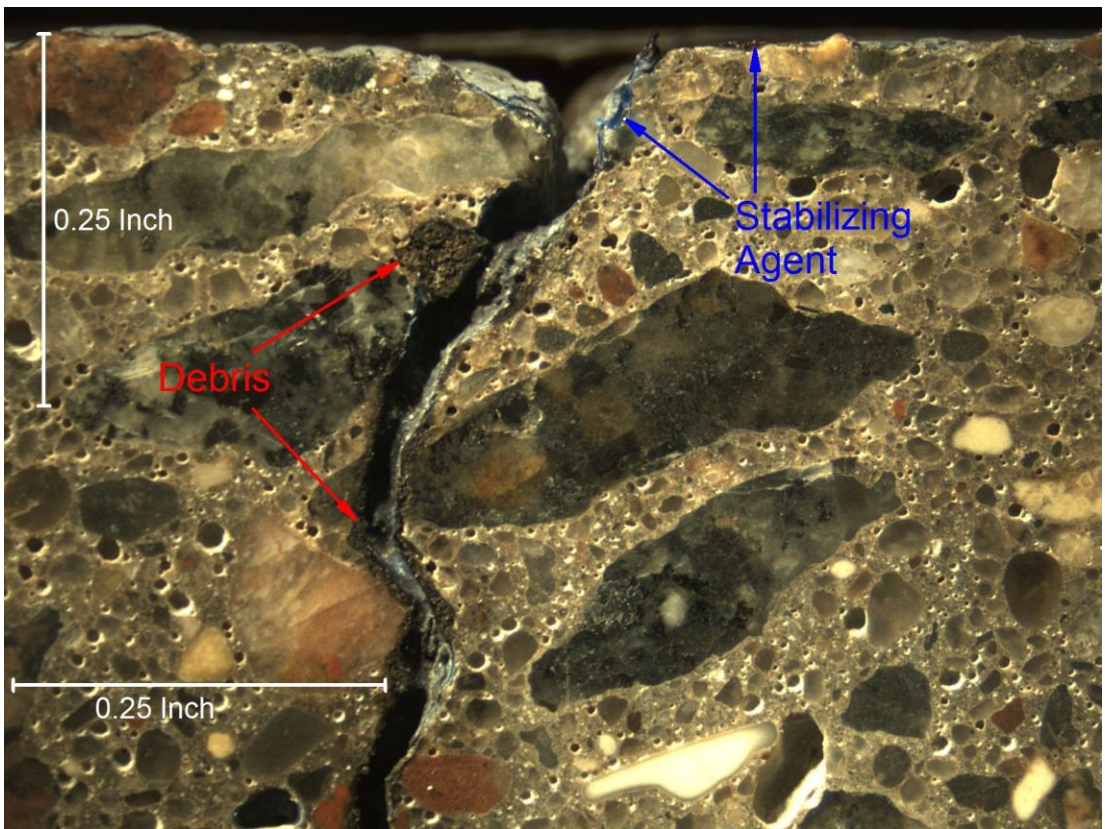
BRAUN
INTERTEC



Core #: 12A
Subject: Test Section 5, Test 12A - TK-2414
Notes: Depth of Maximum Penetration is 0.000 in.

Project BL-09-03973

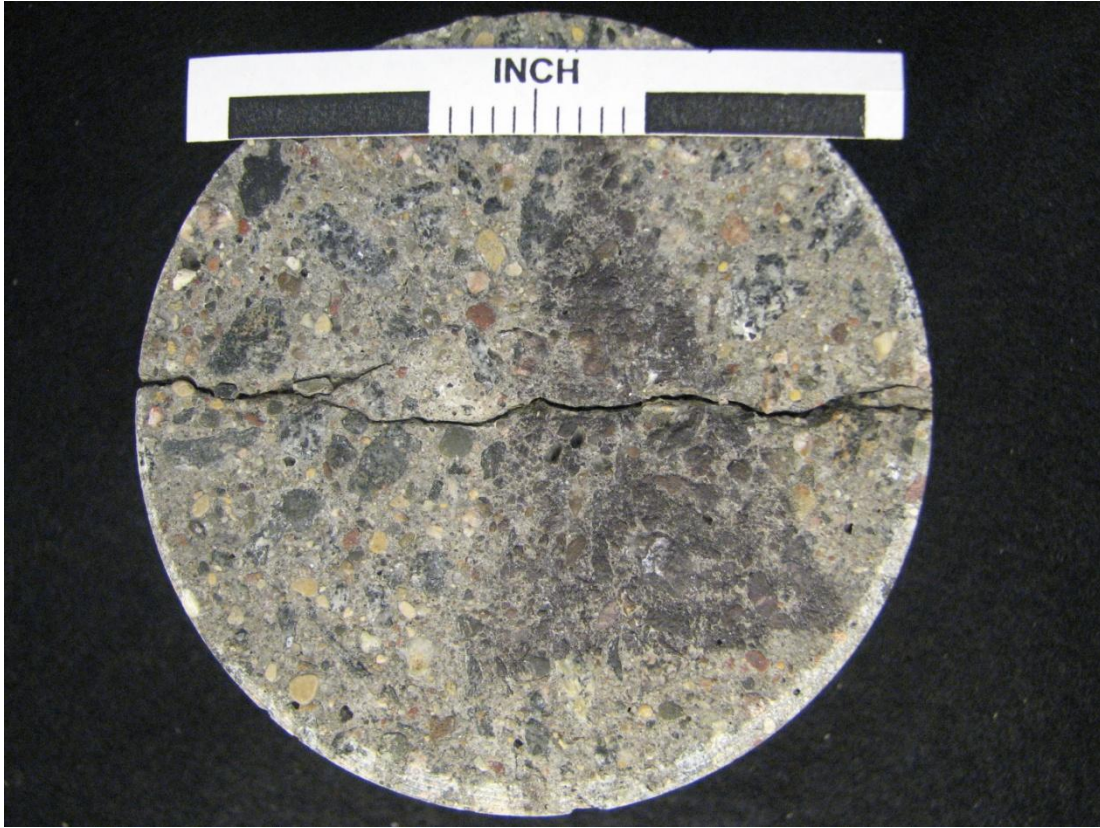
BRAUN
INTERTEC



Core #: 12A
Subject: Test Section 5, Test 12A - TK-2414
Comments: Depth of Maximum Penetration is 0.000 in.

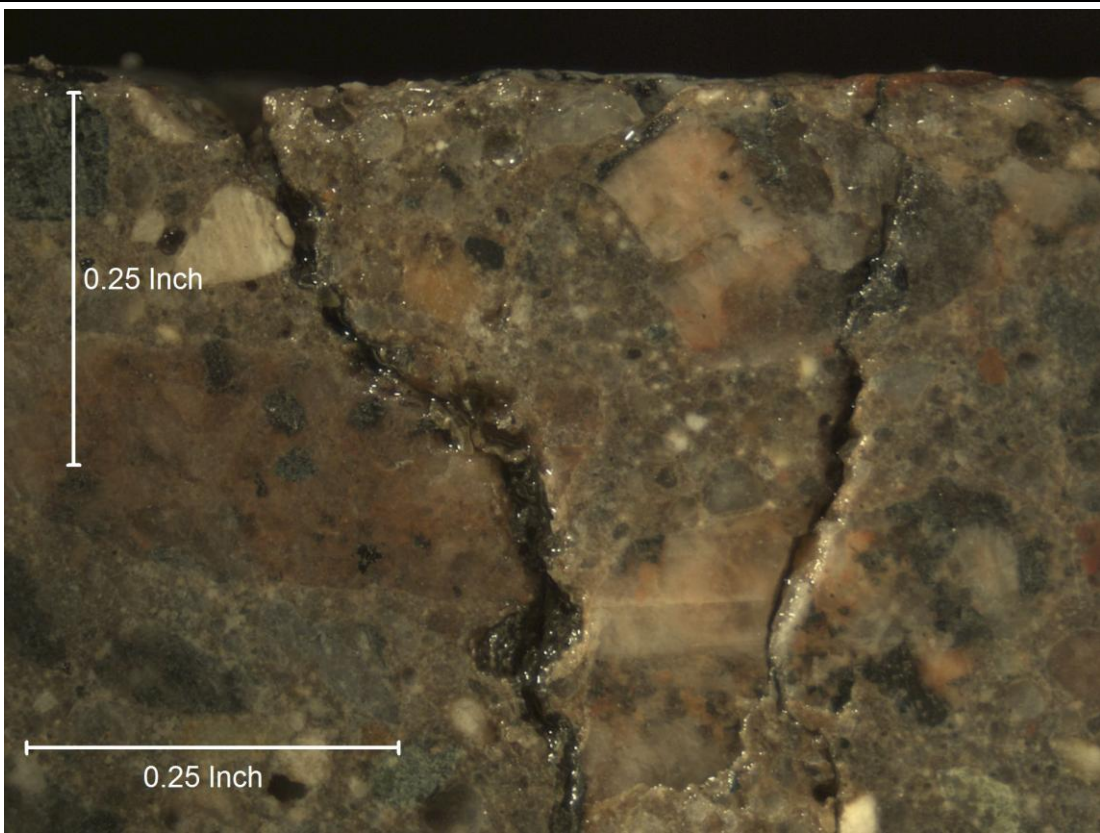
Project BL-09-03973

BRAUN
INTERTEC



Core #:	12B	Project BL-09-03973
Subject:	Test Section 6, Test 12B - Control	
Location:	Smith Avenue High Bridge	
Notes:	Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.	

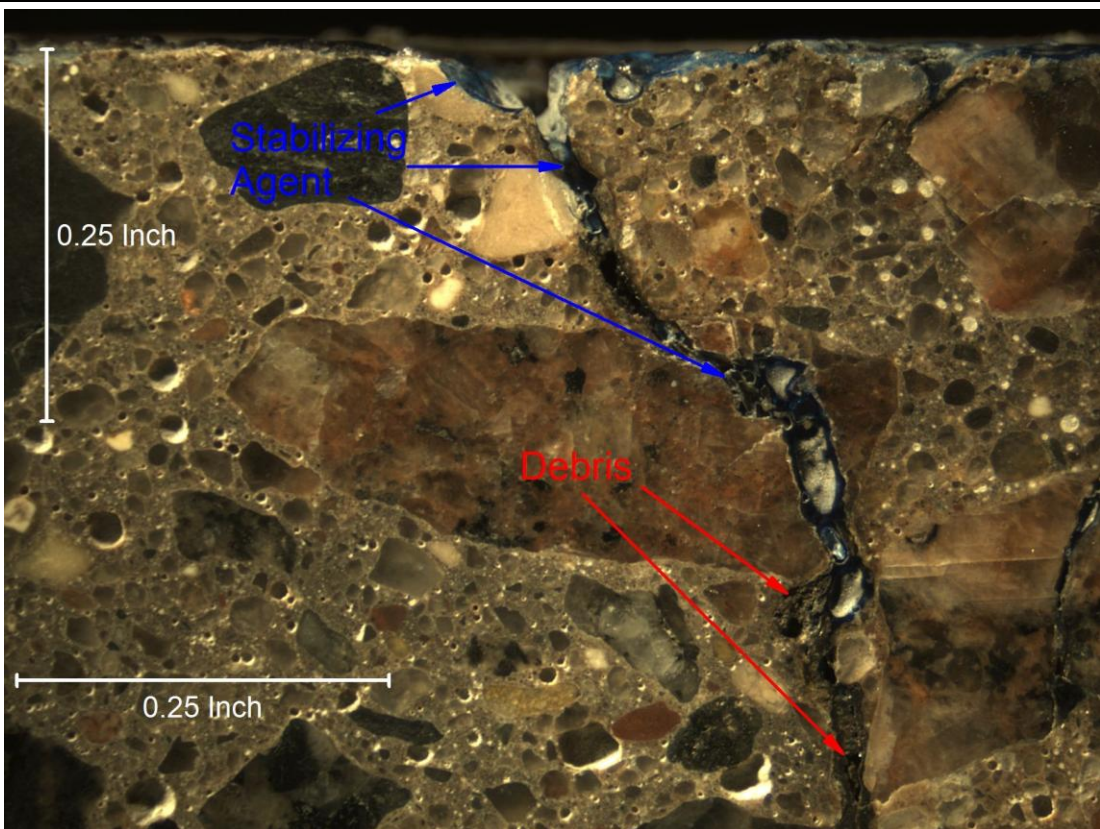




Core #: 12B
Subject: Test Section 6, Test 12B - Control
Notes: Depth of Maximum Penetration is 0.000 in.

Project BL-09-03973

BRAUN
INTERTEC



Core #: 12B
Subject: Test Section 6, Test 12B - Control
Comments: Depth of Maximum Penetration is 0.000 in.

Project BL-09-03973

BRAUN
INTERTEC



Core #: 17A

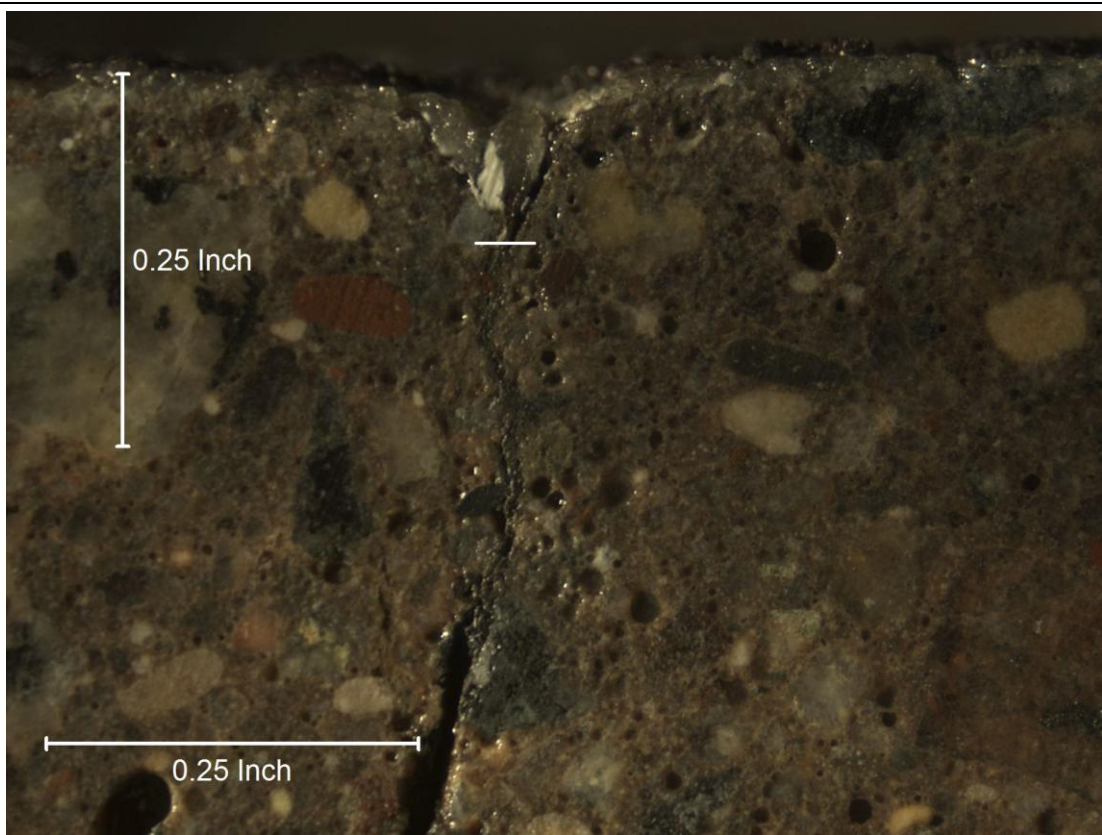
Subject: Test Section 7, Test 17A –Epoxyal GS Structural

Location: Smith Avenue High Bridge

Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

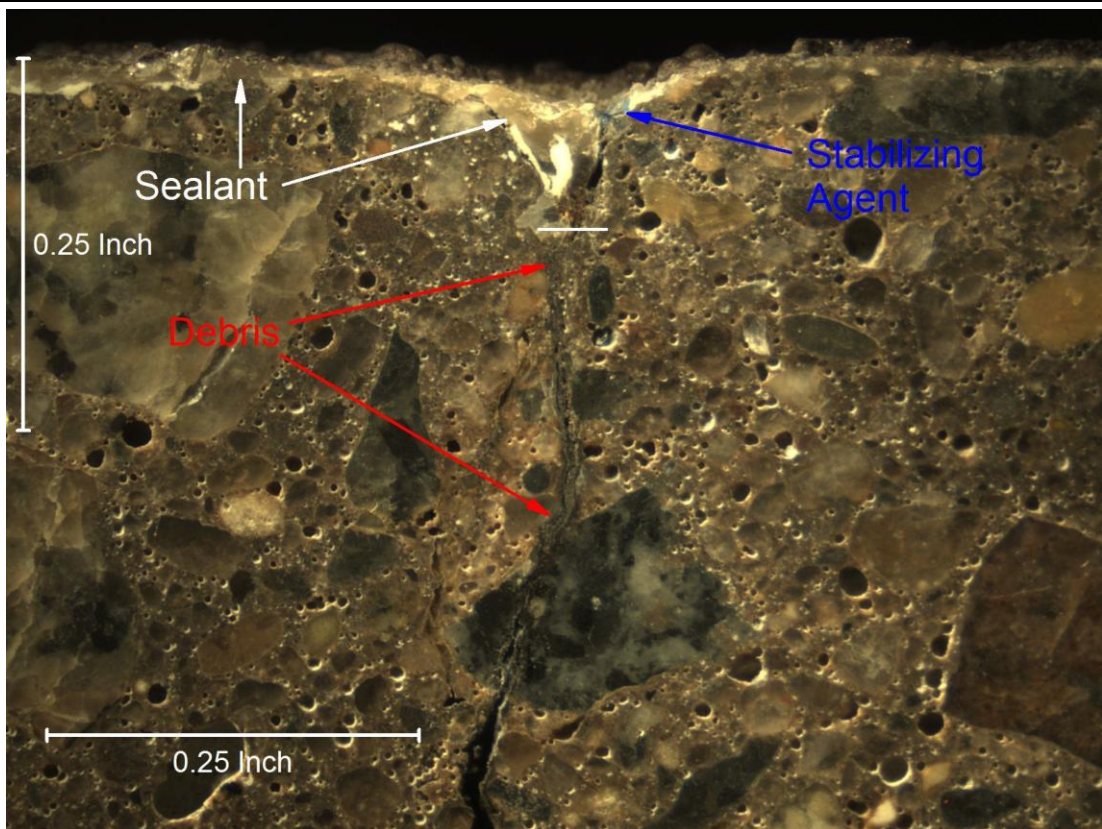
Project BL-09-03973

BRAUN
INTERTEC



Core #: 17A
 Subject: Test Section 7, Test 17A –Epoxyal GS Structural
 Notes: Depth of Maximum Penetration is 0.115 in. White horizontal line marks the approx. depth of sealant.

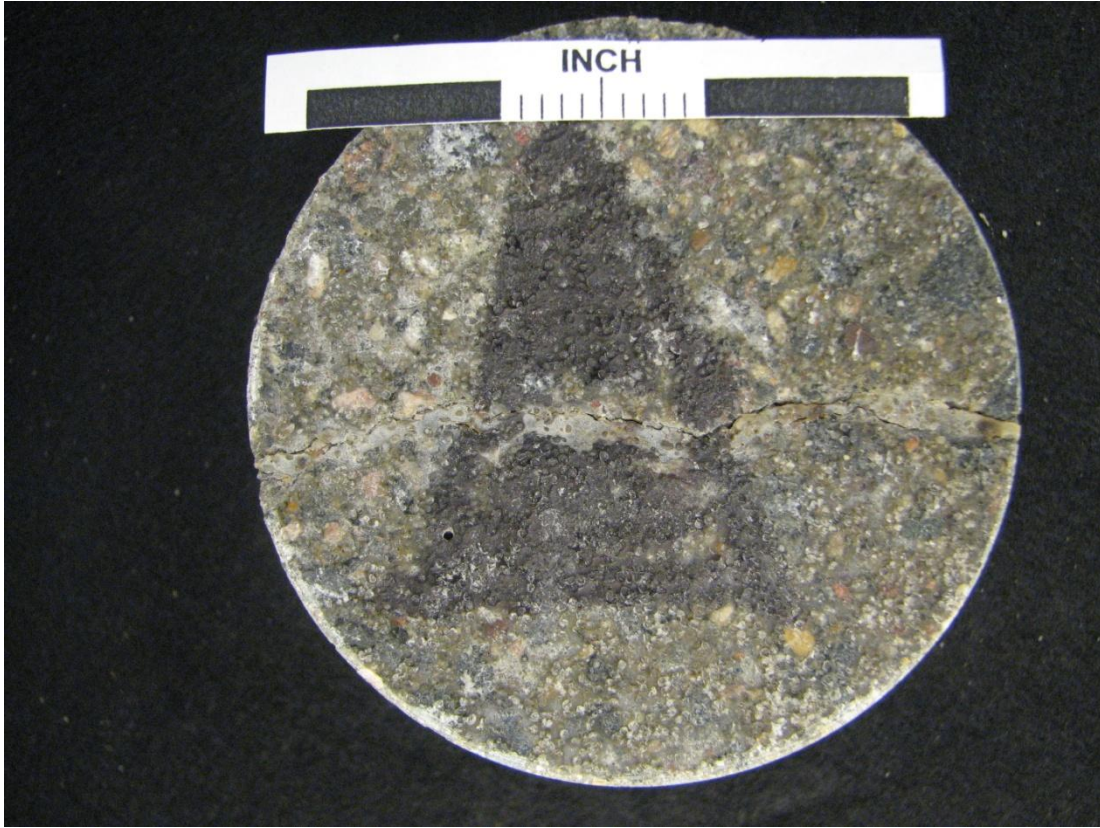
Project BL-09-03973



Core #: 17A
 Subject: Test Section 7, Test 17A –Epoxyal GS Structural
 Comments: Depth of Maximum Penetration is 0.121 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973





Core #: 19A

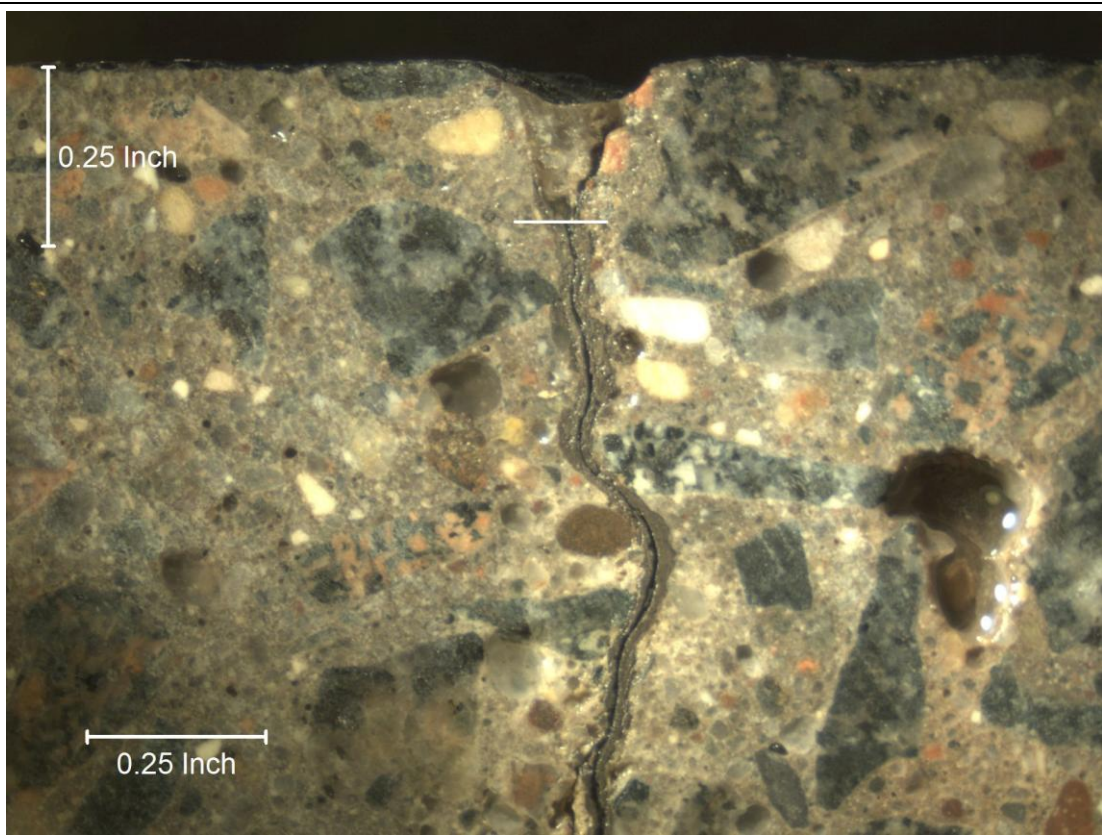
Subject: Test Section 7, Test 19A –Epoxyal GS Structural

Location: Smith Avenue High Bridge

Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

Project BL-09-03973

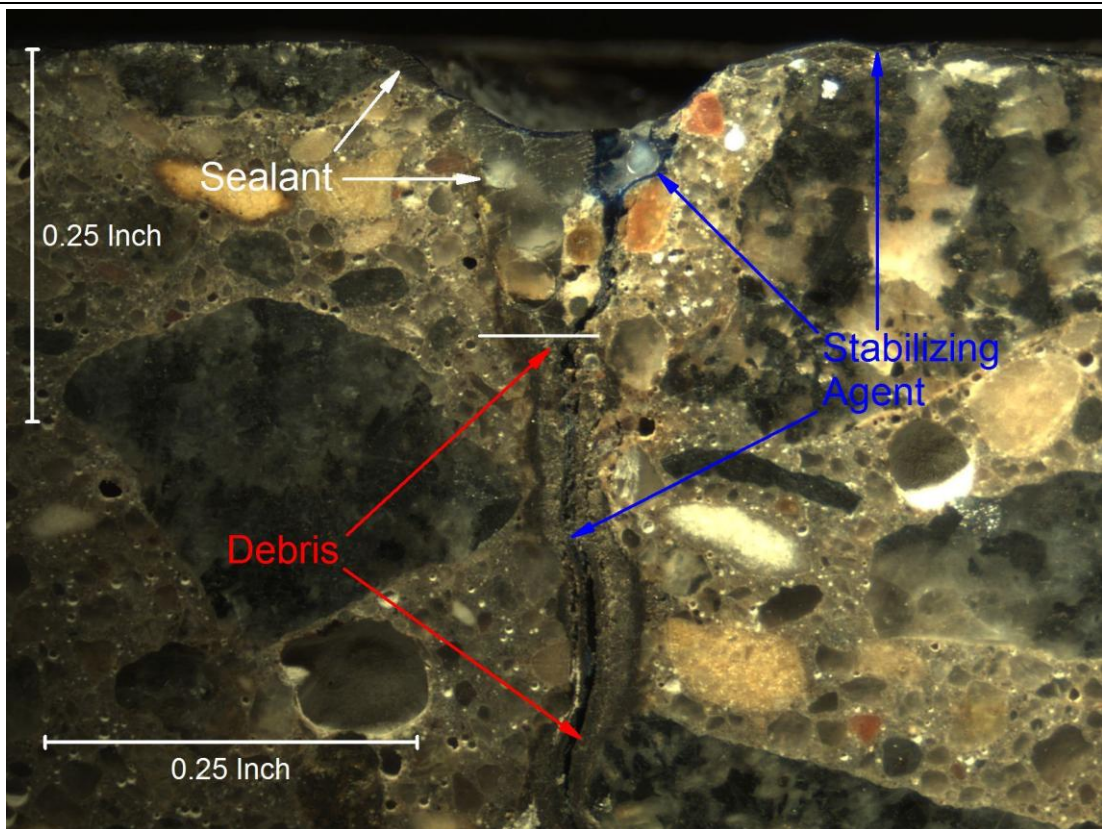
BRAUN
INTERTEC



Core #: 19A
 Subject: Test Section 7, Test 19A –Epoxy GS Structural
 Notes: Depth of Maximum Penetration is 0.202 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973

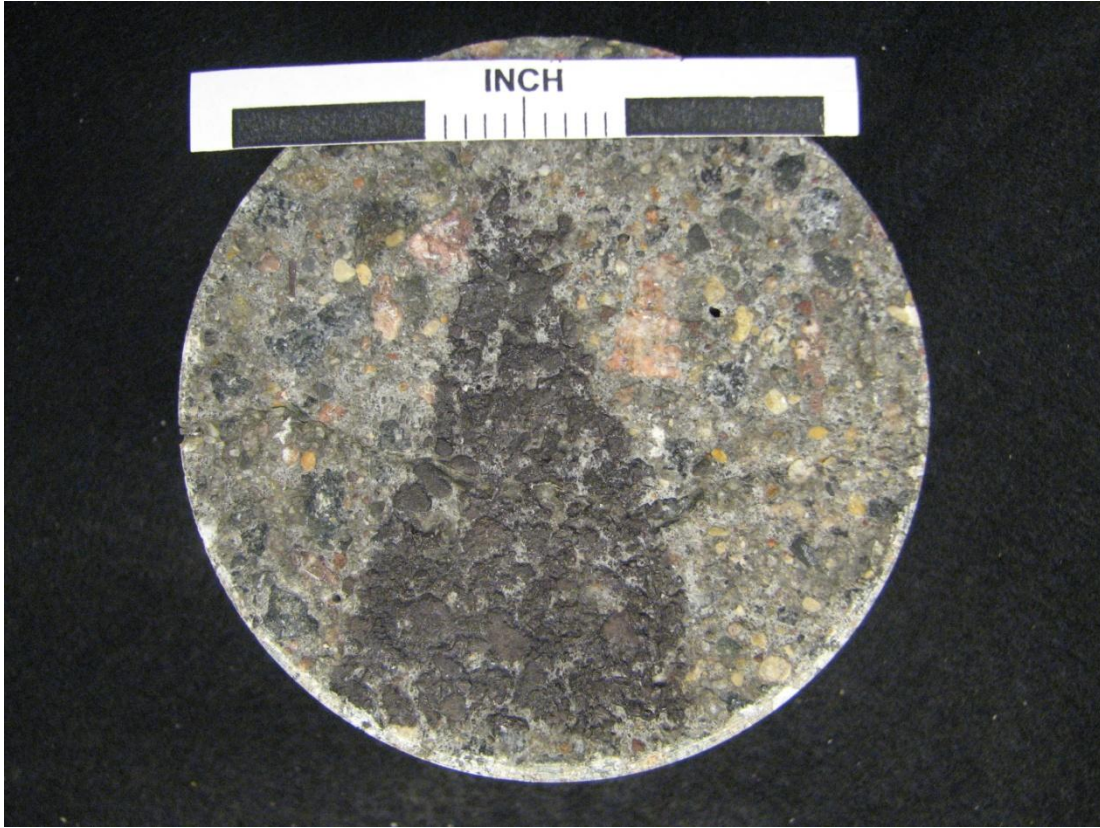
BRAUN
 INTERTEC



Core #: 19A
 Subject: Test Section 7, Test 19A –Epoxy GS Structural
 Comments: Depth of Maximum Penetration is 0.211 in. White horizontal line marks the approx. depth of sealant.

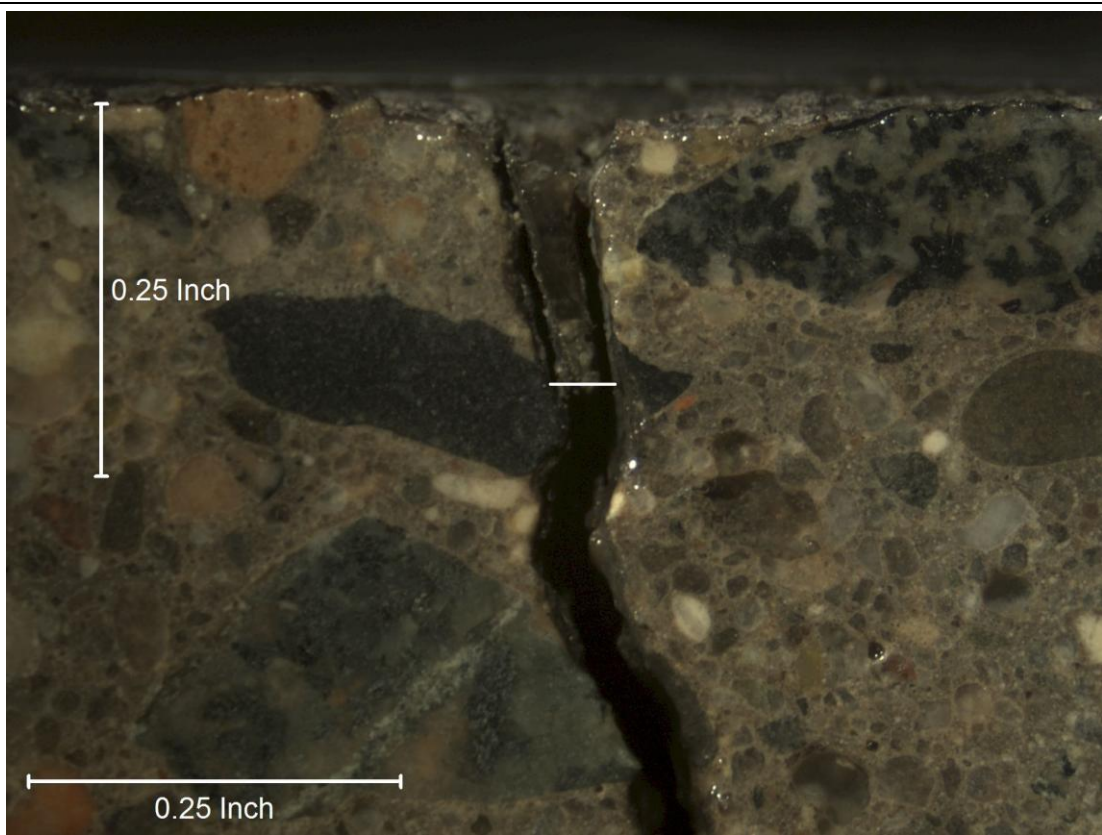
Project BL-09-03973

BRAUN
 INTERTEC



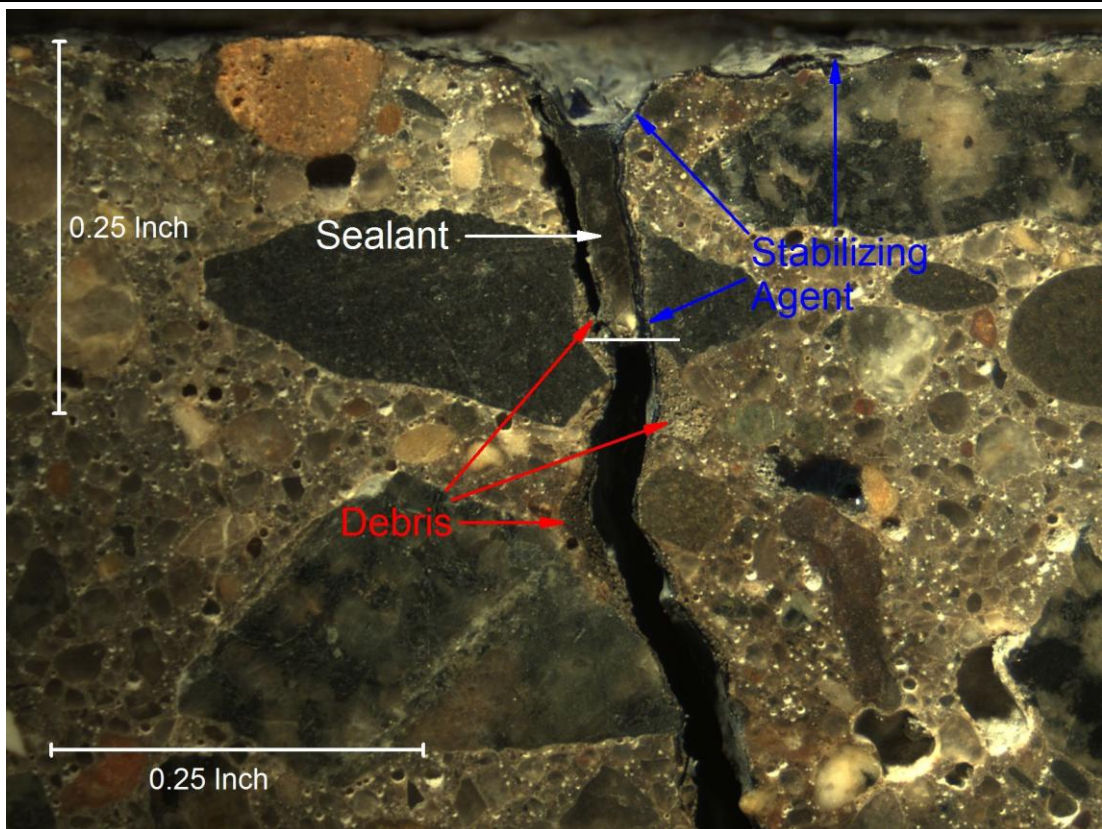
Core #:	18A	Project BL-09-03973
Subject:	Test Section 8, Test 18A – Kwik Bond KBP 204	
Location:	Smith Avenue High Bridge	
Notes:	Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.	





Core #: 18A
 Subject: Test Section 8, Test 18A – Kwik Bond KBP 204
 Notes: Depth of Maximum Penetration is 0.193 in. White horizontal line marks the approx. depth of sealant.

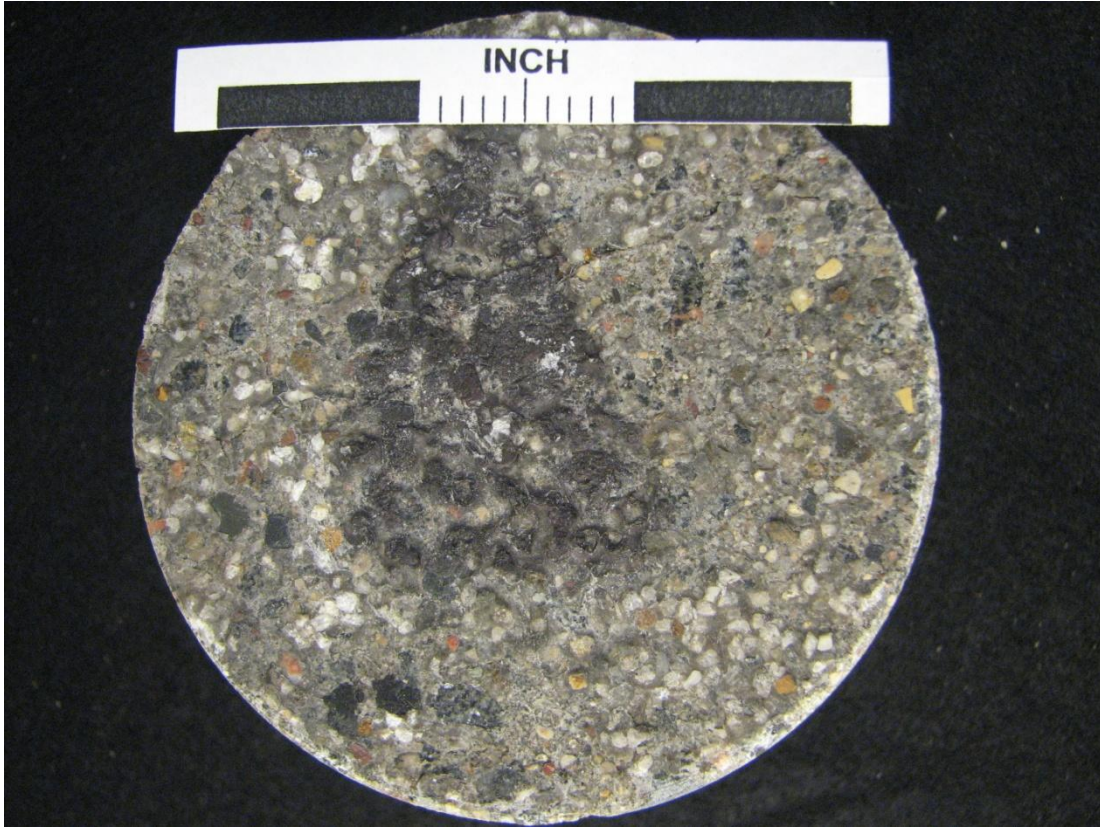
Project BL-09-03973



Core #: 18A
 Subject: Test Section 8, Test 18A – Kwik Bond KBP 204
 Comments: Depth of Maximum Penetration is 0.204 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973





Core #: 20A

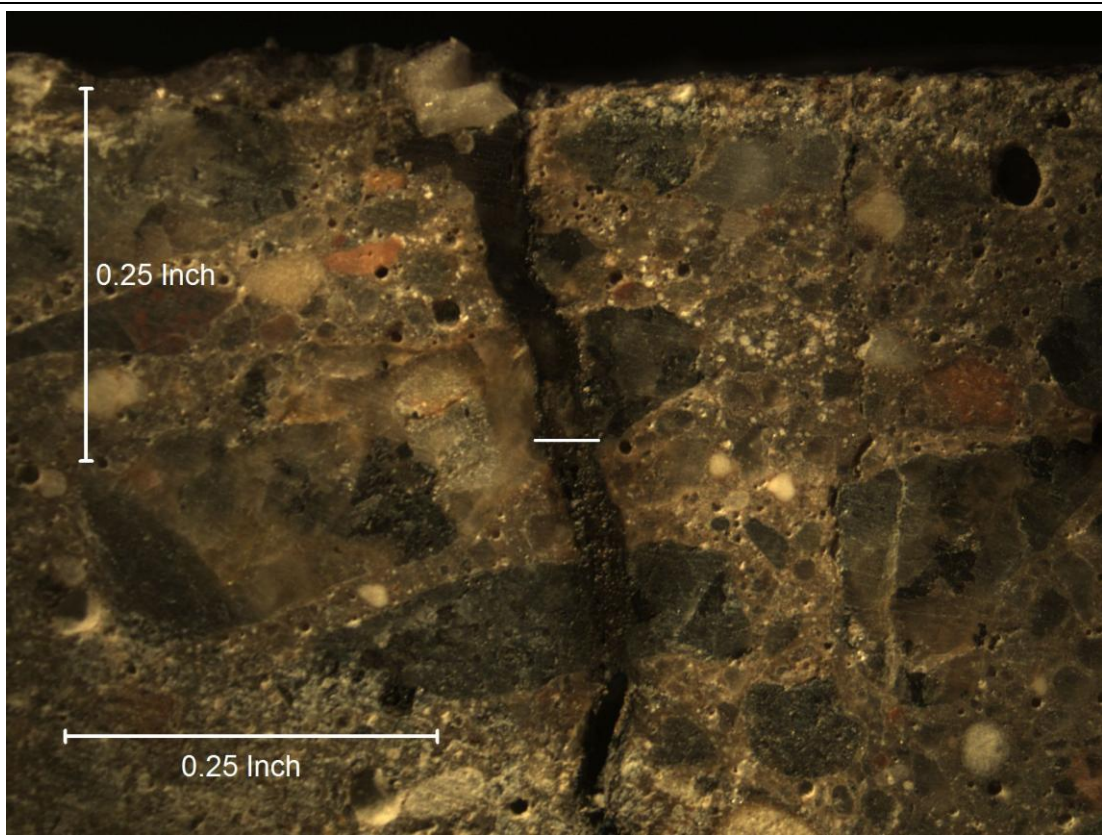
Subject: Test Section 8, Test 20A – Kwik Bond KBP 204

Location: Smith Avenue High Bridge

Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

Project BL-09-03973

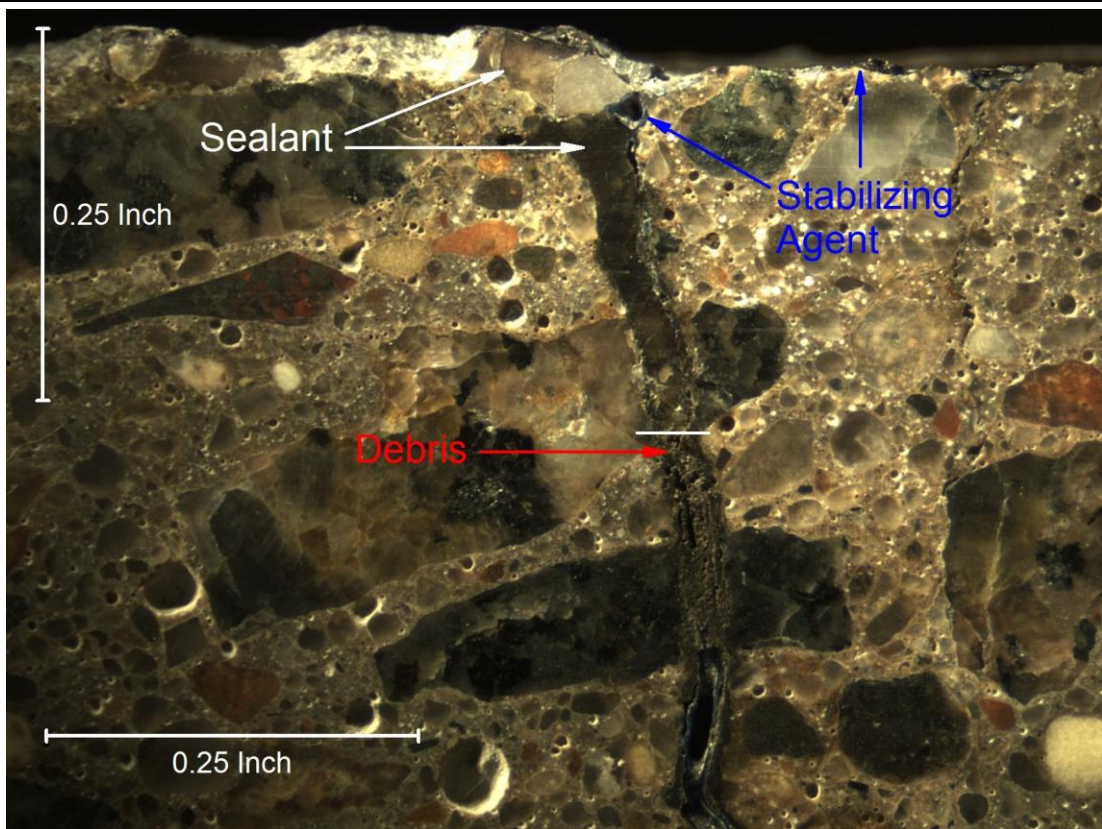
BRAUN
INTERTEC



Core #: 20A
 Subject: Test Section 8, Test 20A – Kwik Bond KBP 204
 Notes: Depth of Maximum Penetration is 0.239 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973

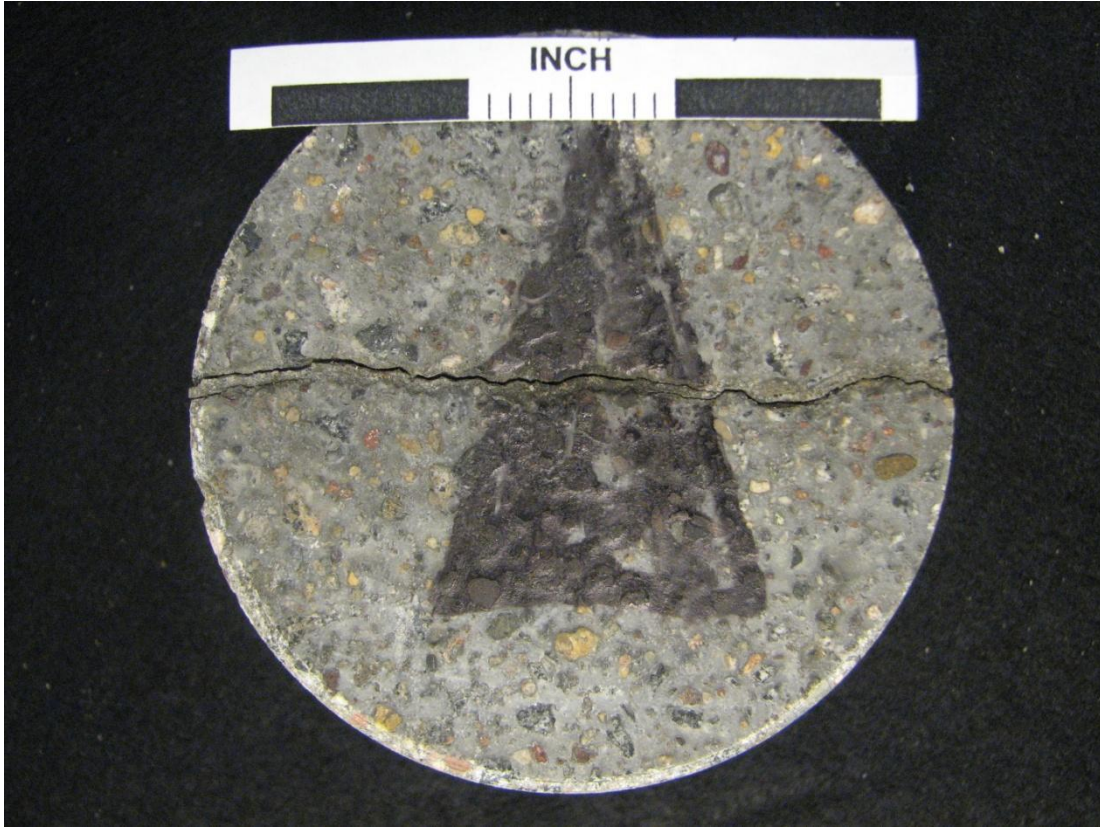
BRAUN
 INTERTEC



Core #: 20A
 Subject: Test Section 8, Test 20A – Kwik Bond KBP 204
 Comments: Depth of Maximum Penetration is 0.266 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973

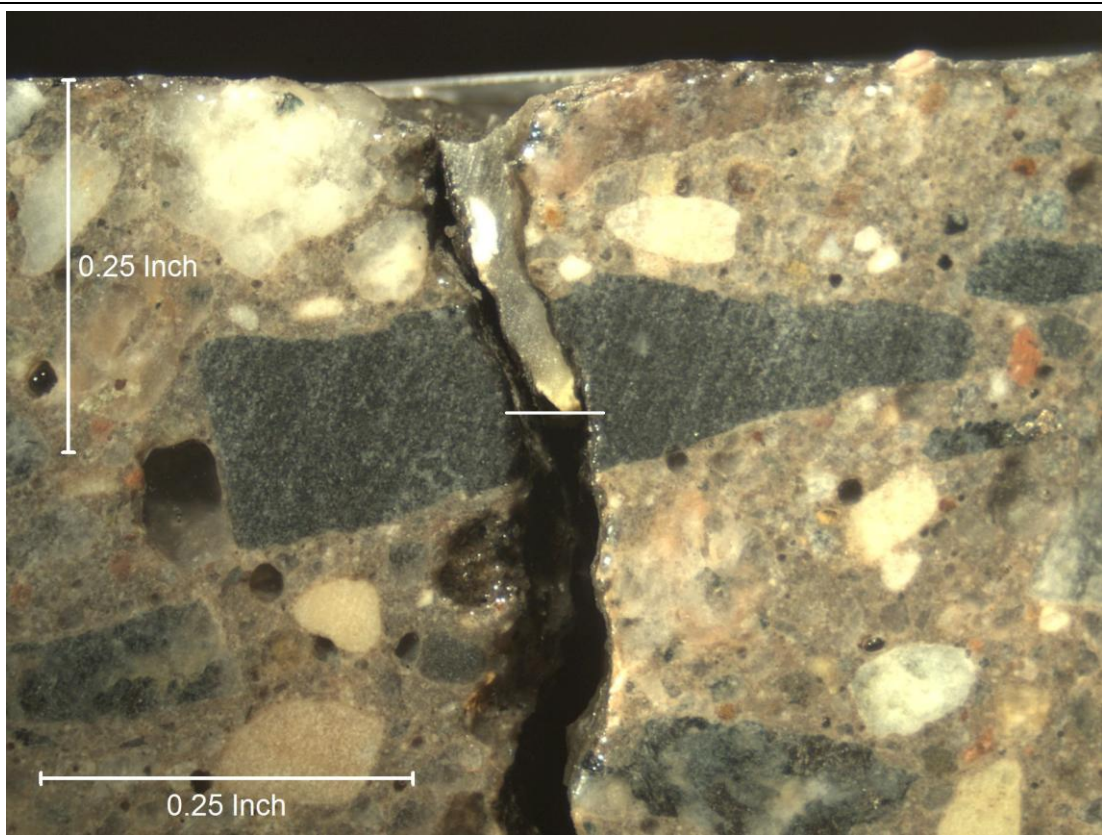
BRAUN
 INTERTEC



Core #: 21A
Subject: Test Section 9, Test 21A – Degadeck Crack Sealer Plus
Location: Smith Avenue High Bridge
Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

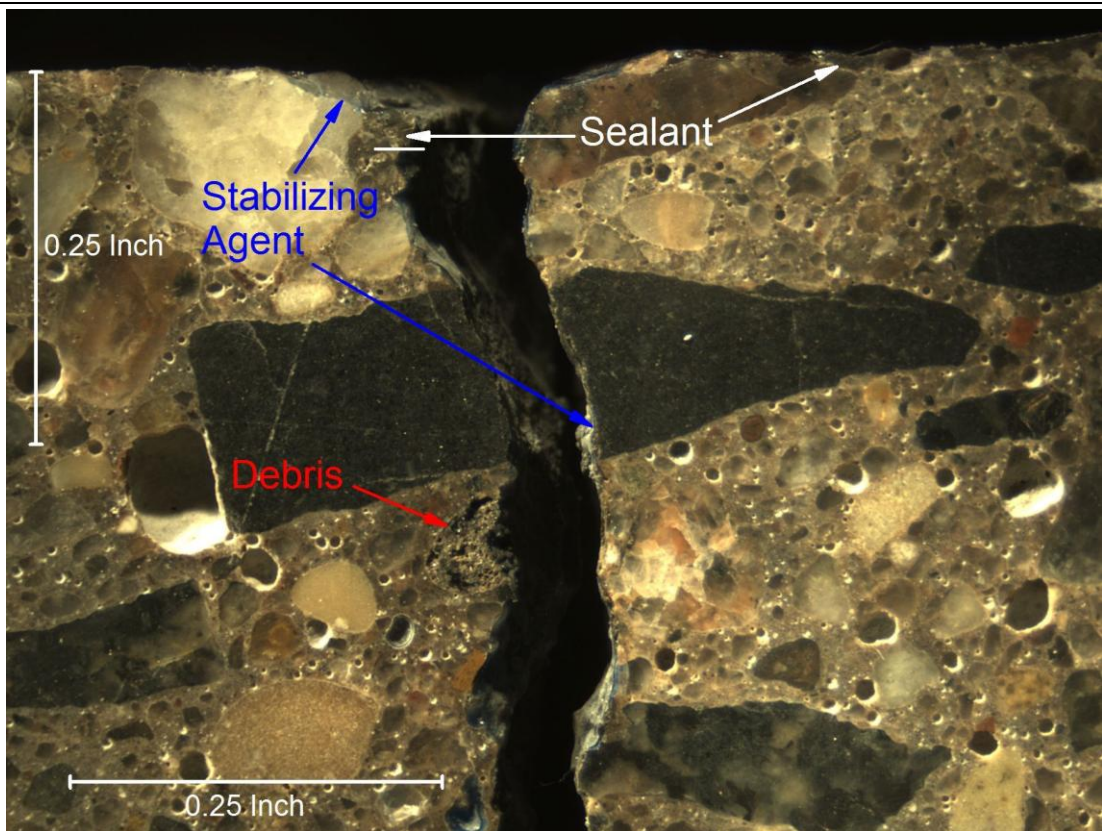
Project BL-09-03973

BRAUN
INTERTEC



Core #: 21A
 Subject: Test Section 9, Test 21A – Degadeck Crack Sealer Plus
 Notes: Depth of Maximum Penetration is 0.226 in. White horizontal line marks the approx. depth of sealant.

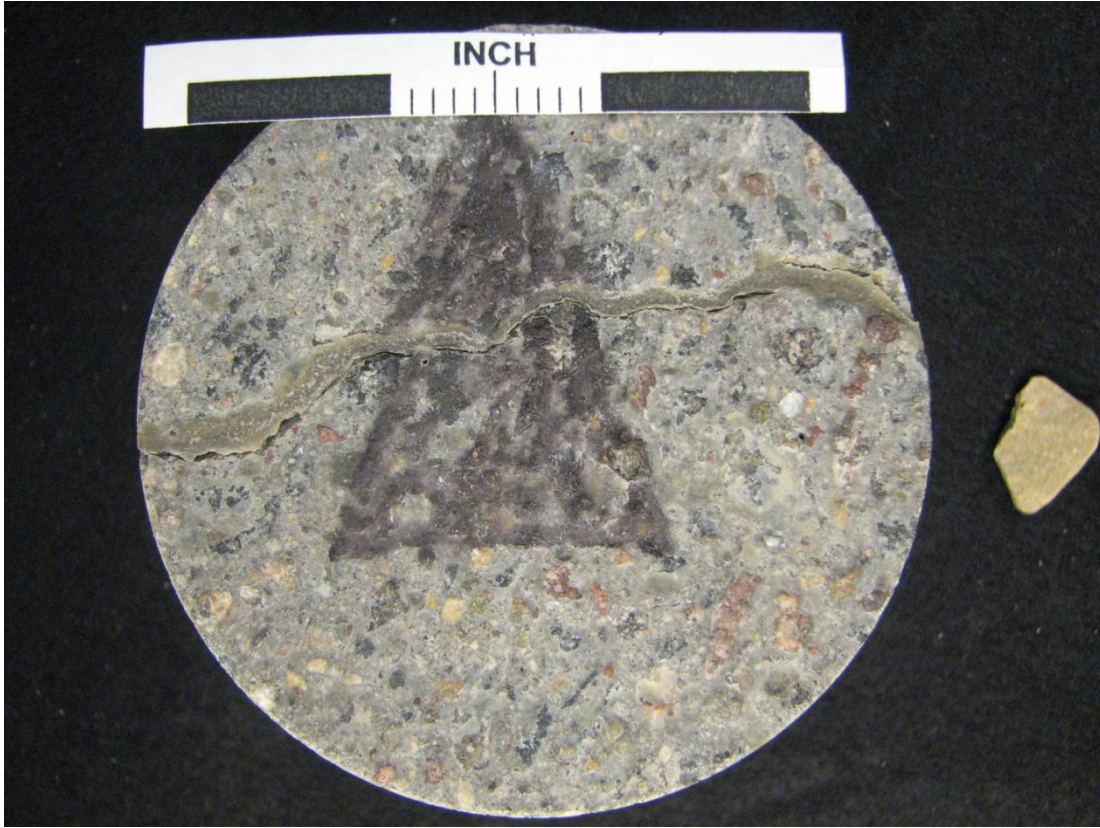
Project BL-09-03973



Core #: 21A
 Subject: Test Section 9, Test 21A – Degadeck Crack Sealer Plus
 Comments: Depth of Maximum Penetration is 0.057 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973





Core #: 21B

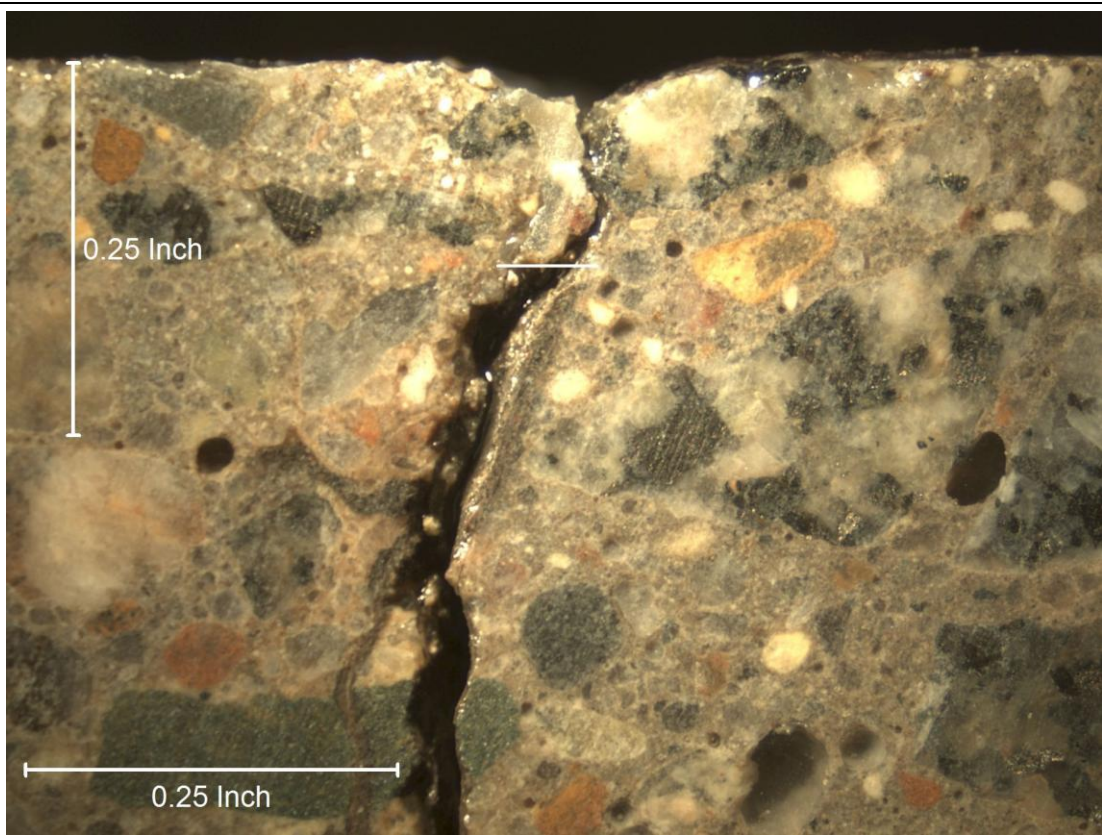
Subject: Test Section 9, Test 21B – Degadeck Crack Sealer Plus

Location: Smith Avenue High Bridge

Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

Project BL-09-03973

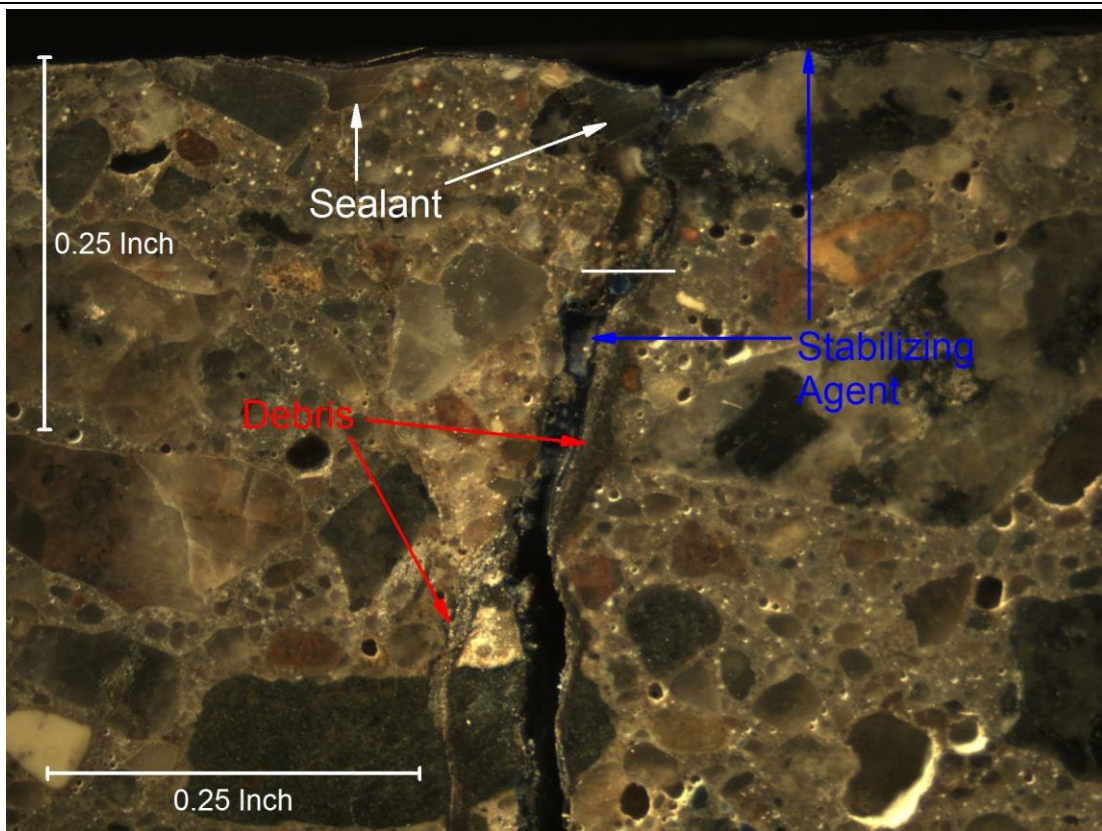
BRAUN
INTERTEC



Core #: 21B
 Subject: Test Section 9, Test 21B – Degadeck Crack Sealer Plus
 Notes: Depth of Maximum Penetration is 0.134 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973

BRAUN
 INTERTEC



Core #: 21B
 Subject: Test Section 9, Test 21B – Degadeck Crack Sealer Plus
 Comments: Depth of Maximum Penetration is 0.158 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973

BRAUN
 INTERTEC



Core #: 22A

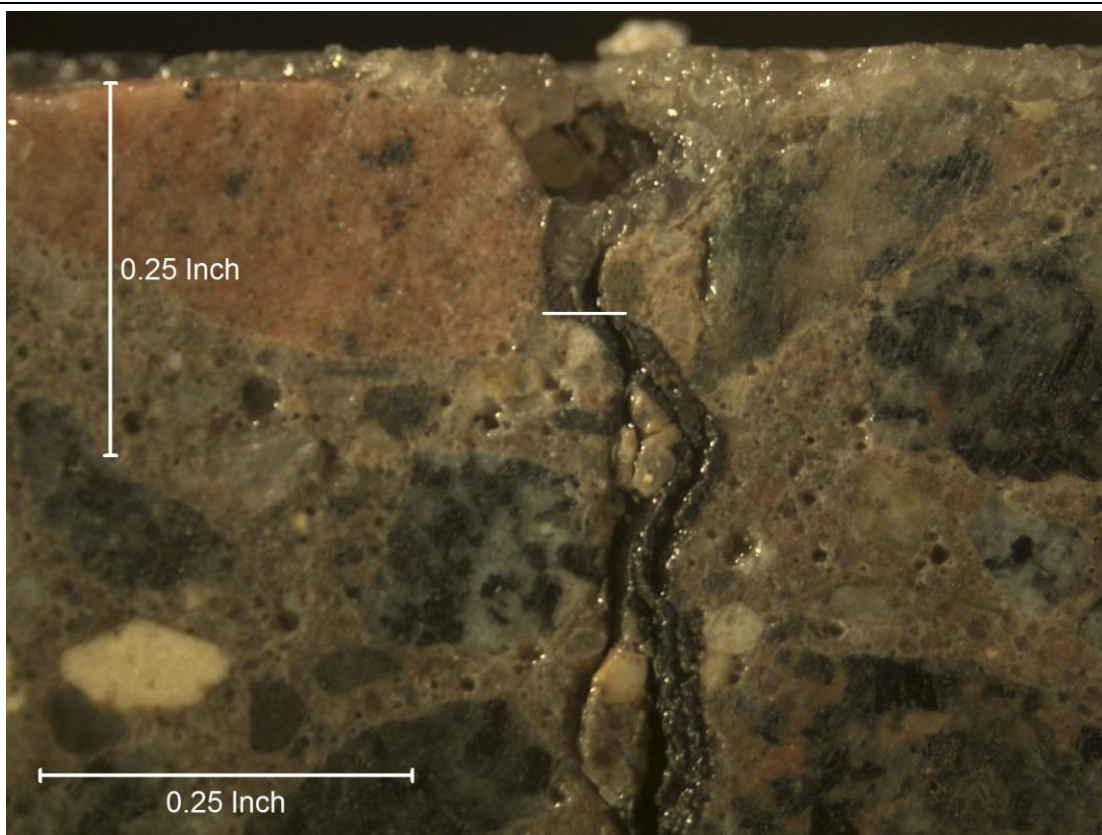
Subject: Test Section 10, Test 22A – Sikadur 55 SLV

Location: Smith Avenue High Bridge

Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

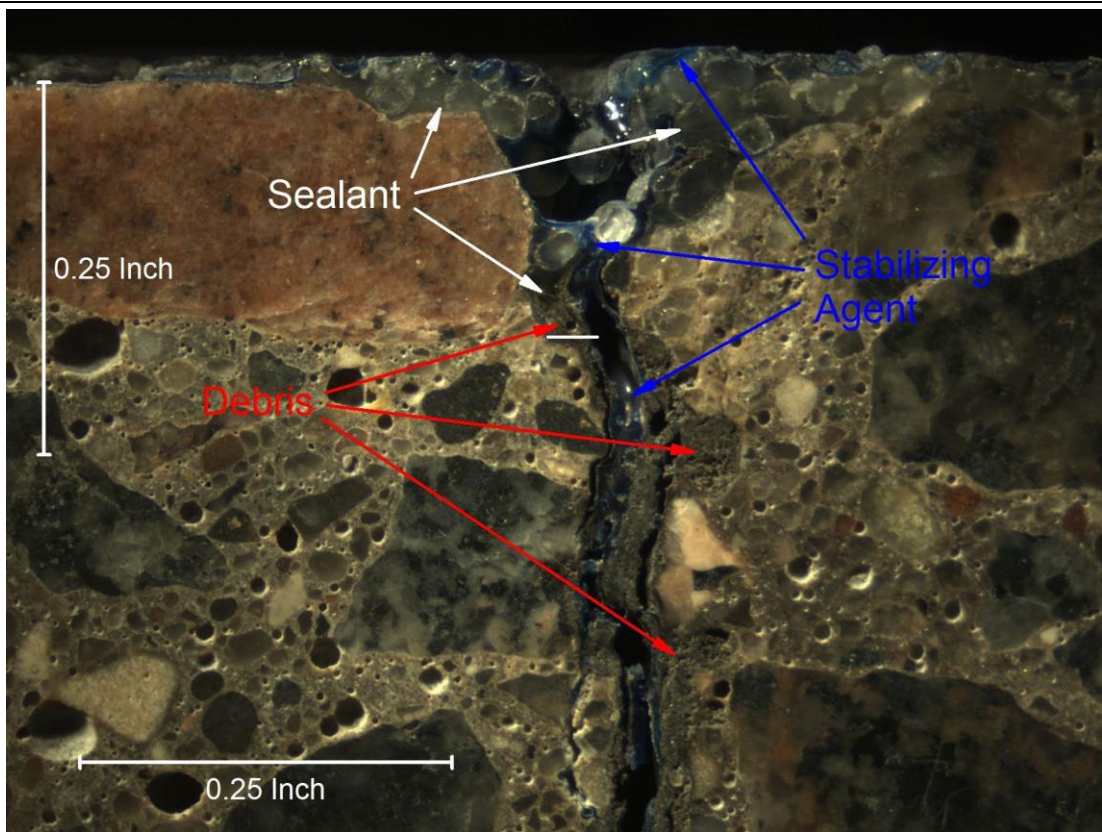
Project BL-09-03973

BRAUN
INTERTEC



Core #: 22A
 Subject: Test Section 10, Test 22A – Sikadur 55 SLV
 Notes: Depth of Maximum Penetration is 0.159 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973




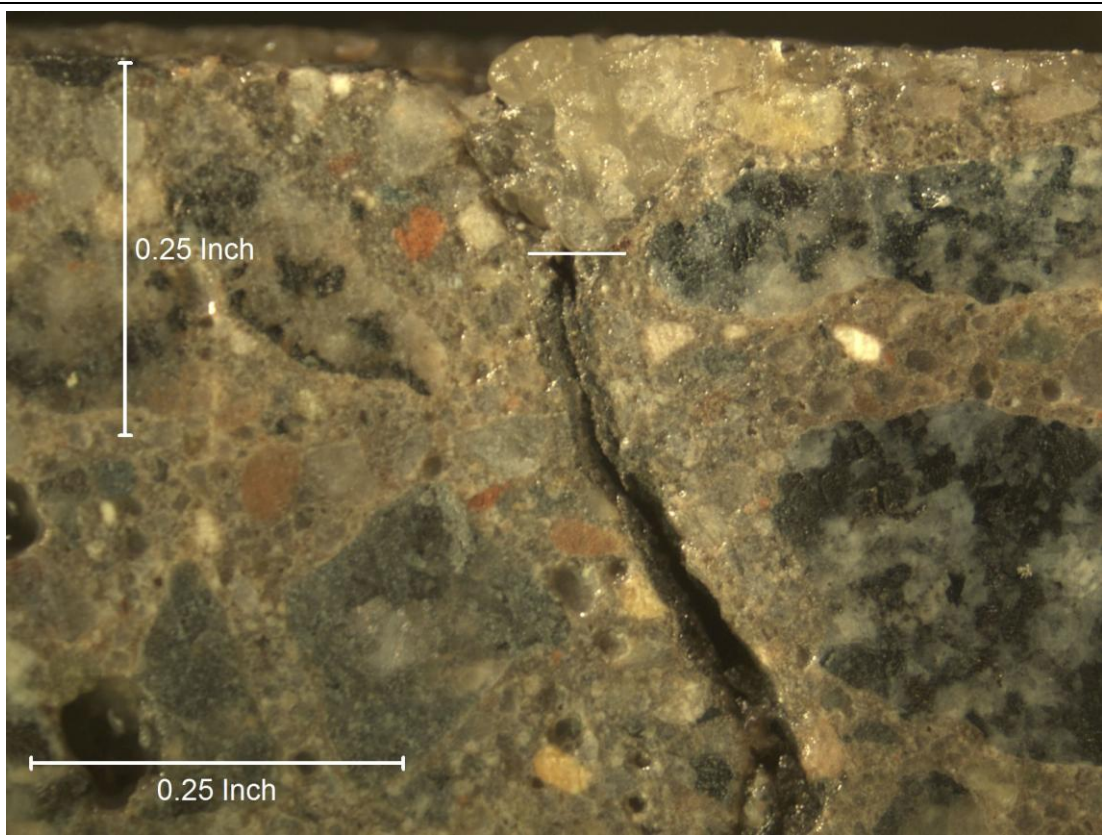
Core #: 22A
 Subject: Test Section 10, Test 22A – Sikadur 55 SLV
 Comments: Depth of Maximum Penetration is 0.180 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973



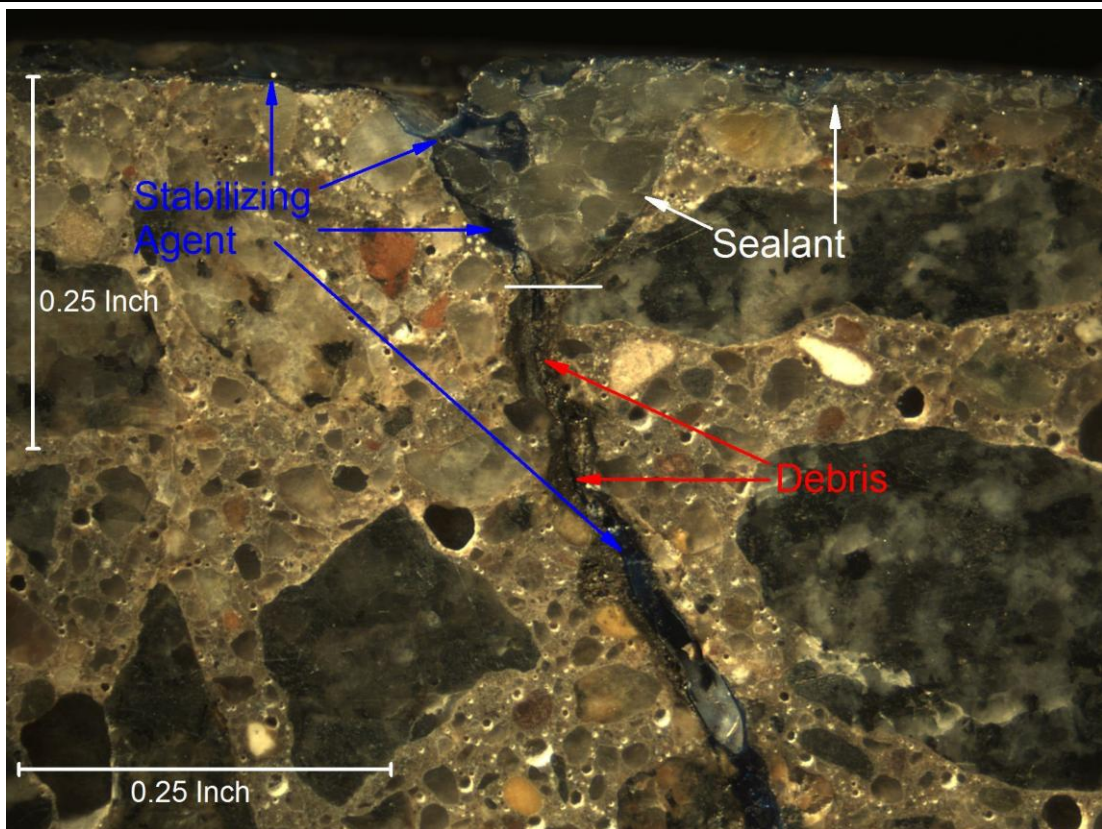


Core #:	23A	Project BL-09-03973
Subject:	Test Section 10, Test 23A – Sikadur 55 SLV	
Location:	Smith Avenue High Bridge	
Notes:	Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.	



Core #: 23A
 Subject: Test Section 10, Test 23A – Sikadur 55 SLV
 Notes: Depth of Maximum Penetration is 0.124 in. White horizontal line marks the approx. depth of sealant.

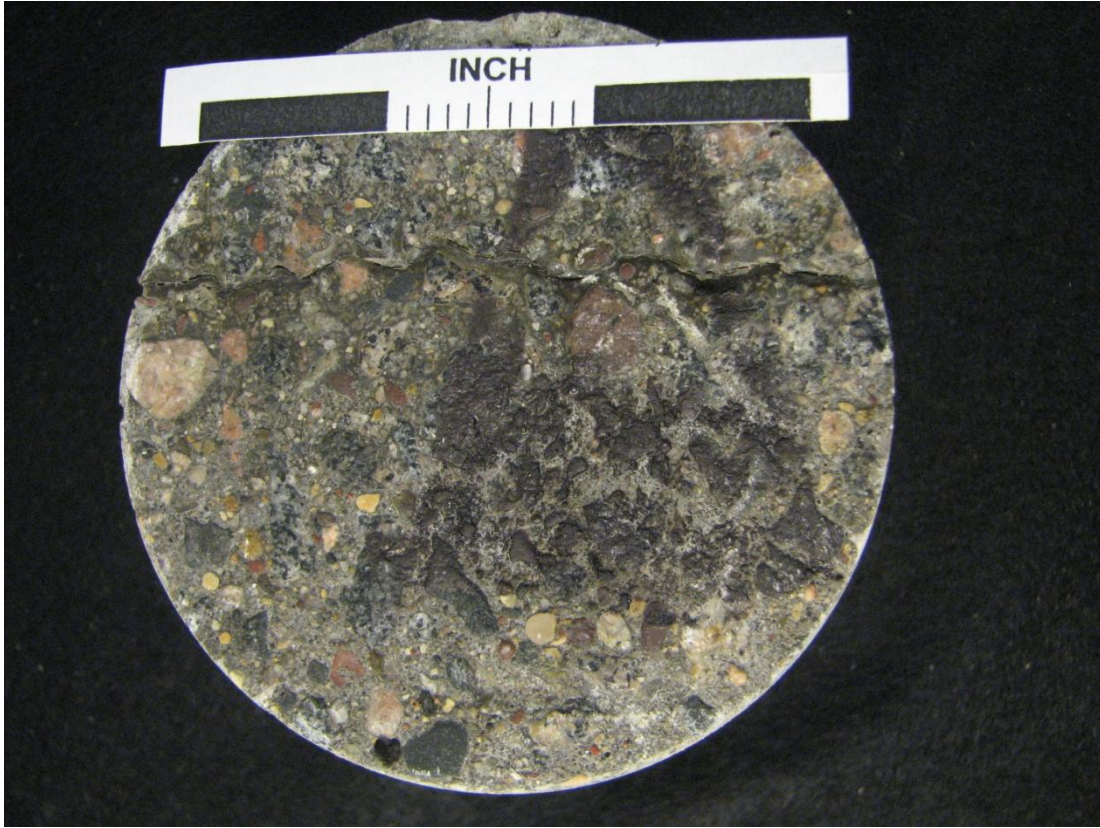
Project BL-09-03973



Core #: 23A
 Subject: Test Section 10, Test 23A – Sikadur 55 SLV
 Comments: Depth of Maximum Penetration is 0.135 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973



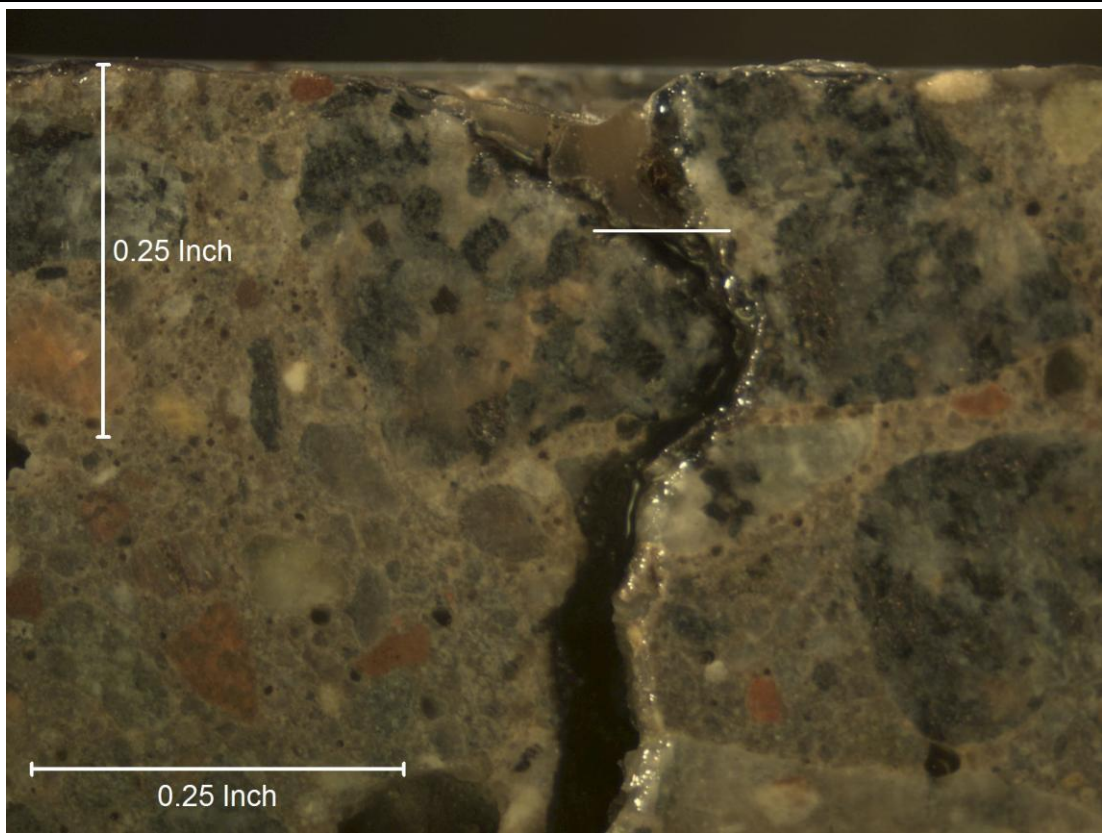


Core #: 22B
Subject: Test Section 11, Test 22B, Paulco TE-3008-1
Location: Smith Avenue High Bridge

Project BL-09-03973

Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

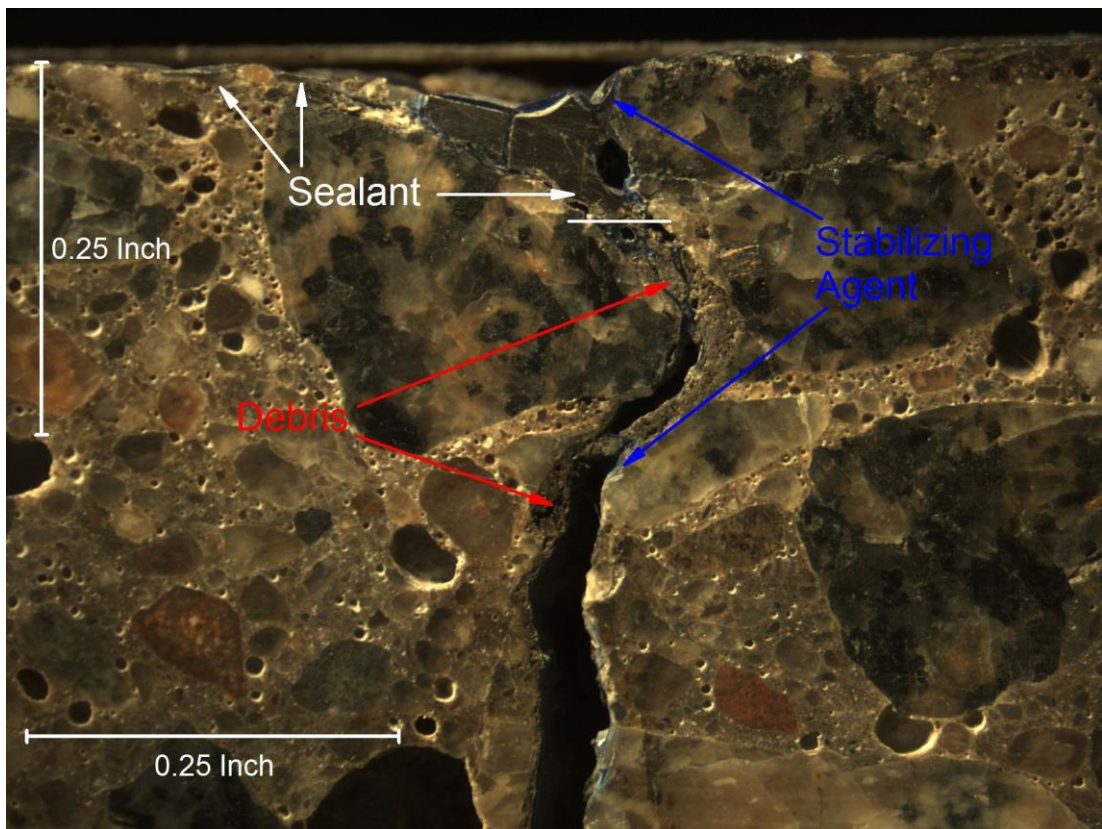
BRAUN
INTERTEC



Core #: 22B
 Subject: Test Section 11, Test 22B, Paulco TE-3008-1
 Notes: Depth of Maximum Penetration is 0.109 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973

BRAUN
 INTERTEC



Core #: 22B
 Subject: Test Section 11, Test 22B, Paulco TE-3008-1
 Comments: Depth of Maximum Penetration is 0.113 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973

BRAUN
 INTERTEC



Core #: 34A

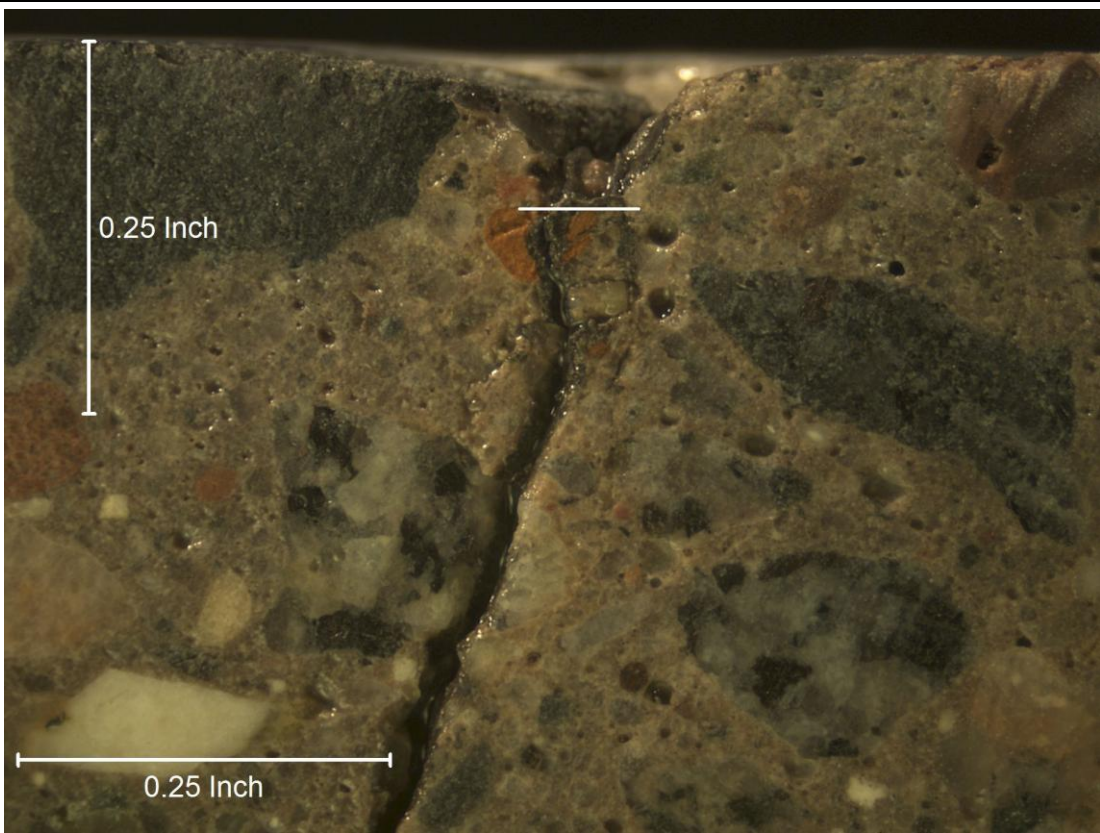
Subject: Test Section 11, Test 34A, Paulco TE-3008-1

Location: Smith Avenue High Bridge

Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

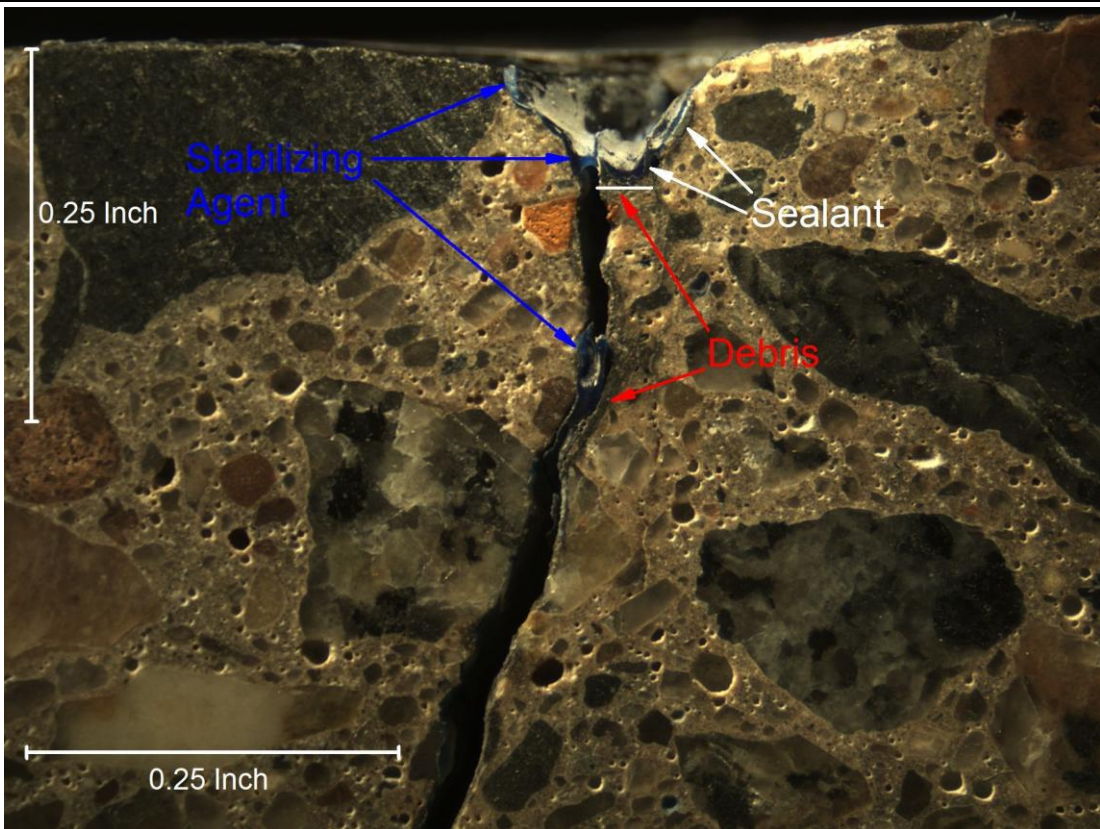
Project BL-09-03973

BRAUN
INTERTEC



Core #: 34A
 Subject: Test Section 11, Test 34A, Paulco TE-3008-1
 Notes: Depth of Maximum Penetration is 0.111 in. White horizontal line marks the approx. depth of sealant.

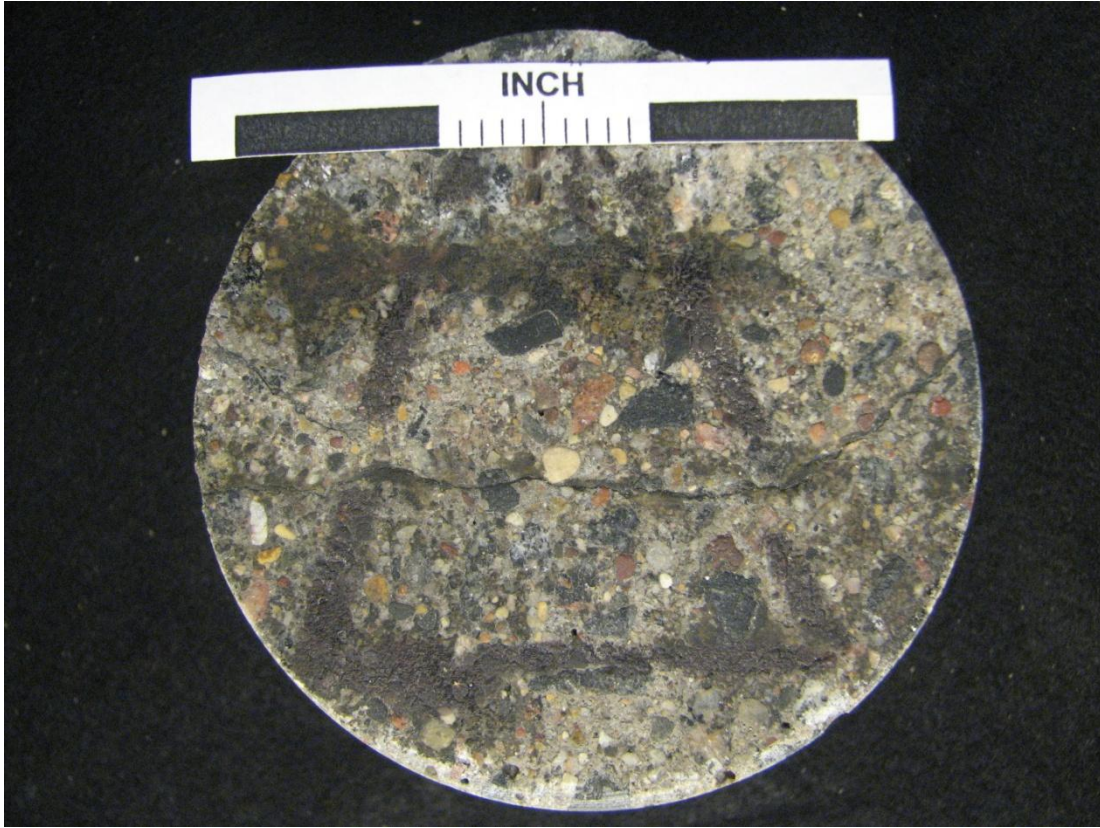
Project BL-09-03973



Core #: 34A
 Subject: Test Section 11, Test 34A, Paulco TE-3008-1
 Comments: Depth of Maximum Penetration is 0.113 in. White horizontal line marks the approx. depth of sealant.

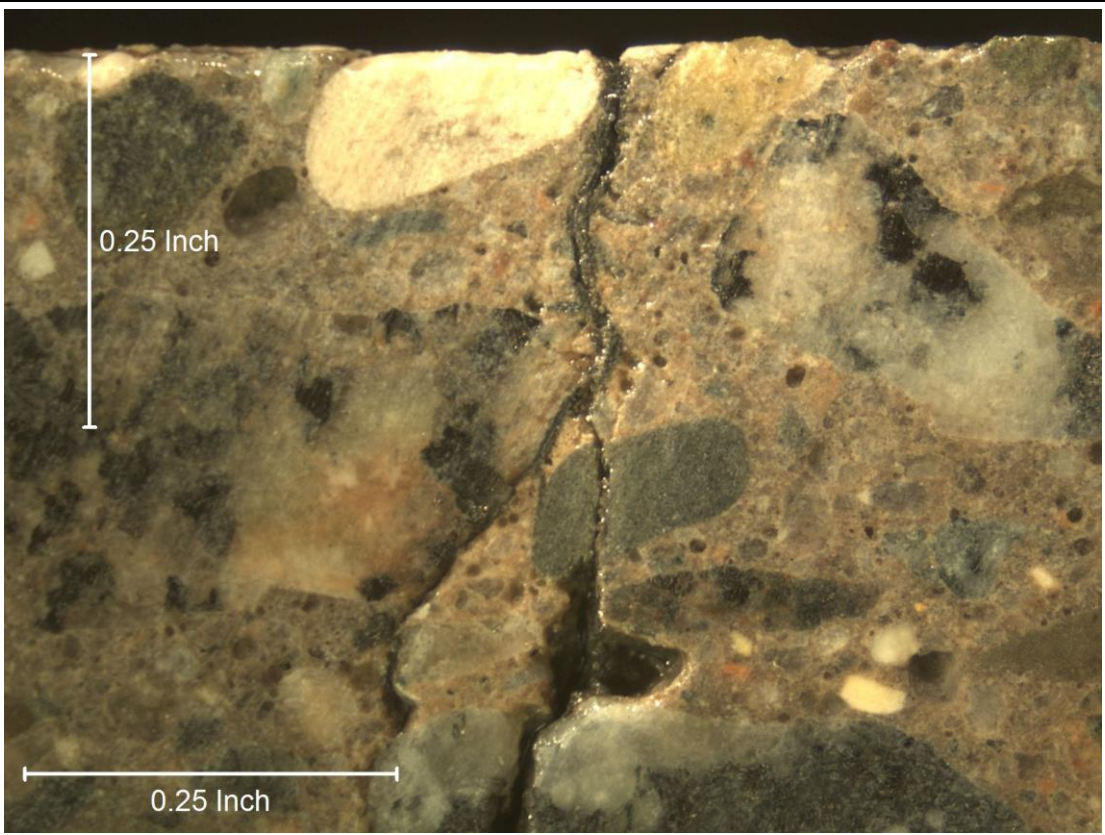
Project BL-09-03973





Core #:	24A	Project BL-09-03973
Subject:	Test Section 12, Test 24A – Paulco TE-2501	
Location:	Smith Avenue High Bridge	
Notes:	Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.	

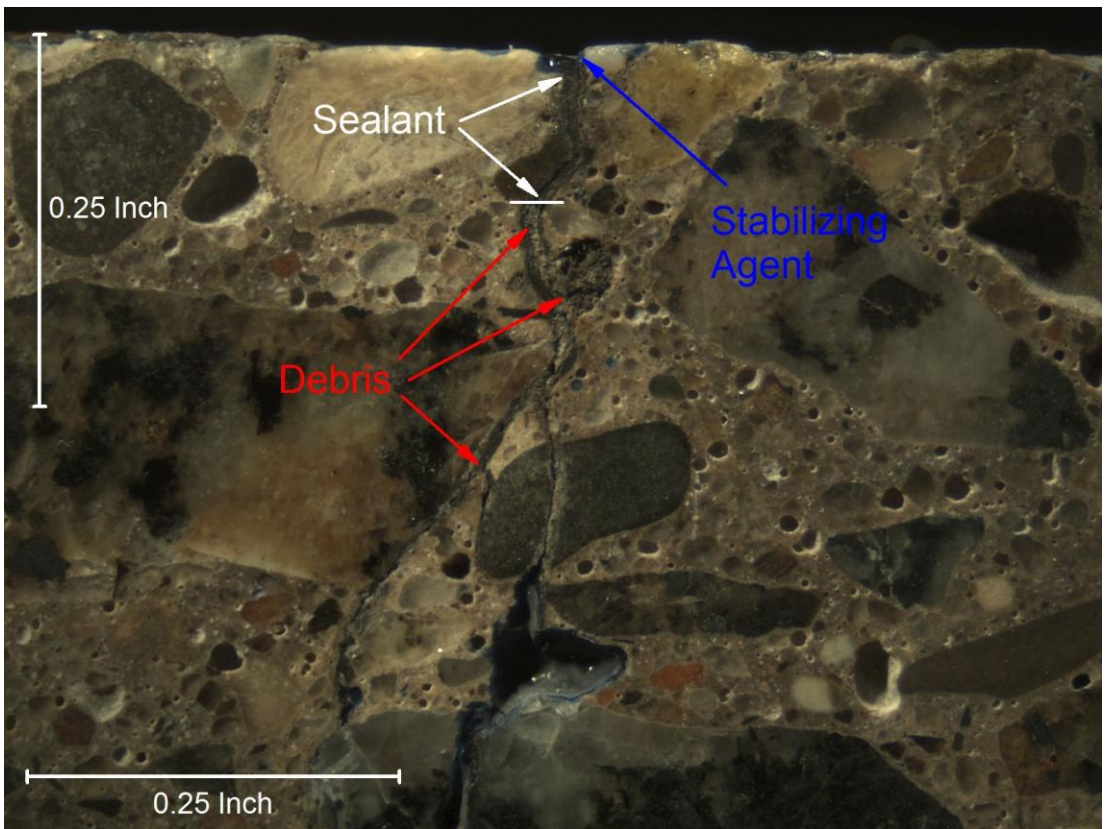




Core #: 24A
 Subject: Test Section 12, Test 24A – Paulco TE-2501
 Notes: Depth of Maximum Penetration is 0.000 in.

Project BL-09-03973

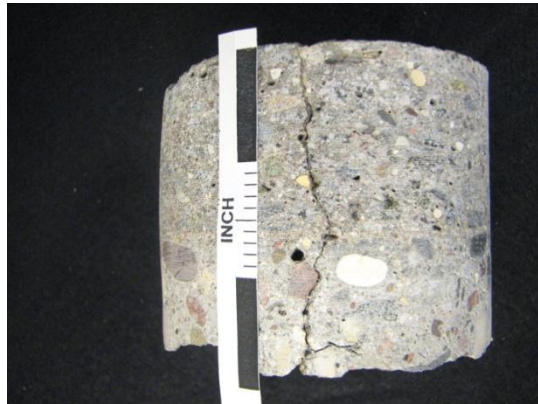
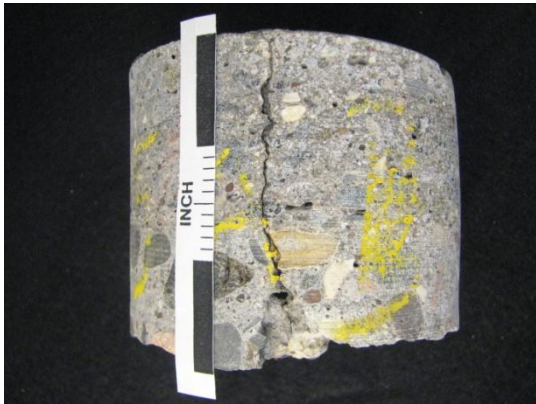
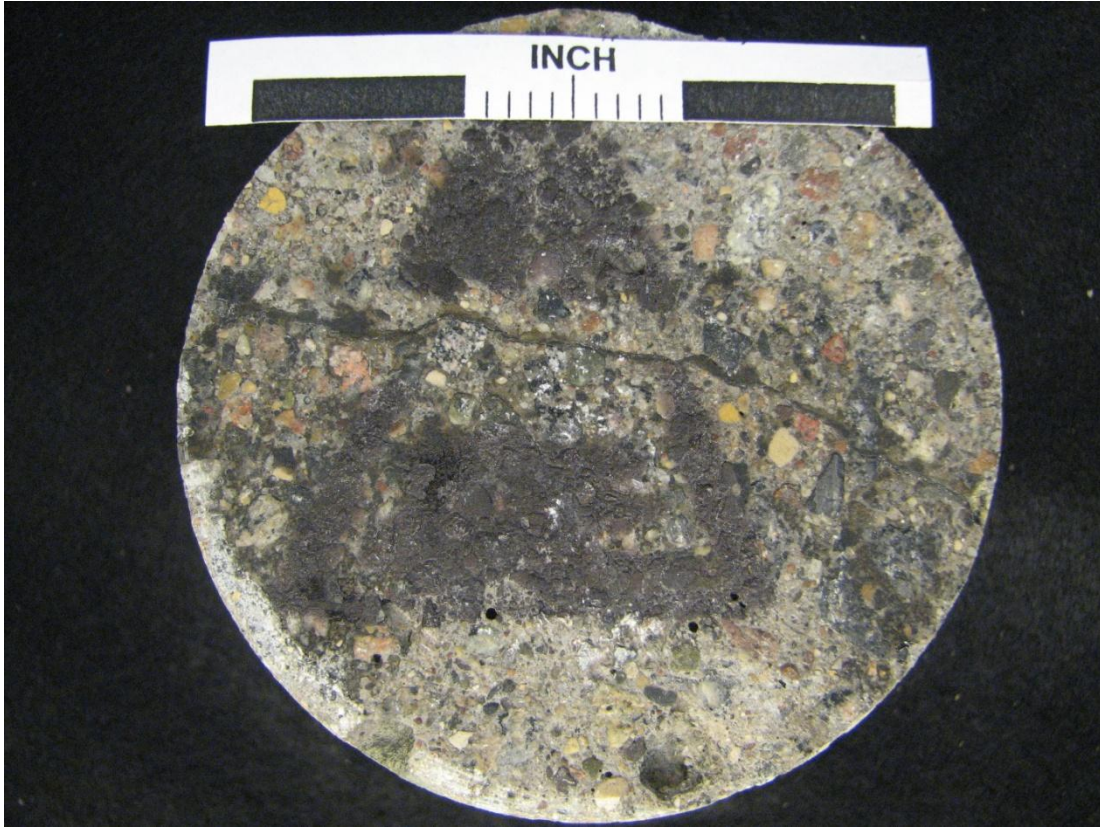
BRAUN
 INTERTEC



Core #: 24A
 Subject: Test Section 12, Test 24A – Paulco TE-2501
 Comments: Depth of Maximum Penetration is 0.108 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973

BRAUN
 INTERTEC



Core #: 35A

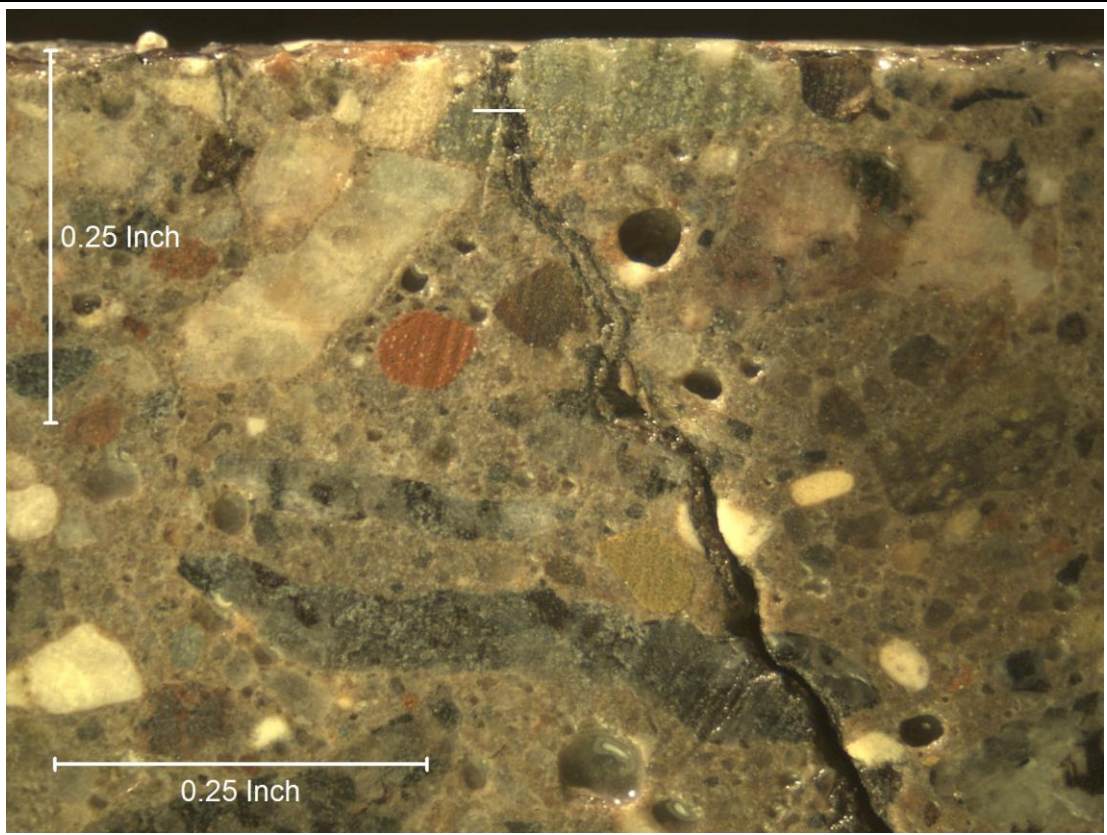
Subject: Test Section 12, Test 35A – Paulco TE-2501

Location: Smith Avenue High Bridge

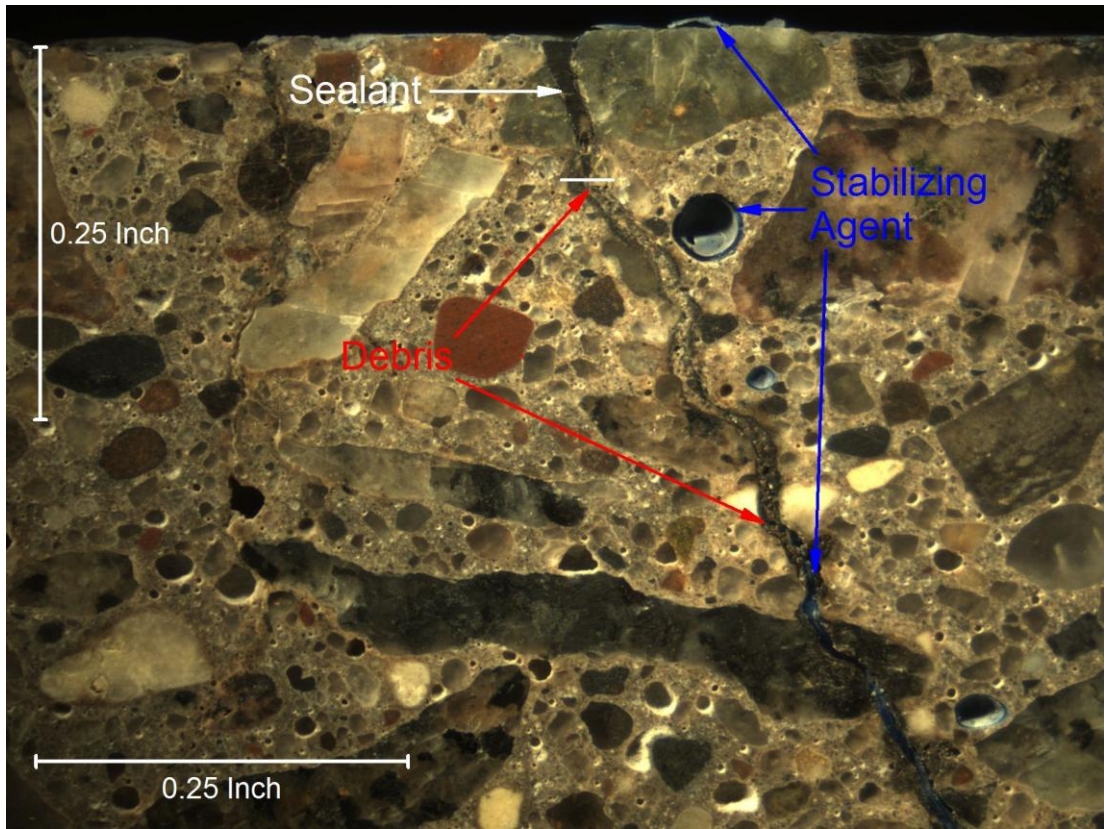
Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

Project BL-09-03973

BRAUN
INTERTEC

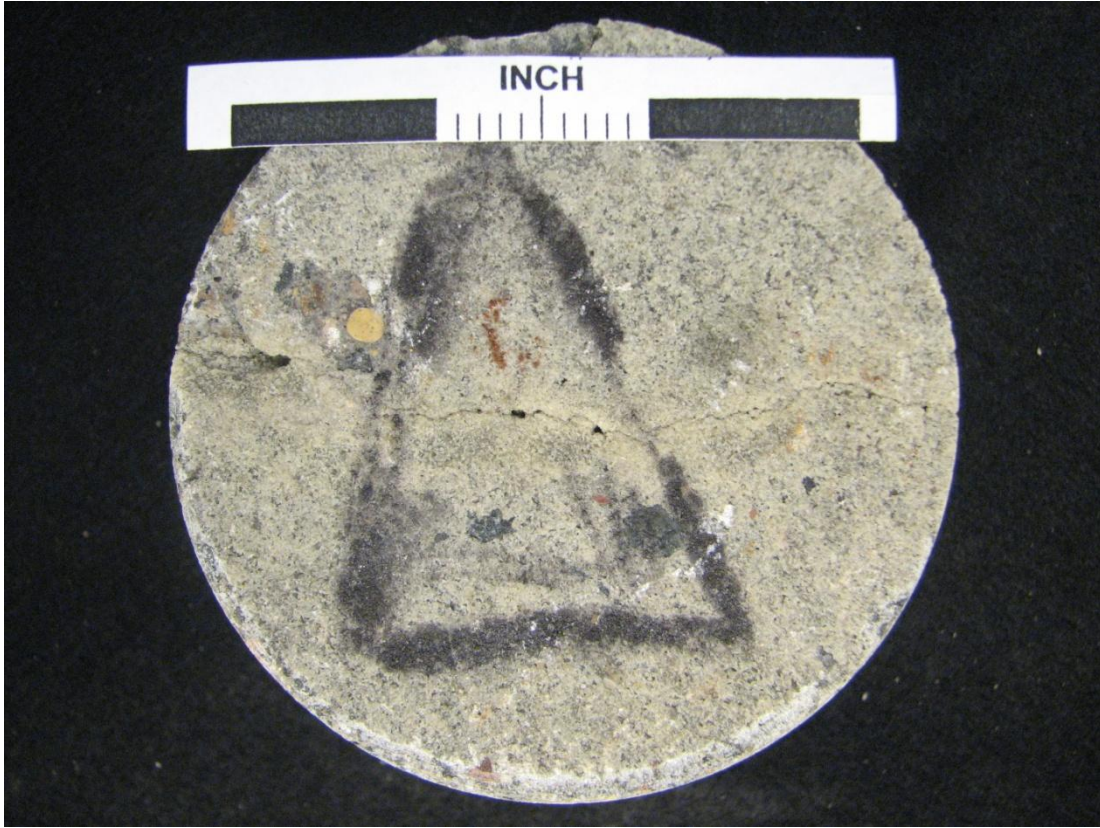


Core #: 35A Project BL-09-03973
 Subject: Test Section 12, Test 35A – Paulco TE-2501
 Notes: Depth of Maximum Penetration is 0.041 in. White horizontal line marks the approx. depth of sealant.



Core #: 35A Project BL-09-03973
 Subject: Test Section 12, Test 35A – Paulco TE-2501
 Comments: Depth of Maximum Penetration is 0.106 in. White horizontal line marks the approx. depth of sealant.





Core #: 25A

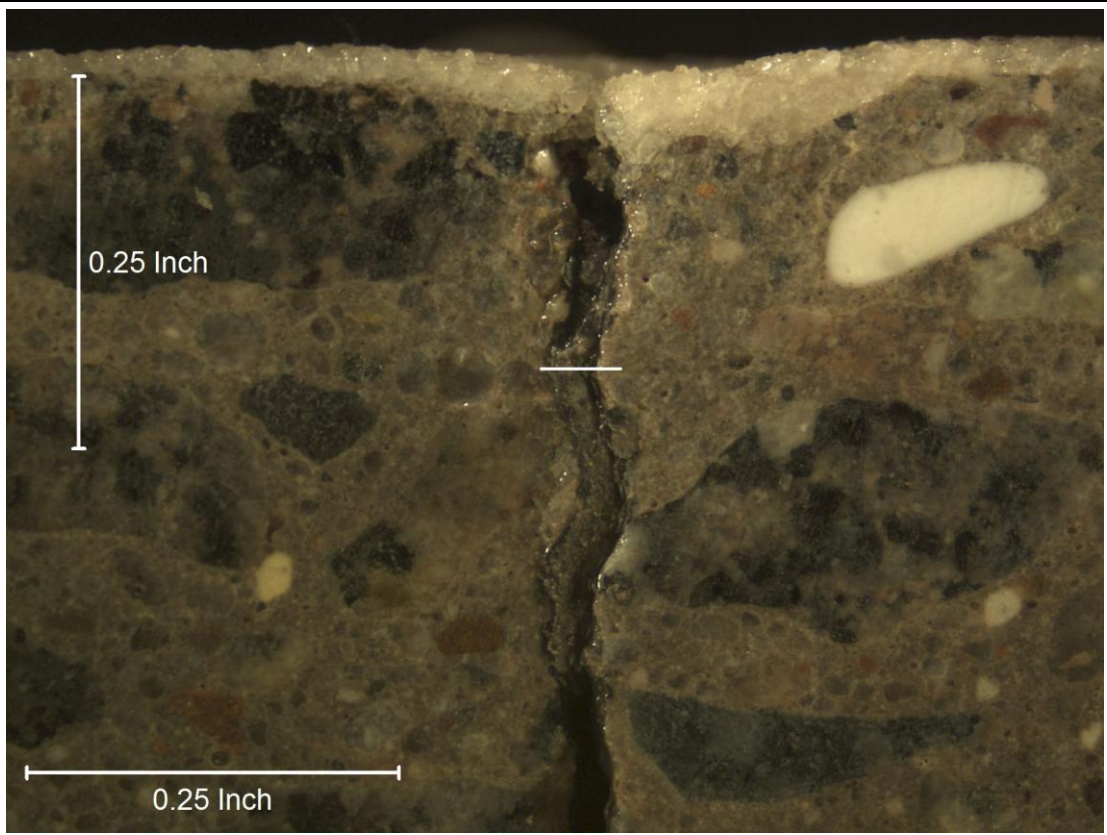
Subject: Test Section 13, Test 25A – Euclid, Dural 50 LM

Location: Smith Avenue High Bridge

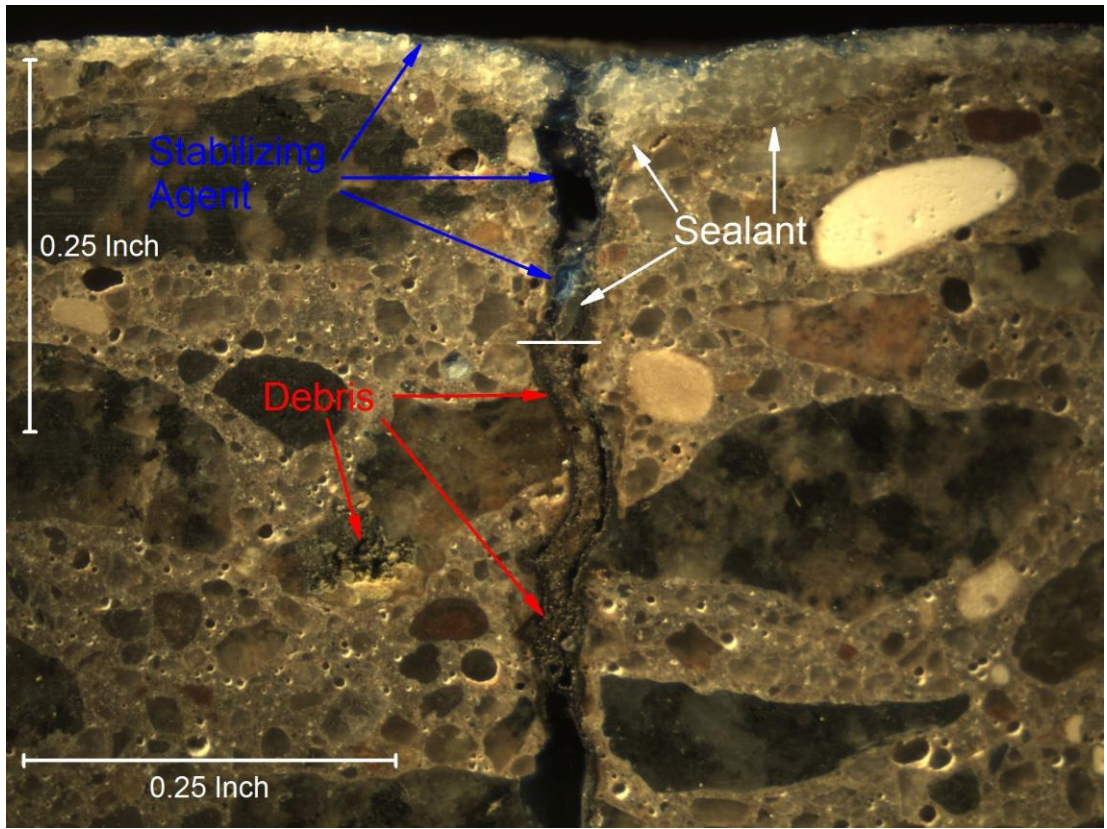
Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

Project BL-09-03973

BRAUN
INTERTEC

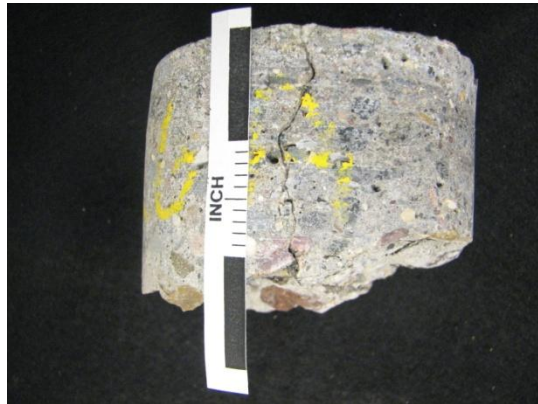


Core #: 25A Project BL-09-03973
 Subject: Test Section 13, Test 25A – Euclid, Dural 50 LM
 Notes: Depth of Maximum Penetration is 0.194 in. White horizontal line marks the approx. depth of sealant.



Core #: 25A Project BL-09-03973
 Subject: Test Section 13, Test 25A – Euclid, Dural 50 LM
 Comments: Depth of Maximum Penetration is 0.196 in. White horizontal line marks the approx. depth of sealant.





Core #: 26A

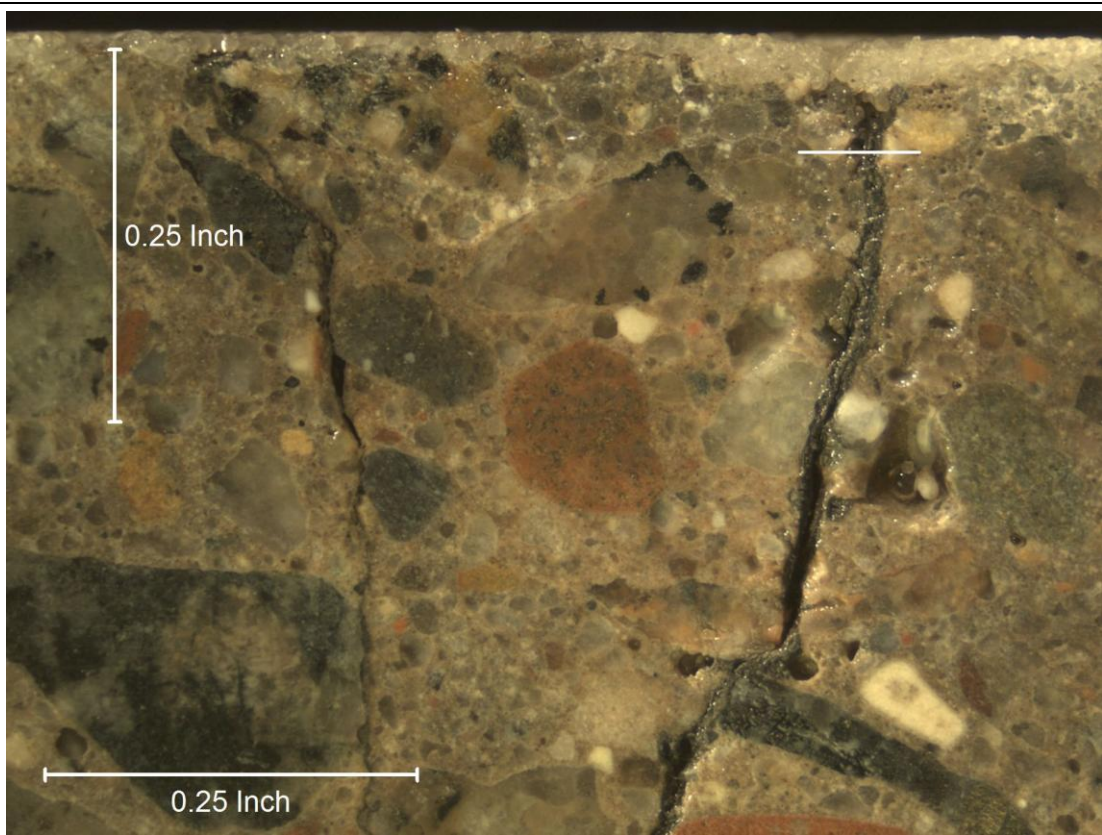
Subject: Test Section 13, Test 26A – Euclid, Dural 50 LM

Location: Smith Avenue High Bridge

Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

Project BL-09-03973

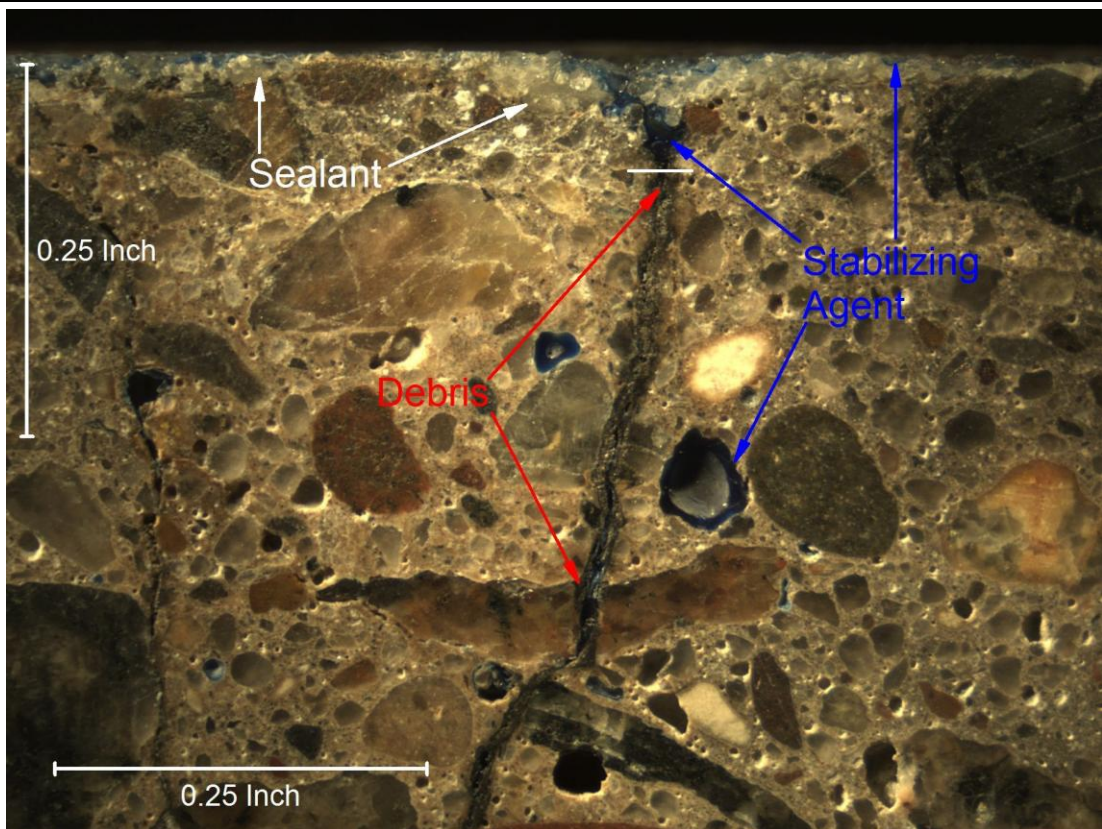
BRAUN
INTERTEC



Core #: 26A
 Subject: Test Section 13, Test 26A – Euclid, Dural 50 LM
 Notes: Depth of Maximum Penetration is 0.064 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973

BRAUN
 INTERTEC



Core #: 26A
 Subject: Test Section 13, Test 26A – Euclid, Dural 50 LM
 Comments: Depth of Maximum Penetration is 0.066 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973

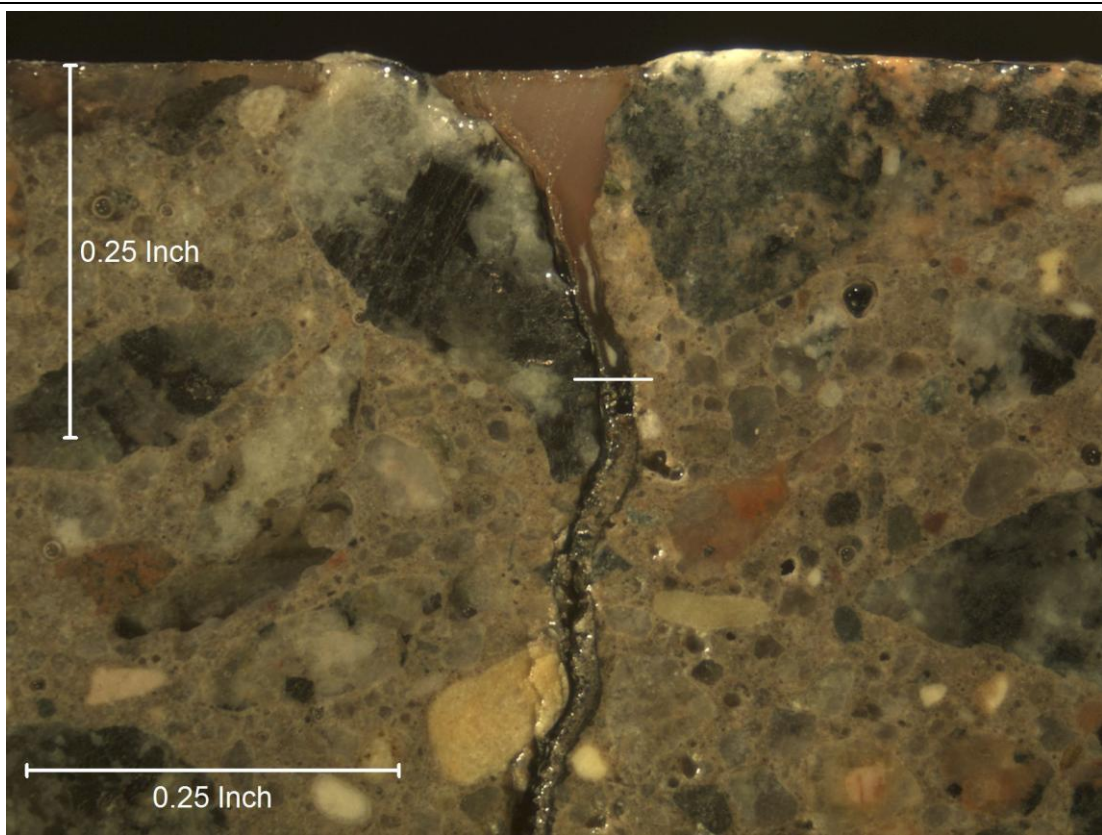
BRAUN
 INTERTEC



Core #: 27A
Subject: Test Section 14, Test 27A – Transpo T-70, MX-30
Location: Smith Avenue High Bridge
Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

Project BL-09-03973

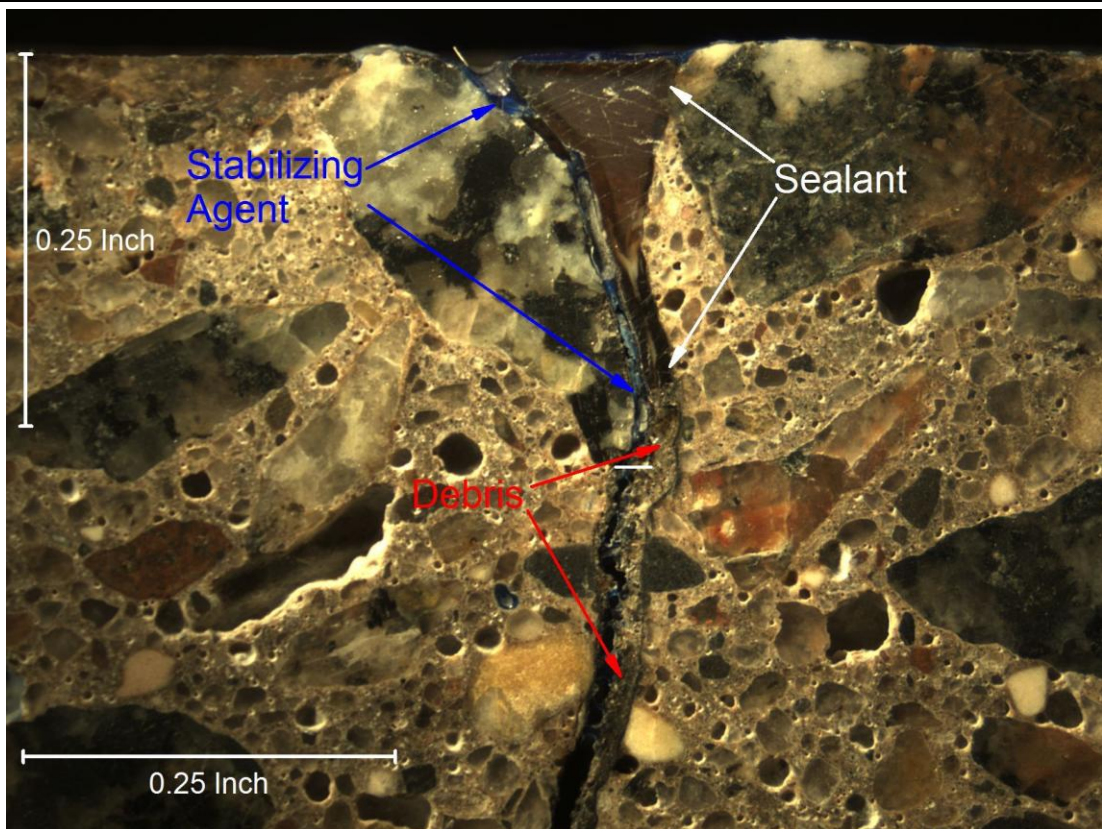
BRAUN
INTERTEC



Core #: 27A
 Subject: Test Section 14, Test 27A – Transpo T-70, MX-30
 Notes: Depth of Maximum Penetration is 0.214 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973

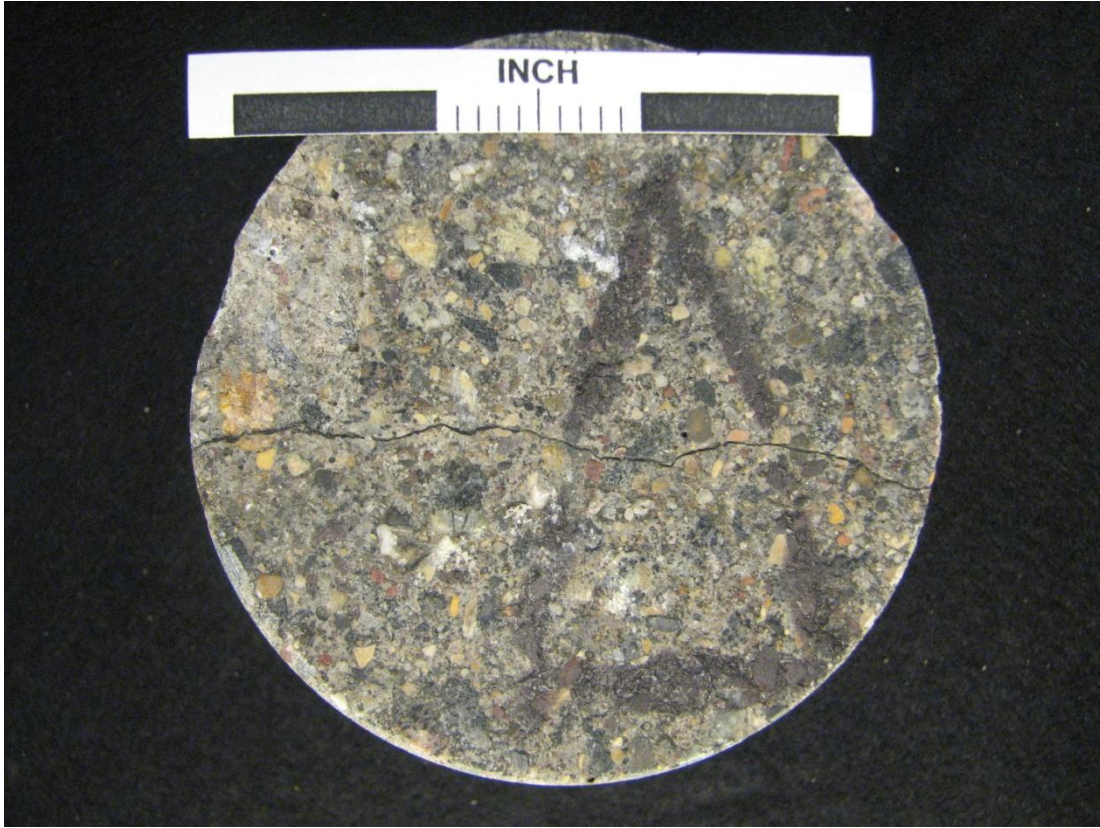
BRAUN
 INTERTEC



Core #: 27A
 Subject: Test Section 14, Test 27A – Transpo T-70, MX-30
 Comments: Depth of Maximum Penetration is 0.299 in. White horizontal line marks the approx. depth of sealant.

Project BL-09-03973

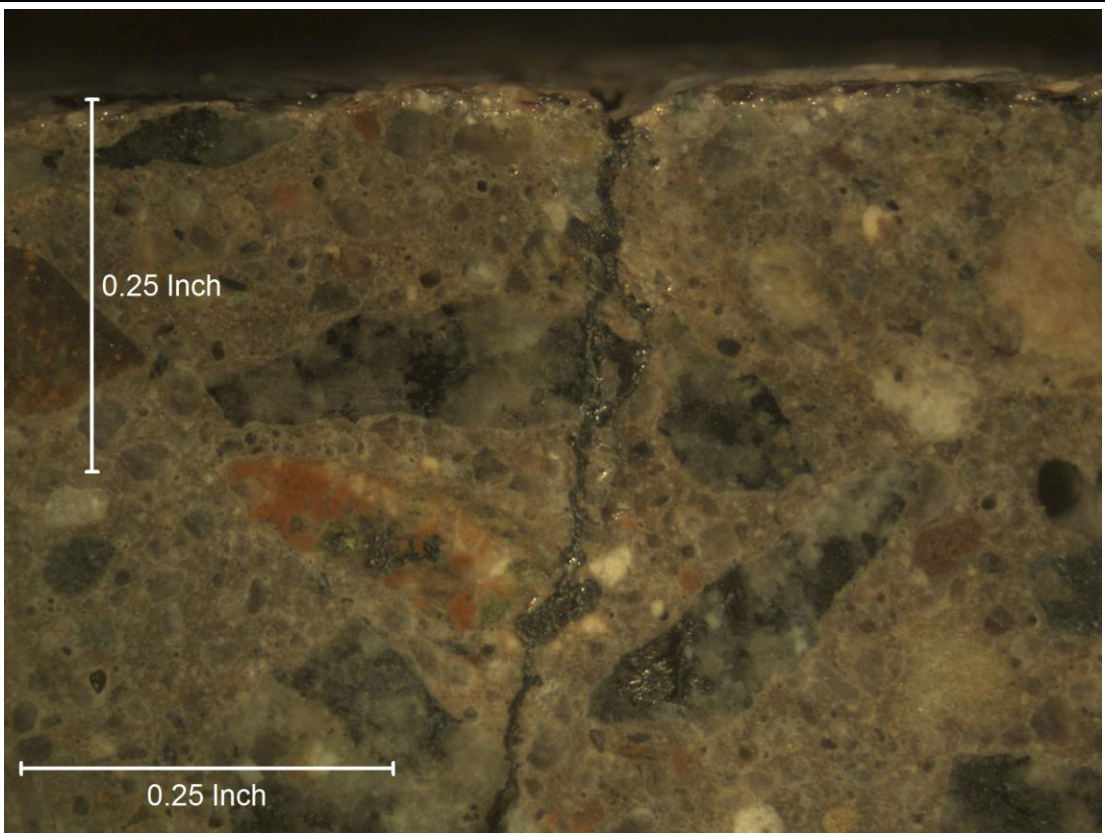
BRAUN
 INTERTEC



Core #: 28A
Subject: Test Section 14, Test 28A – Transpo T-70, MX-30
Location: Smith Avenue High Bridge
Notes: Top photo is the top surface of the core. The direction of traffic flow is towards the top of photo. Bottom two photos are the left and right side of the core when viewed in the direction of traffic flow.

Project BL-09-03973

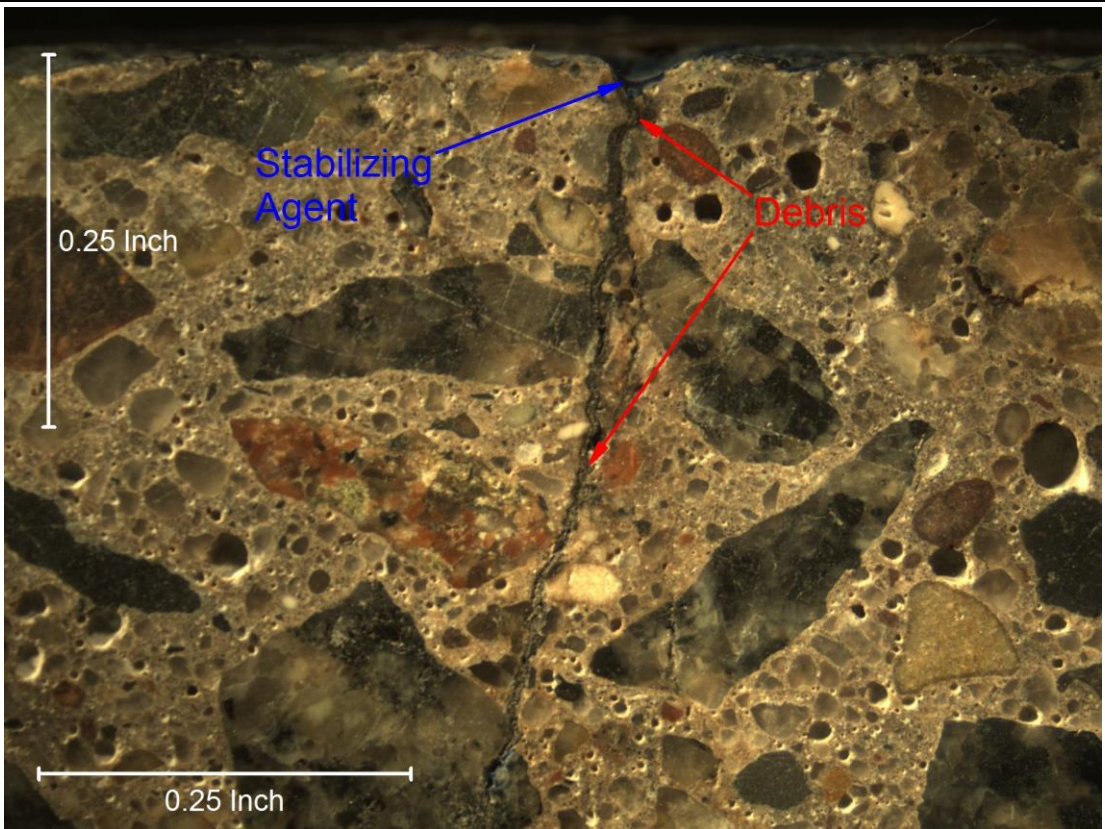
BRAUN
INTERTEC



Core #: 28A
Subject: Test Section 14, Test 28A – Transpo T-70, MX-30
Notes: Depth of Maximum Penetration is 0.000 in.

Project BL-09-03973

BRAUN
INTERTEC



Core #: 28A
Subject: Test Section 14, Test 28A – Transpo T-70, MX-30
Comments: Depth of Maximum Penetration is 0.000 in.

Project BL-09-03973

BRAUN
INTERTEC