Experimental Joint Sealants for Hot Mix Asphalt Pavements and Overlays

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The Illinois Department of Transportation (IDOT) is continually looking for ways to improve long-term performance of pavements. One particular area of concern is the rapid deterioration of longitudinal joints in hot-mix asphalt (HMA) pavements and overlays. In 2003, IDOT constructed four experimental feature projects using longitudinal joint sealant materials as a follow-up to field trials that were constructed in 2001. The experimental feature projects included installing two different products for longer segments to evaluate the constructability of the treatment and monitor long-term performance. This report was published as an internal department report to capture the information for monitoring purposes.

The projects using these materials have seen exceptional performance in Illinois and a third report will be developed to document the long-term performance of all projects. This report is now being released externally to share the information from the early projects with other states. No revisions have been made to the content of the original report during this release.

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16. Abstract

Longitudinal joints in the construction of hot mix asphalt pavements and overlays are a source of failure for the long-term performance of the pavement or overlay. Reduced density and increased permeability to surface water along the longitudinal joint lead to deterioration such as cracking, raveling, and stripping. The challenge of constructing a longitudinal joint that will not deteriorate under environmental and loading conditions has confronted pavement designers and constructors for numerous years.

Many concepts and materials have been developed to address the deterioration of longitudinal joints in hot mix asphalt pavements and overlays. Notched wedge joints, the Michigan step joint, and many others, as well as variations in rolling patterns, have been developed to improve density at the joint. Joint tapes, liquid bituminous adhesives, and other products have been developed to seal the joint itself. In addition to these products, bituminous sealants have now been developed to address the issue of permeability at the longitudinal joint and surrounding area.

Illinois experimented with the use of bituminous sealants on four projects in the fall of 2003. Two projects were constructed on interstate routes, and the remaining two projects were constructed on Illinois primary routes. Two products were used as part of the evaluation; however, both products were not used on each project. The two products include “J-Band®” by Heritage Research Group, and “QuickSeam®” by Hendy Products Inc..

This report will cover the construction and initial testing for all four projects. In addition, the material costs and future research objectives will be discussed.

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Construction Report

EXPERIMENTAL JOINT SEALANTS FOR HOT MIX ASPHALT PAVEMENTS AND OVERLAYS

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ABSTRACT

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INTRODUCTION

A primary focus for the Illinois Department of Transportation (IDOT) is the rehabilitation and maintenance of existing interstates, state primary routes, and local agency roadways. Many of these facilities have surpassed their design lives and they are beginning to deteriorate rapidly. The most common form of rehabilitation in Illinois is a hot mix asphalt (HMA) overlay. The current policy for rehabilitation of interstate pavements is a 3.75-inch HMA overlay, while the policy for state primary routes is a 2.5-inch HMA overlay. Research indicates that this type of overlay will only last approximately 10 to 12 years on an existing concrete pavement with no durability cracking [1].

A major factor in the failure of a HMA overlay is the deterioration of the longitudinal joints. The construction of a HMA overlay with uniform properties across the entire lane width is very challenging. Achievement of density at the unconfined edges without over rolling the material can be difficult. Also, permeability of the bituminous overlay increases in areas of low density. Reduced density and increased permeability of surface water and air leads to premature failures such as cracking, raveling, oxidation, and stripping.

In an effort to reduce or prevent the occurrence of longitudinal joint deterioration, IDOT initiated a research study to investigate the constructability and performance of two bituminous sealant systems for longitudinal joints. The two products selected for this research effort are “J-Band®” by Heritage Research Group and “QuickSeam®” by Hendy Products Incorporated.

This report will cover the project selection and construction of four experimental projects in Illinois. Project details, construction details, and field permeability testing will be included. Also, the material costs and future research objectives will be discussed.

OBJECTIVE

The objectives of this research effort are to evaluate the constructability and performance of two bituminous longitudinal joint sealant systems. This objective will be accomplished through construction inspection, field permeability testing, laboratory permeability testing, and performance monitoring. This report details the constructability and initial field permeability testing for both joint sealant systems.

The objective of the bituminous joint sealant systems is to decrease the permeability of the hot mix asphalt surface layer along the longitudinal joint by decreasing the amount of interconnected air voids. The sealant systems are applied to the longitudinal joint area prior to placing the surface layer of HMA. Placement of the surface layer of HMA reheats the sealant system, and in combination with the vibratory roller, the heat draws the sealant material up and into the surface layer. The desired migration of the sealant system is roughly three-fourths the thickness of the surface layer.

Once the interconnected void system at the longitudinal joint is filled with the bituminous sealant, the permeability of the joint to surface water and air is reduced. The reduction in permeability at the longitudinal joint will help to minimize cracking, raveling, oxidation, and stripping failures at the joint.

PLANNING AND DESIGN

Planning for the use of these sealant products began several years ago. The need was evident for a material that could be easily, and quickly, applied to the longitudinal joint area for improvement of the joint performance. Several formulations of both sealant products were tested in the laboratory and at isolated field trials. The field trials provided invaluable information concerning proper material placement, migration amounts, permeability results, and density results at the longitudinal joint. Based on the laboratory results and application at the field trials the products were adjusted to optimize migration in the field.

Several material and application requirements were placed upon the products to optimize the performance. Material requirements included limits on dynamic shear, creep stiffness, ash percentage, and elastomeric polymer percentage. Application requirements included tolerances on the thickness placed, width of material placed, and placement time prior to paving operations. A copy of the specification may be found in Appendix A of this report.

The Bureau of Materials and Physical Research made a formal request of the IDOT Districts to submit potential projects for construction with the bituminous joint sealant. As a result of this request, five locations were submitted as potential projects. Four of these projects continued on to the construction phase, while the fifth one was terminated due to a lack of funding. Two of the four projects are on interstate routes, while the remaining two are on state primary routes. Both experimental sealant products were used on the state primary route projects, while only the J-Band® material was used on the interstate projects.

Design for these projects also included the use of a control section for reference. Comparisons of visual performance, as well as field and laboratory testing, between the various experimental and control sections will be performed throughout the course of the research effort.

CONSTRUCTION

The construction of all four experimental projects took place in the fall of 2003. The following sections describe the application and construction process for each experimental project. The placement of the two experimental bituminous joint sealants involves completely different procedures.

The J-Band® material is supplied to the jobsite in a single unit tanker truck. The material is heated and pumped to a smaller tank, where it is heated to the application temperature and pumped to the application tool. The application tool places the sealant material as an 18-inch wide band centered over the longitudinal joint of the hot mix asphalt binder material. The sealant material is placed with variable thickness across the band width. The thickness increases between the edge and center of the 18-inch wide band in a triangular shape. The total thickness is also varied based on the thickness of the HMA surface overlay. Thicker surface material overlays require additional sealant material in order to acquire the desired amount of migration. An illustration of the J-Band® material placement may be found in Figure 1.

Figure 1

J-Band® Material Placement

The QuickSeam® material is packaged and shipped to the construction site in prefabricated rolls. The material is packaged with a wax paper backing on one side and a thin plastic backing on the other. The first pass of the material is placed 9-inches wide and adjacent to the longitudinal joint of the hot mix asphalt binder material. This pass is covered up by the first pass of the HMA surface layer. The second pass is also placed 9-inches wide, however, this pass is placed so that a portion of the material rests on the vertical face of the first pass of the HMA surface overlay. A diagram of the QuickSeam® material placement may be found in Figure 2.

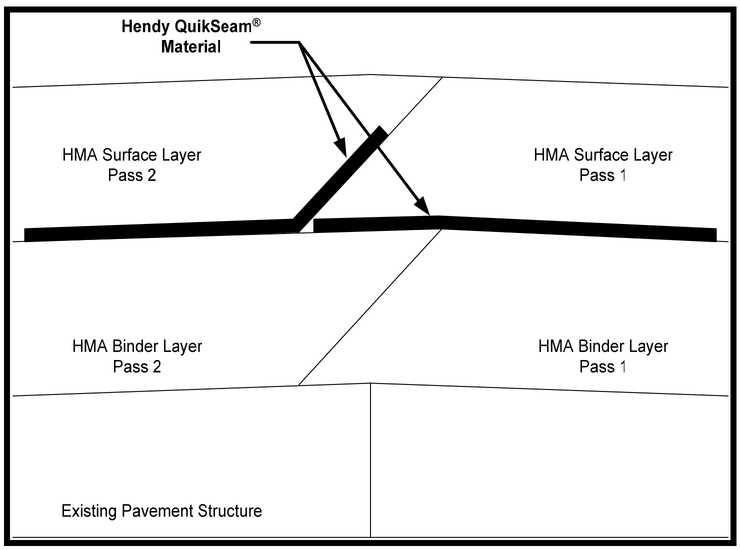

Figure 2

QuickSeam® Material Placement

ILLINOIS ROUTE 50

The first full-scale experimental project was constructed in IDOT District 1 on Illinois Route 50 (Cicero Avenue) in Richton Park during August and September. Illinois Route 50 is a four-lane divided highway through this urban setting. The average daily traffic in 2003 was 22,100 vehicles with 5.0 percent heavy commercial vehicles.

The limits for the experimental portion of this project are between Sauk Trail Road (Station 246+50) on the north and Steger Road (Station 191+30) on the south. The length of the experimental section is slightly more than one mile. The J-Band® material was used in the southbound lanes and the QuickSeam® material was used in the northbound lanes. The experimental sealant materials were only used at the centerline joint of the two lanes. The experimental sealant materials were not used at the longitudinal joint between the lane and shoulder. The control section for each experimental material is located immediately north of Sauk Trail Road (Station 255+00 to 280+00) in both the northbound and southbound lanes. The control sections are 2,500 feet in length. A detailed project layout with stations for permeability testing may be found in Figure 3.

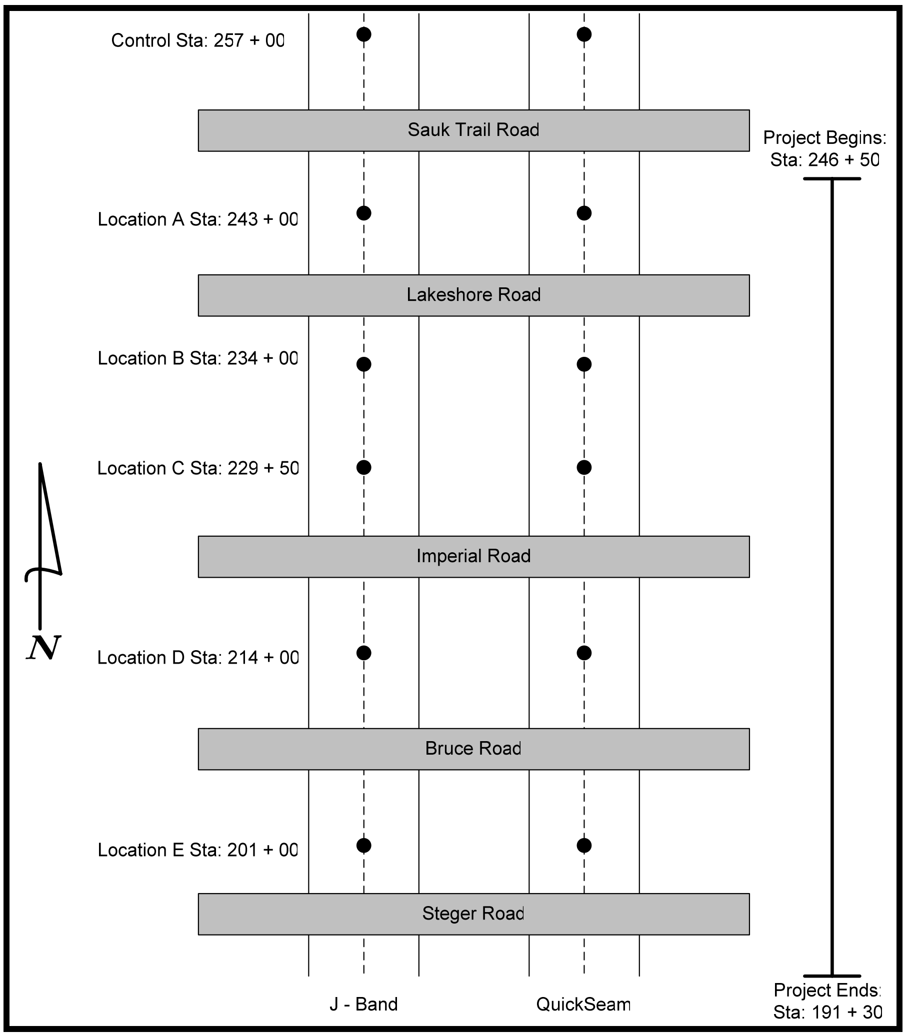

Figure 3

Illinois Route 50 Project Layout

The original pavement prior to this rehabilitation was Portland cement concrete with a HMA surface. The first step in this rehabilitation process was to mill the existing HMA overlay and place a 0.75-inch HMA leveling binder. This leveling binder was a surface course mixture (9.5 mm NMAS, N design 70) with a small percentage of recycled materials. The complete mixture design for the leveling binder may be found in Appendix B.

Following placement of the leveling binder, the experimental sealant materials were placed on the centerline longitudinal joint. Through traffic was restricted to one lane for the duration of the time between placement of the experimental sealant materials, and placement of the HMA surface course. Traffic turning onto side streets was allowed to cross over the sealant material. Following placement of the experimental sealant materials, a 1.75-inch HMA surface course mixture (9.5 mm NMAS, N design 90) was placed. The complete mixture design for the surface course may also be found in Appendix B.

Placement of the J-Band® sealant material took place on August 14th in the southbound lanes. The ambient conditions were dry with an overcast sky and a mean temperature of 70 – 75° Fahrenheit. Prior to placement of the material, a hand broom was used to sweep away any rocks, dirt, and debris that were lying along the centerline joint.

The J-Band® material was supplied to the job site in a single unit tanker truck. This truck was equipped with a tank heater and a pump to transfer the material to a smaller tank on a trailer pulled by a pick-up truck. Material was only transferred from the supply tank to the trailer tank when the trailer tank was empty. This smaller tank was also equipped with a heater and a pump to transfer the material to the application tool.

The application tool is similar to a square box with a strike-off plate at the trailing edge. The 18-inch strike-off plate was tapered to allow for more material to be placed over the exact longitudinal joint than at the edges. For this project, the sealant material was placed 0.25-inches thick directly over the joint, and 0.219-inches thick at the outside edges. A schematic of the application tool may be found in Figure 4. The rate of material placement depended largely on the supply pumps, application tool, and the rate of speed of the applicator, but averaged between 40 and 45 feet per minute or roughly 2,500 feet per hour. Four people were utilized to perform the placement; one person to operate the broom, one to drive the material supply truck and trailer, one to operate the material supply trailer, and one to operate the application tool on the pavement.

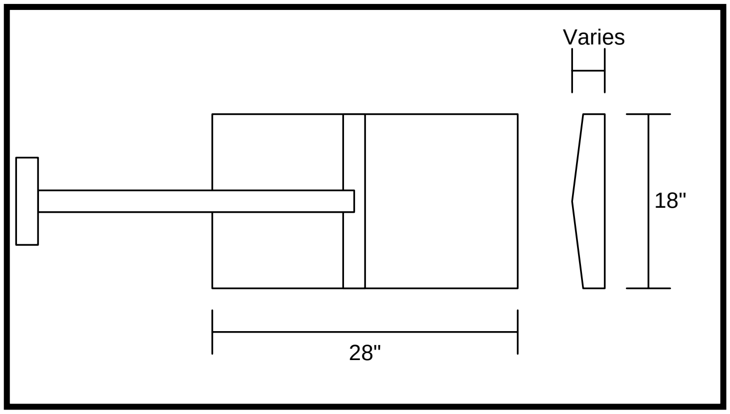

Figure 4

Schematic of J-Band® Application Tool

The J-Band® material was placed at approximately 300 – 320° Fahrenheit and required approximately 10 minutes to cool to ambient temperatures. The material was viscous, however uniform in texture and consistency, and when placed at these elevated temperatures easily flowed through the application tool.

The placement of the J-Band® material presented a couple of problems. Even with sweeping the pavement surface at the joint, sand sized rocks remained that caught the strike-off plate and left a track mark in the material. More critical, however, was the difference in elevation between the two lanes of leveling binder on either side of the longitudinal joint. This difference in elevation resulted in thick and thin areas of material placement depending on the location of the strike-off plate with relation to the joint. Figure 5 illustrates the elevation difference and the resultant problems with the sealant material placement.

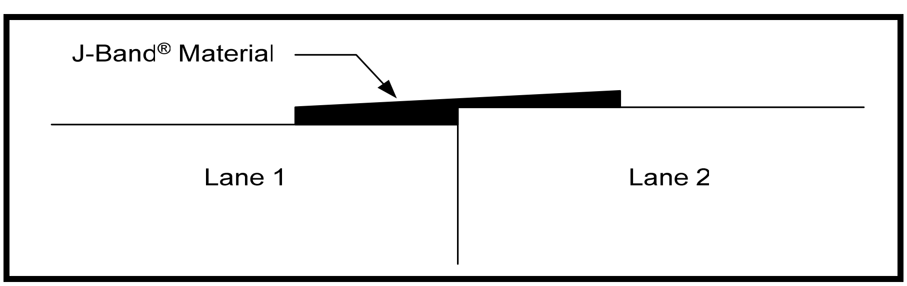

Figure 5

Lane to Lane Elevation Difference With J-Band® Placement

An initial concern with this material was tracking or “picking up” under a vehicle tire. This concern is especially true on hot summer days that may soften the material on the pavement surface. The tracking problem was encountered at a couple of locations where side street traffic crossed the material before it cooled to ambient temperatures and solidified. Only a slight amount of material was tracked onto the vehicle tires at these locations.

It was also noted that once placed, and cooled, the material remained pliable enough to deform and pick up under the static weight of a traffic barricade. Figure 6 illustrates how the material deformed and picked up in chunks once adhered to another surface.

Figure 6

J-Band® Material Pick Up Under Traffic Barricade

The HMA surface was placed for this section on September 9 and 10. The driving lane was placed first on September 9th, and the passing lane was placed on September 10th. No problems were encountered with the placement of the surface course over the sealant material. The exposed sealant material that was not covered by the paving of the driving lane did warm up slightly in the area of the joint. However, the material did not deform or migrate away from the joint.

The first pass of the QuickSeam® sealant material was placed in the northbound lanes between August 14th and 18th, while the second pass was placed on September 9th. The ambient conditions were dry with a partly sunny sky and a mean temperature of 75 – 80° Fahrenheit for all four days. Prior to placement of the material, compressed air was used to remove any rocks, dirt, and debris from the pavement surface along the centerline joint.

Three people were used to perform the placement of the sealant for the first pass; one person at either end of the roll of material, and one person in the middle of the roll to remove the wax paper backing and help guide the material into place. The rate of material placement averaged 100 to 150 feet per hour. Additional personnel were brought in to place the second pass, and the rate of material placement was greatly increased as the entire pass was placed in one day.

The placement of the QuickSeam® material was very labor intensive and presented several problems to the contractor. The first major problem was the amount of time required to place the material. Placement of one mile of the material during the first pass required three people three working days to complete. This production rate was much too slow when compared to the production rate of the HMA paving machine. The second pass was completed in only one day, however, additional labor was required.

A second problem with the material was the removal of the wax paper backing material. The material was shipped in boxes of four rolls stacked end to end. By stacking the rolls end to end, the backing material on the bottom three rolls was marred and deformed at the edges. Once unrolled, the backing material did not release easily at the deformed edges and tore into smaller pieces. The removal of these small pieces of wax paper was extremely labor intensive. The thin plastic backing that remained on the top surface of the sealant material was swept away with the mechanical broom immediately prior to paving of the surface course. This process worked fairly well as the thin plastic backing had dried out in the sun and crumbled under the action of the broom.

Finally, once the sealant material was unrolled and placed, there was a tremendous amount of waste from the wax paper backing material. This backing material must be collected and disposed of properly. The collection and disposal of the backing material was time consuming and expensive for the contractor.

The concern of tracking under vehicle tires was not a concern for this material on this project as the thin plastic backing was left in place until just prior to paving. However, this material is very tacky and will stick to itself and other objects upon contact during placement. The HMA surface course for the driving lane of this section was placed on September 9th, and for the passing lane on September 10th. No problems were encountered with the placement of the surface course over the sealant material.

The control sections for this project received the same leveling binder and surface course mixture designs and thickness. However, the control sections received a layer of Petromat over the longitudinal joints in place of the experimental sealants. The HMA surface course for the control sections was also placed on September 9th in the driving lane, and 10th in the passing lane. No problems were encountered with the placement of the surface course in the control sections.

ILLINOIS ROUTE 26

The second full-scale project was constructed in IDOT District 2 on Illinois Route 26 between Cedarville and the Wisconsin State line during September. Illinois Route 26 is a two-lane highway through this rural setting of rolling terrain. The average daily traffic in 2003 was 4,550 vehicles with 12.0 percent heavy commercial vehicles.

The combined length of the experimental and control sections is nearly six miles; however, there is a three mile, recently rehabilitated, portion of Illinois Route 26 that separates the experimental and control sections. The J-Band® material was used on 3.98 miles of pavement, while the QuickSeam® was used on approximately 0.80 miles. The control section for this project is approximately 0.90 miles. The experimental sealant materials were only used at the centerline joint of the two lanes. The materials were not used at the longitudinal joint between the lane and shoulder. A detailed layout of the experimental and control sections with stations for permeability testing may be found in Figure 7.

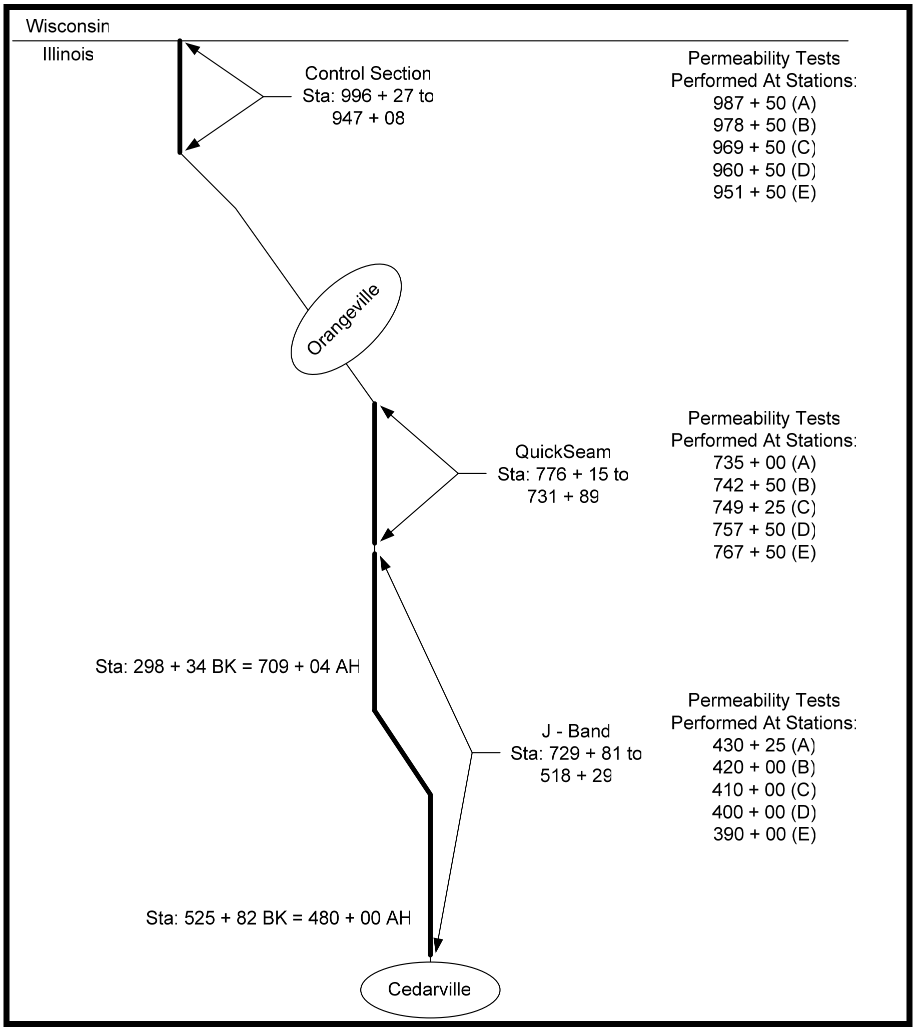

Figure 7

Illinois Route 26 Project Layout

The existing pavement prior to this rehabilitation consisted of a Portland cement concrete pavement with a HMA surface. Milling of the existing HMA surface was limited to the butt joint areas around two structures and the start / stop locations for each section. There was no milling of the existing mainline HMA surface course. The first step in the rehabilitation effort was to place a 0.75-inch HMA leveling binder. The leveling binder was only placed over the lane and not on the shoulder area. The leveling binder was a surface course mixture (9.5 mm NMAS, N design 50). The 1.5-inch surface course was placed over the lane and shoulder during one pass throughout the experimental sections. The surface course was placed over the lane and shoulder as two separate passes within the control section, due to a full ten foot shoulder. The mixture design for the surface course

(9.5 mm NMAS, N design 50) was the same as the leveling binder. The complete mixture design may be found in Appendix B.

The entire 3.98 miles of the experimental J-Band® material was placed on September 3rd. The ambient conditions for the day of placement were sunny and dry with a high temperature of 85° Fahrenheit. There was no special preparation (brooming, compressed air, etc.) prior to placement of the sealant material.

The J-Band® material was supplied to the job site by a single unit tanker truck. Material was heated and transferred from this truck to a smaller tank on a trailer pulled by a pick-up truck. This smaller tank was also equipped with a heater and a pump to transfer the material to the application tool at the application temperature. Four people were used to perform the placement; one person to drive the material supply truck and trailer, two to operate the material supply trailer, and one to operate the application tool on the pavement.

The J-Band® material was placed at approximately 300° Fahrenheit and required about 10 to 15 minutes to cool. Flagmen were used to control traffic and prevent vehicles from crossing the material before it was solidified. However, at a couple of locations a vehicle did manage to cross the material before it cooled, and the material did track onto the vehicle tires. Figure 8 illustrates the amount and condition of the material when it tracks onto a vehicle tire. A thin layer of lime dust was spread over the material at all cross roads and driveway entrances to prevent tracking when vehicles did cross the material. Figure 9 illustrates the application of lime dust at a crossroad intersection to prevent tracking.

Figure 8

Tracking of J-Band® material

Figure 9

Application of lime dust at intersections

The HMA surface was placed in the southbound lane on September 5th and 10th. The surface was placed in the northbound lane on September 8th and 9th. Significant problems were encountered while placing the surface lift over the J-Band® material on this project.

The first problem noted occurred at the start of paving in the area of a butt joint to a mainline bridge. The existing pavement was milled down to bare concrete, and the J-Band® material was placed directly on the concrete. The first few loads of surface HMA material arrived at the project around 310° Fahrenheit. The elevated temperature of the HMA, and the impermeable concrete below, forced the sealant material to migrate through to the surface of the pavement. The action of the vibratory break down roller caused the vertical edge of the centerline joint to slough and flow under the roller. Once the rolling patterns were completed and the extra rich material at the centerline joint sloughed, a crack developed in the surface of the pavement at the outside edge of the J-Band® material.

Additional cracks of this nature were noted throughout the length of the J-Band® experimental section. However, it is believed that these cracks were introduced more by the rolling pattern of the vibratory roller, as these cracks developed in areas where a leveling binder was placed below the surface lift. In these areas, the sealant material did not migrate to the surface. The cracks were believed to be created by a distinct boundary line between asphalt cement contents within the surface lift. The surface lift material placed directly over the J-Band® material absorbed the sealant material and changed physical properties in relation to the surface material adjacent to it. The two materials responded differently to the action of the vibratory roller. Another contributing factor is the relatively low “N” design number of 50 (less stable mixture) for the overlay. Cracks also developed along the confined edge at the boundary between the J-Band® material and regular surface HMA. An example of this boundary cracking may be found in Figure 10.

Figure 10
J-Band® Boundary Cracking

The experimental QuickSeam® material was placed on September 9th. The ambient conditions for the day of placement were sunny and dry with a high temperature of 80° Fahrenheit. No special preparation of the leveling binder was done before placement of the QuickSeam® material. Six to eight people were used throughout the day to place the material. These individuals worked as two teams of three to four people with each team placing every other roll.

The QuickSeam® material was shipped to the project in cardboard boxes containing four 25-foot rolls. The rolls were stacked end to end within the box, which deformed the edges of the material on the bottom three rolls. The rolls were unboxed and laid out along the centerline joint at 25-foot increments ahead of the two placement teams.

Placement began in a fashion similar to that on Illinois Route 50. The wax paper backing was removed from the material as it was unrolled and placed on the pavement. This process was very cumbersome, and the deformed edges from the stacked rolls made it very difficult to remove the wax paper backing. The wax paper ripped and left small fragments of the paper stuck to the QuickSeam® material. The removal of these small pieces of wax paper was extremely tedious and time consuming, however, necessary to prevent impurities and the creation of a slippage plane for the overlay materials. Once the wax paper was removed and the material was positioned along the centerline joint, the plastic backing material was removed from the top of the material. Again, this material ripped and left small fragments behind that had to be cleaned off. The tedious, time consuming, effort to remove the small fragments of plastic may be seen in Figure 11.

Figure 11
Removal of QuickSeam® plastic backing

A trial and error process was used to establish a better method for removing the plastic backing once the material was placed on the pavement. Eventually, a utility knife was used to cut the plastic backing into two separate halves. The halves were then easily peeled off the material from the center towards the outer edges. This process eliminated the small fragments of plastic that were left on the material at the material edges. This process also increased the placement rate for the QuickSeam® material. The average placement rate for the first pass of the material was approximately 800 linear feet per hour. The entire first pass took approximately six hours to place.

Placement of the second pass of the material presented many of the same problems; however, the second pass had to be placed so that a portion of the material laid against the vertical face of the HMA surface placed in the adjacent lane. Again, a trial and error process was used to develop a solution for placement. The best method determined was to place the material against the adjacent HMA surface and press it into place by foot.

The problem still remained of peeling the wax paper backing off the material before placing it onto the pavement. Eventually, it was determined that the material could be completely unrolled upside down and the wax paper backing cut into halves with the utility knife. Once cut, the two halves of wax paper were peeled off from the center towards the outer edges. Three to four people were then used to flip the material right side up and place it along the centerline joint all at once. This process dramatically improved the placement rate. Placement of the second pass of the sealant material was done at a rate of approximately 1,500 feet per hour. The second pass of the material was placed in approximately three hours. Illustrations of this placement method may be found in Figures 12 and 13.

Figure 12

Preparation of the QuickSeam® material for placement

Figure 13
Placement of the QuickSeam® material

The wax paper and plastic backings from the sealant material were collected in trash bags and placed along the shoulder of the highway. Once all the material was placed, the trash bags were collected and hauled off the jobsite in a tractor trailer.

Placement of the QuickSeam® material was done immediately prior to the HMA paving machine. The production rate for the paving machine was very slow, and at times was stopped to wait on the placement of the QuickSeam® material. However, the entire QuickSeam® experimental section was placed and paved over in one day. There were no problems with the placement and compaction of the HMA over the QuickSeam® material.

INTERSTATE 57

The third full-scale project was constructed in District 1 on Interstate 57 around milepost 325 near Peotone. This project was also constructed in September. Interstate 57 is a major north-south interstate through Illinois. This section of the interstate is four lanes, and the terrain is relatively flat. The average daily traffic in 2003 was 30,700 vehicles with 20.0 percent heavy commercial vehicles.

The experimental portion of this project lies between stations 818+67 and 837+67 in the northbound lanes only. The control section is also in the northbound lanes, and falls between stations 840+00 and 855+00. The J-Band® product was the only material used on this project. The experimental sealant material was used at the centerline joint only, and not used at the longitudinal joint between the traveling lanes and shoulders. A detailed project layout with stations for permeability testing may be found in Figure 14.

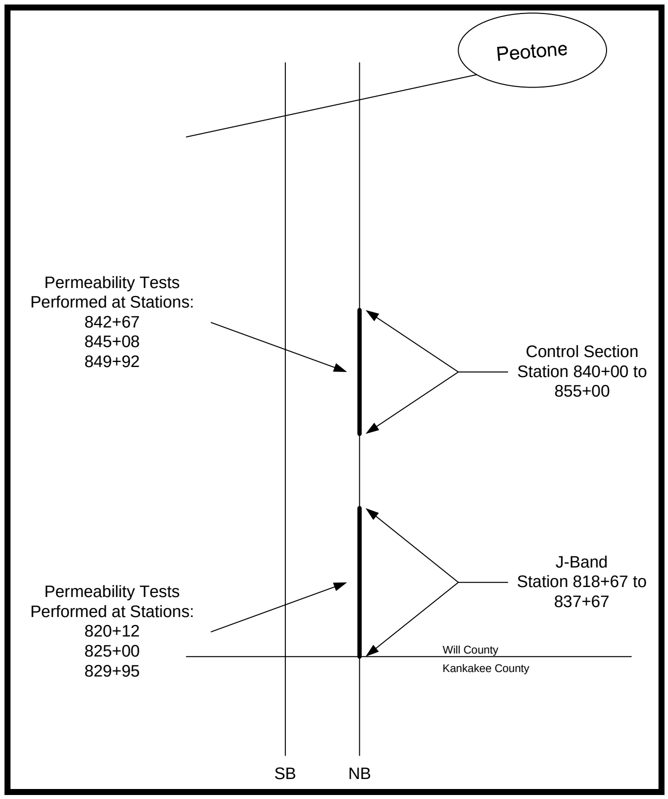

Figure 14

Interstate 57 Project Layout

The existing pavement prior to this rehabilitation was a continuously reinforced concrete pavement with a 3.25-inch HMA overlay placed in 1990. The existing surface material was milled and removed prior to the placement of a new HMA binder material. This binder layer mixture design (12.5 mm NMAS, N design 80) is a stone matrix asphalt design with 85 percent crushed dolomite for coarse aggregate. The complete mixture design may be found in Appendix B.

The experimental J-Band® sealant was placed directly on the centerline joint of the binder material. Through traffic was restricted to one lane for the duration of the time between placement of the sealant material and placement of the HMA surface course mixture.

The surface mixture was a stone matrix asphalt design (12.5 mm NMAS, N design 80) with 85 percent crushed steel slag for coarse aggregate.

Placement of the J-Band® sealant material took place on September 13th in the northbound lanes. The ambient conditions were dry with a sunny sky and a mean temperature of 75 – 80° Fahrenheit. No special preparation of the joint area (brooming, compressed air, etc.) was done prior to placing the joint sealant material. The material was placed in a fashion similar to the Illinois Route 26 project with no problems encountered.

INTERSTATE 70

The joint sealant material that was placed on interstate 70 was done as a trial section for higher volume traffic. The material was placed at milepost 138 in the westbound lanes. Interstate 70 is a four-lane highway through this rural setting of rolling terrain near Martinsville. The average daily traffic in 2003 was 19,800 vehicles with 58 percent heavy commercial vehicles.

The manufacturer of the J-Band® product had some of the material left after completing the project on Illinois Route 50. IDOT agreed to allow them to place the left over material on a short section of the westbound lanes of Interstate 70. The experimental section is 700 feet in length, and located between stations 1176+80 and 1169+80. The adjacent control section is 700 feet in length and located between stations 1185+00 and 1178+00. The experimental sealant material was only used at the centerline joint of the two lanes. The material was not used at the longitudinal joint between the lane and shoulder. A detailed layout of the experimental and control sections with stations for permeability testing may be found in Figure 15.

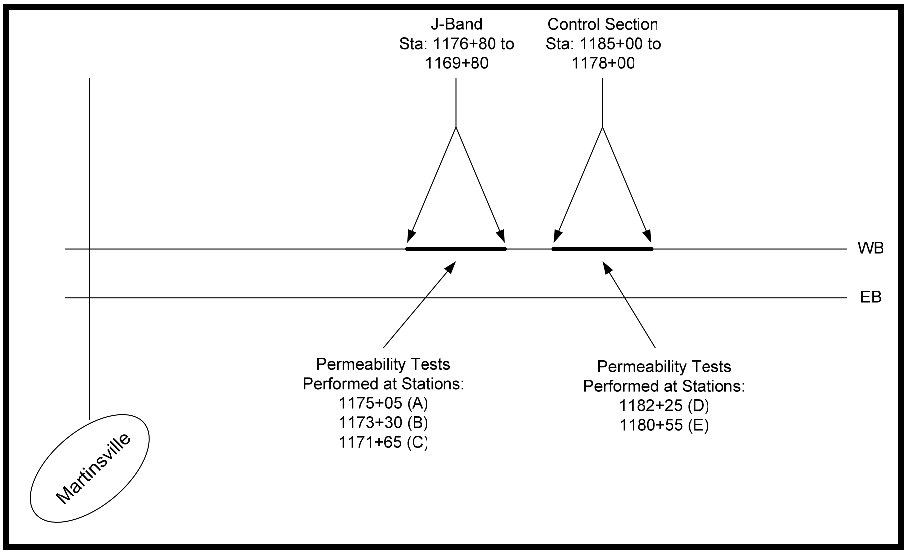

Figure 15

Interstate 70 Project Layout

This section of Interstate 70 was under complete reconstruction at this time with a new full-depth HMA cross section. The experimental sealant material was placed along the centerline joint on the top of the last lift of HMA binder material (19.0 mm NMAS, N design 105). The surface material used for this project was a stone matrix asphalt (12.5 mm NMAS, N design 80). The complete mixture designs for the binder and surface layers may be found in Appendix B.

PERMEABILITY TESTING

The primary method of in-situ testing for performance of the joint sealant materials is a field permeability test. This test involves recording the time required for a known volume of water to permeate the surface of the pavement through a known constant area. The test is performed by placing a neoprene gasket down on the pavement with a silicon seal between the pavement and the gasket. A three tier graduated cylinder is placed on the gasket, and a 20 pound weight is placed over the graduated cylinder to ensure a good seal between the cylinder and the gasket.

The graduated cylinder is filled with water and the time is recorded for a known amount of water to permeate the pavement surface. Each successive tier of the graduated cylinder decreases in diameter and volume for a more timely reading of pavement surfaces with reduced permeability. The largest diameter cylinder is used for high permeability measurements, and the smallest diameter cylinder is used for low permeability measurements. Figure 16 below illustrates the setup of the permeability testing apparatus.

Figure 16

Permeability Testing Apparatus

The test is performed three times at the same position, and the average time is recorded. This time and the dimensions of the graduated cylinder used for the test are entered into the following equation, which is used to determine the actual permeability of the pavement surface. Permeability values greater than 100 for surface mixtures are considered undesirable according to the National Center for Asphalt Technology.

$$k = \frac{aL}{At} \ln\left(\frac{h_1}{h_2}\right)$$

Where:
- k = coefficient of permeability, cm/sec (X 10^{-5})
- a = inside cross sectional area of the standpipe, cm^2
- L = lift height, cm
- A = cross sectional area of the pavement surface tested, cm^2
- t = elapsed time, sec
- h_1 = initial head, cm
- h_2 = final head, cm

Permeability tests were run at select locations throughout the experimental and control sections for each project. At each location, a pattern of seven permeability tests were run. Three tests were run directly over the longitudinal joint at a spacing of two feet. Two tests were then run on the unconfined side of the longitudinal joint. The first of these two located at four inches from the joint, and the second located at 12 inches from the joint. Finally, two tests were run on the confined side of the longitudinal joint. Again, the first test was run at four inches from the joint, and the second at 12 inches from the joint. The permeability testing layout is presented below in Figure 17.

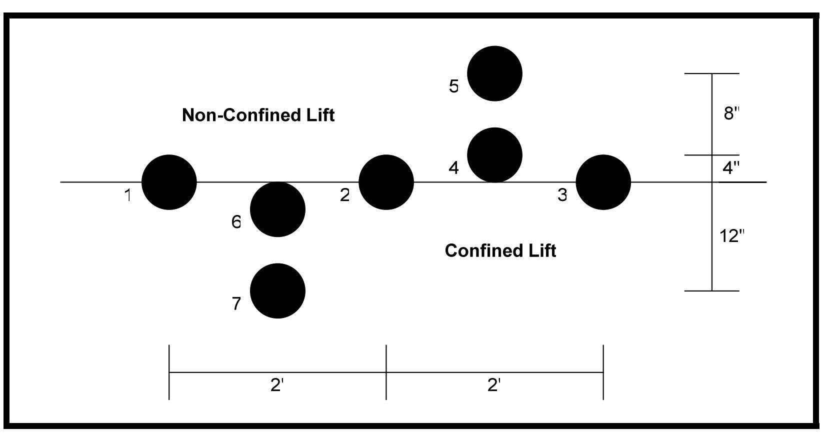

Figure 17

Permeability Testing Layout

Following the permeability tests, two pavement cores were extracted for additional testing in the laboratory. These cores were taken outside the limits of the permeability testing and adjacent to permeability tests one and three as noted in the figure above. The cores were taken back to the laboratory for additional permeability testing and observations of the sealant material migration.

The laboratory permeability test was performed exactly the same as the permeability test on the pavement surface using the same equipment. Once completed, the cores were broke in half through split tensile testing. The broken faces of each core were investigated to identify the amount of migration of the joint sealant materials.

ILLINOIS ROUTE 50

Permeability testing for the project on Illinois Route 50 was performed at five locations within each of the experimental sections. The five stations selected for permeability testing are identical for both the northbound and southbound experimental sections. One permeability test location was selected for each of the control sections, one in the northbound lanes and one in the southbound lanes. Pavement cores were taken at each of the permeability test locations.

Three permeability readings were taken at each test position, and averaged for the final reading at that position. Table 1 below lists the final permeability readings for each test position and an average for that test position within each experimental section. Figure 18 illustrates the test position averages for each of the experimental sections and the control section.

Table 1

Illinois Route 50 Field Permeability Test Results

Position	On Joint	On Joint	On Joint	Non-Confined 4” Offset	Non-Confined 12” Offset	Confined 4” Offset	Confined 12” Offset
#	1	2	3	4	5	6	7
Control Section							
SB	3060	1962	1248	2575	626	101	109
NB	17651	14739	12129	3704	1200	3225	886
Avg.	10356	8351	6689	3140	913	1663	498
J-Band® Section							
A	9156	10952	8676	7286	882	2780	1486
B	11154	11046	12667	8554	2677	11754	4905
C	4500	6543	11301	3586	1149	5243	2217
D	10062	13120	8434	8640	1963	2343	950
E	11754	12086	9765	6473	997	1760	1347
Avg.	9325	10749	10169	6908	1534	4776	2181
QuickSeam® Section							
A	9945	12186	7444	6061	2149	2130	1207
B	15197	13571	9148	6100	1775	4414	12172
C	4329	4472	6054	3878	221	1510	1270
D	5854	5491	4116	4151	95	4206	4155
E	11987	13187	9831	6641	125	4055	2534
Avg.	9462	9781	7319	5366	873	3263	4268

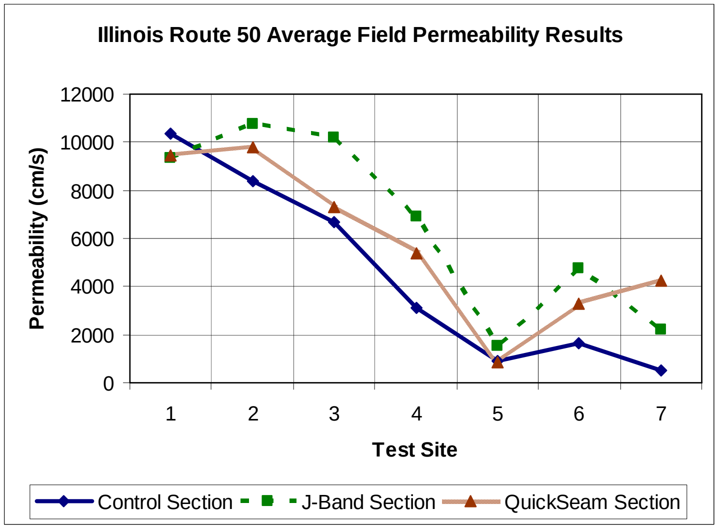

Figure 18

Illinois Route 50 Average Field Permeability Test Results

The figures in Table 1 and the graphs in Figure 18 indicate that there was no advantage to using the experimental sealant materials according to the initial permeability results. In fact, the experimental sections displayed a higher permeability than the control sections. This is contradictory to what is expected with the use of these joint sealant materials. An explanation for the results may stem from the reduced amount of testing performed in the control sections. Future permeability testing for this project should include more test locations within the control section for statistically comparable results.

ILLINOIS ROUTE 26

Permeability testing for the project on Illinois Route 26 was performed at five locations within each of the experimental sections and five locations within the control section. Pavement cores were taken at each of the permeability test locations for the two experimental sections. Due to time constraints, only three pavement cores were taken from the control section. These three cores were taken at the north end of the control section.

Three permeability readings were taken at each test position, and averaged for the final reading at that position. Table 2 below lists the final permeability readings for each test position and an average for that test position within each experimental section. Figure 19 illustrates the test location averages for each of the experimental sections and the control section.

Table 2

Illinois Route 26 Field Permeability Test Results

Position	On Joint	On Joint	On Joint	Non-Confined 4” Offset	Non-Confined 12” Offset	Confined 4” Offset	Confined 12” Offset
#	1	2	3	4	5	6	7
Control Section							
A	11678	12046	10396	4581	902	5091	3656
B	9249	9817	5808	4714	1422	2836	1250
C	24257	15130	15923	4029	1331	5152	2147
D	24392	27690	20573	10571	1511	3063	819
E	6763	5304	5333	1906	208	480	281
Avg.	15268	13997	11607	5160	1075	3324	1631
J-Band® Section							
A	3811	4433	3453	3279	178	1061	1111
B	11835	13006	11318	7362	764	2357	844
C	6768	9040	9163	5108	1346	1061	935
D	3797	3120	4023	4657	2080	641	698
E	3852	5789	5353	2890	205	1044	886
Avg.	6013	7078	6662	4659	915	1233	895
QuickSeam® Section							
A	8199	7684	8346	6691	2172	3421	1948
B	3082	3799	2533	4770	4125	1819	172
C	4325	3768	3959	3183	969	1782	1085
D	4878	3731	3624	2773	157	1823	828
E	10952	9550	11062	11964	3195	3085	1054
Avg.	6287	5706	5905	5876	2124	2386	1017

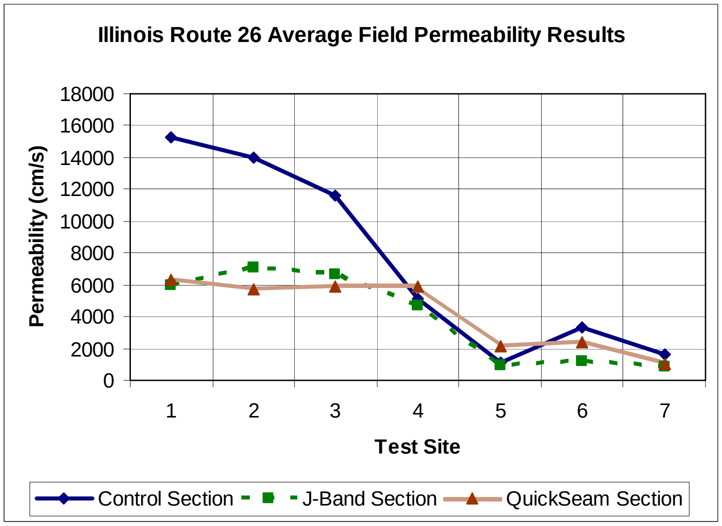

Figure 19

Illinois Route 26 Average Field Permeability Test Results

The initial permeability testing for this project produced the anticipated test results. The permeability of the sealant material sections is much reduced from that of the control section for test sites 1, 2, and 3, which are located along the centerline joint. The permeability at test sites 4, 5, 6, and 7 are relatively the same for the control section and the experimental sections. Also, there is no difference in the initial permeability results between the J-Band® and QuickSeam® experimental sections.

INTERSTATE 57

Permeability testing was conducted at three sites within the experimental section and two sites within the control section for the project on Interstate 57. Pavement cores were not taken from the control section or experimental section.

Three permeability readings were taken at each test position, and averaged for the final reading at that position. Table 3 below lists the final permeability readings for each test position and an average for that test position within each experimental section. Figure 20 illustrates the test location averages for the experimental section and the control section.

Table 3

Interstate 57 Field Permeability Test Results

Position	On Joint	On Joint	On Joint	Non-Confined 4" Offset	Non-Confined 12" Offset	Confined 4" Offset	Confined 12" Offset
#	1	2	3	4	5	6	7
Control Section							
A	14353	12320	13074	N/A	N/A	809	58
B	12320	14975	9310	N/A	N/A	236	88
AVG	13337	13648	11192	N/A	N/A	523	73
J-Band® Section							
A	25467	6519	15675	N/A	N/A	2552	1123
B	12463	20706	22621	N/A	N/A	5951	2242
C	9445	10464	10344	N/A	N/A	4326	2122
AVG	15792	12563	16213	N/A	N/A	4276	1829

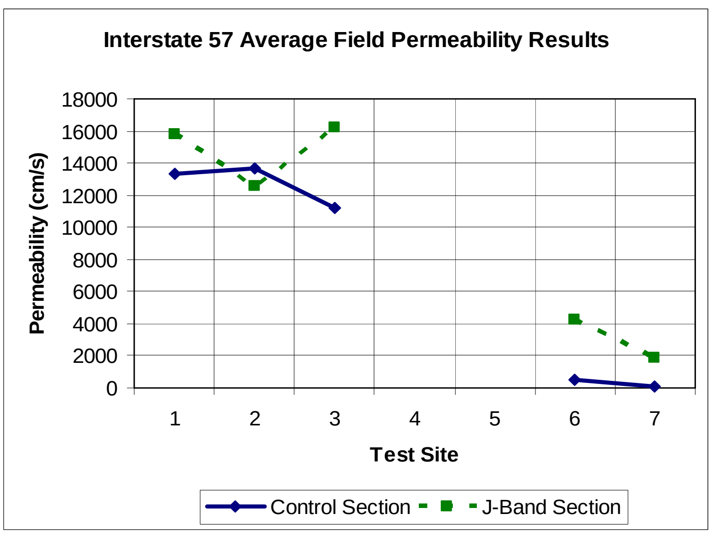

Figure 20

Interstate 57 Average Field Permeability Test Results

The initial permeability test results for the Interstate 57 project are similar to those on Illinois Route 50. The control section and J-Band® section have very similar results, and in several cases, the J-Band® section was more porous than the control section.

Permeability tests were not performed at test positions 4 and 5 due to traffic on the non-confined lane.

INTERSTATE 70

Permeability testing for the project on Interstate 70 was performed at three locations within the experimental section and two locations within the control section. Pavement cores were taken at each of the permeability test locations for the experimental section. Pavement cores were taken from only one of the control section permeability test locations.

Three permeability readings were taken at each test position, and averaged for the final reading at that position. Table 4 below lists the final permeability readings for each test position and an average for that test position within each experimental section. Figure 21 illustrates the test location averages for each of the experimental sections and the control section.

Table 4

Interstate 70 Field Permeability Test Results

Position	On Joint	On Joint	On Joint	Non-Confined 4" Offset	Non-Confined 12" Offset	Confined 4" Offset	Confined 12" Offset
#	1	2	3	4	5	6	7
Control Section							
A	43476	44206	43476	9343	1578	4198	1349
B	39323	48972	45269	10268	867	2220	221
AVG	41400	46589	44373	9806	1223	3209	785
J-Band® Section							
A	22870	23274	23822	7692	1148	4257	1961
B	28148	32933	24531	20020	1599	3342	1252
C	31143	32367	28028	14319	1786	2870	313
AVG	27387	29525	25460	14010	1511	3490	1175

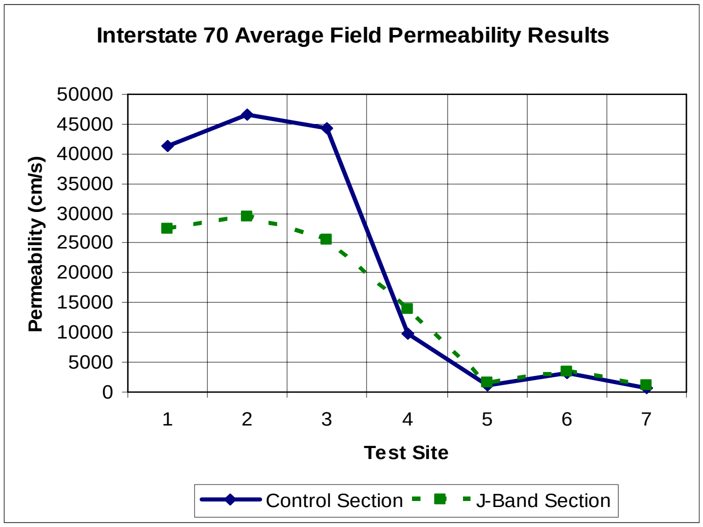

Figure 21

Interstate 70 Average Field Permeability Test Results

The initial permeability test results for the Interstate 70 project are very similar to those on the Illinois Route 26 project, and what is expected with the use of the J-Band® material. The permeability at the centerline joint (test positions 1, 2, and 3) is much lower in the experimental section than the control section. The permeability test results away from the joint (test positions 4, 5, 6, and 7) are very similar for the experimental and control sections.

PROJECT COSTS

A true cost for these materials is difficult to judge based on the small quantities used and the limited number of projects. In addition, material costs are difficult to predict for experimental materials, and will sometimes fluctuate until the product demand and production increase.

Only the Illinois Route 26 experimental project was actually bid according to the contract documents. However, the material was bid at the producer's cost in order to promote the joint sealant research. Two of the projects were paid for through a force account, and not actually bid into the contract documents. The sealant materials were added to these two projects after construction had started. Items that are completed by force account are typically more expensive than the same items bid into the contract documents.

The material for the fourth project was constructed for free. This material was left over from a previous project, and the supplier wanted to clean it out of their storage tanks. The material costs and quantities placed for all four projects are listed below in Table 5.

Table 5

Sealant Material Costs

Project	Material	Unit Cost	Quantity Placed	Total Cost
Illinois Route 50 *	QuickSeam®	$4.19	5,520 ft	$23,128.80
	J-Band®	$1.94	5,520 ft	$10,708.80
Illinois Route 26	QuickSeam®	$1.75	4,426 ft	$7,745.50
	J-Band®	$1.75	20,889 ft	$36,555.75
Interstate 57 *	J-Band®	$1.49	1,900 ft	$2,831.00
Interstate 70	J-Band®	$0.00	700 ft	$0.00

* Experimental sealant material paid for through a force account.

RESEARCH ACTIVITIES

The research activities for this research effort will continue for the next five years. Activities that will be performed during those five years include annual distress surveys, additional permeability testing, and additional pavement coring.

Specific locations have been identified on each project and each sealant material for annual distress surveys of the longitudinal joint performance. These surveys will be conducted to observe any physical deterioration of the joint such as cracking and raveling. The limits of the surveyed sections for each project are listed below in Table 6.

Table 6

Visual Distress Survey Section Locations

	Beginning Station	Ending Station
Illinois Route 50		
J-Band® Survey	244 + 00 (SB)	199 + 00 (SB)
QuickSeam® Survey	244 + 00 (NB)	199 + 00 (NB)
Control Survey	255 + 00 (NB & SB)	280 + 00 (NB & SB)
Illinois Route 26		
J-Band® Survey	432 + 50	387 + 50
QuickSeam® Survey	732 + 50	776 + 00
Control Survey	947 + 50	996 + 00
Interstate 57		
J-Band® Survey	820 + 00	835 + 00
Control Survey	840 + 00	855 + 00
Interstate 70		
J-Band® Survey	MP 138 (WB)	MP 138 + 700’ (WB)
Control Survey	MP 138 + 1,000’ (WB)	MP 138 + 1,700’ (WB)

Additional permeability testing will be performed during the evaluation and at the close of the project evaluation. This testing will be used to determine if the permeability of the longitudinal joint changes as the pavement surface ages. Oxidation, stripping, and physical deterioration all may play a role in changing permeability values over the course of the five year study. Pavement coring will be conducted again at the close of the study to determine laboratory permeability and the condition of the sealant materials.

CONCLUSIONS

Two experimental bituminous sealant systems for longitudinal joints were used at the centerline joint on four hot mix asphalt paving projects in 2003. The two products selected for this research effort were J-Band® by Heritage Research Group and QuickSeam® by Hendy Products Incorporated. The four projects selected include Illinois Route 26 in Stephenson County, Illinois Route 50 in Cook County, Interstate 57 in Will County, and Interstate 70 in Clark County. The four projects were all constructed in August and September of 2003.

Based on construction monitoring of these projects and initial field permeability testing, the following conclusions can be made:

1. The J-Band® material is easy to place.

2. The QuickSeam® material is very labor intensive to place.

3. Both materials are very sticky and will “pick up” on the tires of a passing automobile.

4. The initial field permeability testing produced mixed results. Two of the projects indicate that the experimental sealant had an impact on the permeability of the joint. The remaining two projects indicate that the experimental sealants had no impact on the joint permeability.

REFERENCES

1. Vespa, J.W., K.T. Hall, M.I. Darter, and J.P. Hall, "Performance of Resurfacing of JRCP and CRCP on the Illinois Interstate Highway System," University of Illinois and Illinois Department of Transportation, Report No. FHWA-IL-UI-229, June, 1990.

APPENDIX

A

LONGITUDINAL JOINT SEALANT
SPECIAL PROVISION

LONGITUDINAL JOINT SEALANT (BMPR)

Description. This work shall consist of furnishing and placing longitudinal joint sealant.

Materials. The two longitudinal joint materials used shall be the Heritage Research *JBand* and Quik Pave Products *Quik Seam*. Materials shall meet the following requirements:

TEST	TEST REQUIREMENT	TEST METHOD
Dynamic Shear @ 76°C G*/sinδ (original binder), kPa	1.0 min.	AASHTO T 315
Creep stiffness @ -18°C • Stiffness(S), MPa • m-value	 300 max. 0.300 min	AASHTO T 313
Ash, %	10 max	AASHTO T111
Elastomeric Polymer, %	5.0 min.	Certificate of Analysis
Separation of Polymer, difference, °C (°F), 1/	2 (4) max.	ASTM D5976 (section 6.1.4)

Note - 1. Applies to liquid products.

Two quarts of material shall be sent to the Bureau of Materials and Physical Research at least two weeks prior to placement for migration evaluation. In addition to the above requirements, acceptance of the material for use shall be based on a lab tested migration level that is to the satisfaction of the Engineer.

Equipment: Equipment used to place the longitudinal joint sealant shall be as determined by each manufacturer and approved by the Engineer.

CONSTRUCTION REQUIREMENTS

Joint Sealant Locations. The control section contains no joint sealant and shall be the section in which paving will begin. The joint sealant shall be placed in three adjacent sections as specified in the plans. The joint sealant placed in Section II (see Figure 1) shall be the same material placed in the contractor's option section.

The longitudinal joint sealant shall be placed 3/16 inch thick.

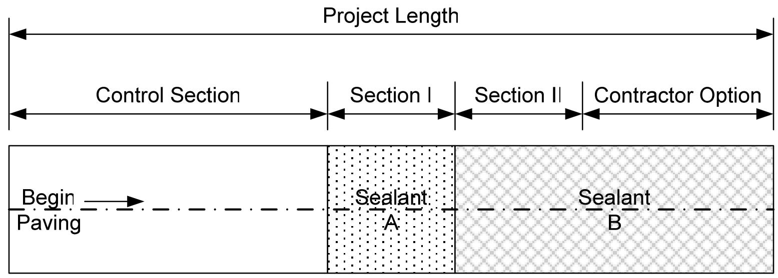

Figure 1: Project Layout

Placement. Each material shall be placed per the manufacturer's recommendations and as follows:

Heritage Research JBand: The product shall be placed 18 inches wide by the manufacturer as shown in Figure 2. The material shall be placed 30 minutes to 24 hours prior to placing the bituminous surface mixture on the first lane paved.

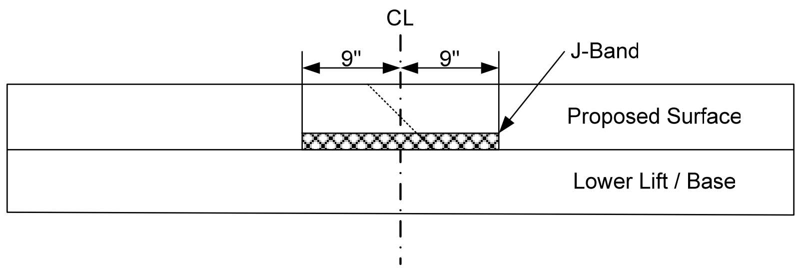

Figure 2: J-Band® Placement

Quik Pave Products Quik Seam: The product shall be placed in two 9-inch wide strips. The first strip shall be placed to ensure that an overlap of the product will occur when the second strip is placed. The material shall be placed 100 to 250 feet in front of the paver. The second strip shall be placed so it overlaps the first strip and the edge of the first lane. See Figure 3.

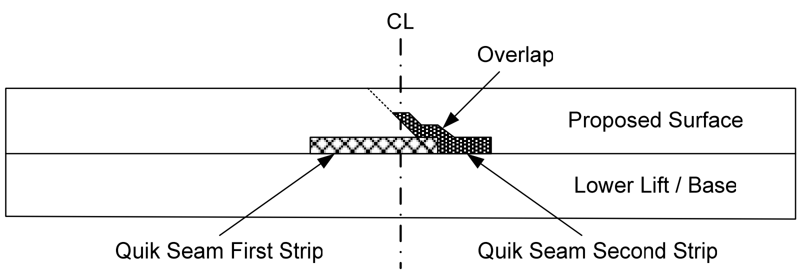

Figure 3: Quik Seam Placement

Testing. The Department testing will occur within the Contractor's traffic control and protection. No additional compensations will be given.

Meetings. A pre-laydown meeting is required 3 to 5 days prior to the longitudinal joint sealant placement.

Method of Measurement. This work will be measured for payment in meters (feet) along the lane line.

Basis of Payment. This work will be paid for at the contract unit price per foot (meter) for LONGITUDINAL JOINT SEALANT.

APPENDIX

B

HOT MIX ASPHALT MIXTURE DESIGNS

Illinois Route 50 HMA Mixture Designs

Design Value	**Leveling Binder**	**Surface Course**
Mixture Type	“D” Mix	“E” Mix
Mixture Gradation	3/8” (9.5 mm)	3/8“ (9.5 mm)
“N” Design Number	70	90
Asphalt Cement Grade	PG 64-22	PG 70-22 Modified
% Crushed Stone	58.3	27.0
% Crushed Slag	0.0	35.0
% Manufactured Sand	23.2	26.5
% Natural Sand	8.0	10.0
% Recycled Material	9.5	0.0
% Mineral Filler	1.0	1.5
% Lime	0	0
Special Additives	No	No
% Asphalt Cement	5.4	5.4
Bulk Specific Gravity (d)	2.414	2.586
Maximum Specific Gravity (D)	2.514	2.694
% Voids	4.0	4.0
Gradation	**Percent Passing**	**Percent Passing**
1/2” (12.5 mm)	100	100
3/8” (9.5 mm)	99	95
#4 (4.75 mm)	55	53
#8 (2.36 mm)	39	34
#16 (1.18 mm)	27	24
#30 (0.6 mm)	18	16
#50 (0.3 mm)	10	9
#100 (0.15 mm)	6	6
#200 (0.075 mm)	4.6	4.5

Illinois Route 26 HMA Mixture Designs

Design Value	Leveling Binder	Surface Course
Mixture Type	“D” Mix	“D” Mix
Mixture Gradation	3/8” (9.5 mm)	3/8” (9.5 mm)
“N” Design Number	50	50
Asphalt Cement Grade	PG 64-22	PG 64-22
% Crushed Stone	56	56
% Crushed Slag	0	0
% Manufactured Sand	25.5	25.5
% Natural Sand (Gravel)	17	17
% Recycled Material	0	0
% Mineral Filler	1.5	1.5
% Lime	0	0
Special Additives	No	No
% Asphalt Cement	5.9	5.9
Bulk Specific Gravity (d)	2.357	2.357
Maximum Specific Gravity (D)	2.460	2.460
% Voids	4.2	4.2
Gradation	**Percent Passing**	**Percent Passing**
1/2” (12.5 mm)	100	100
3/8” (9.5 mm)	97	97
#4 (4.75 mm)	58	58
#8 (2.36 mm)	37	37
#16 (1.18 mm)	27	27
#30 (0.6 mm)	19	19
#50 (0.3 mm)	12	12
#100 (0.15 mm)	6	6
#200 (0.075 mm)	4.1	4.1

Interstate 57 HMA Mixture Designs

Design Value	Binder Course	Surface Course
Mixture Type	Stone Matrix Asphalt	Stone Matrix Asphalt
Mixture Gradation	1/2” (12.5 mm)	1/2” (12.5 mm)
“N” Design Number	80	80
Asphalt Cement Grade	SBS PG 76-28	SBS PG 76-28
% Crushed Stone	85	0
% Crushed Slag	0	85
% Manufactured Sand	9	9
% Natural Sand	0	0
% Recycled Material	0	0
% Mineral Filler	6	6
% Lime	0	0
Special Additives	Cellulose Fibers (0.4%)	Cellulose Fibers (0.4%)
% Asphalt Cement	6.3	6.0
Bulk Specific Gravity (d)	2.404	2.850
Maximum Specific Gravity (D)	2.491	2.958
% Voids	3.5	3.5
Gradation	**Percent Passing**	**Percent Passing**
3/4” (19 mm)	100	100
1/2” (12.5 mm)	83	81
3/8” (9.5 mm)	62	63
#4 (4.75 mm)	27	28
#8 (2.36 mm)	17	20
#16 (1.18 mm)	14	15
#30 (0.6 mm)	11	11
#50 (0.3 mm)	10	10
#100 (0.15 mm)	9	9
#200 (0.075 mm)	8.3	8.0

Interstate 70 HMA Mixture Designs

Design Value	Binder Course	Surface Course
Mixture Type	Polymerized Binder	Stone Matrix Asphalt
Mixture Gradation	3/4” (19 mm)	1/2” (12.5 mm)
“N” Design Number	105	80
Asphalt Cement Grade	SBS PG 76-28	SBS PG 76-28
% Crushed Stone	78.2	0
% Crushed Slag	0	85.5
% Manufactured Sand	20.1	9.0
% Natural Sand	0	0
% Recycled Material	0	0
% Mineral Filler	0.7	4.5
% Lime	1.0	1.0
Special Additives	No	Cellulose Fibers
% Asphalt Cement	4.5	5.4
Bulk Specific Gravity (d)	2.383	2.825
Maximum Specific Gravity (D)	2.484	2.944
% Voids	4.1	4.0
Gradation	**Percent Passing**	**Percent Passing**
1” (25 mm)	100	100
3/4” (19 mm)	95	100
1/2” (12.5 mm)	75	92
3/8” (9.5 mm)	62	78
#4 (4.75 mm)	37	30
#8 (2.36 mm)	21	19
#16 (1.18 mm)	14	14
#30 (0.6 mm)	9	11
#50 (0.3 mm)	6.4	9.7
#100 (0.15 mm)	5.1	8.4
#200 (0.075 mm)	4.4	7.3