

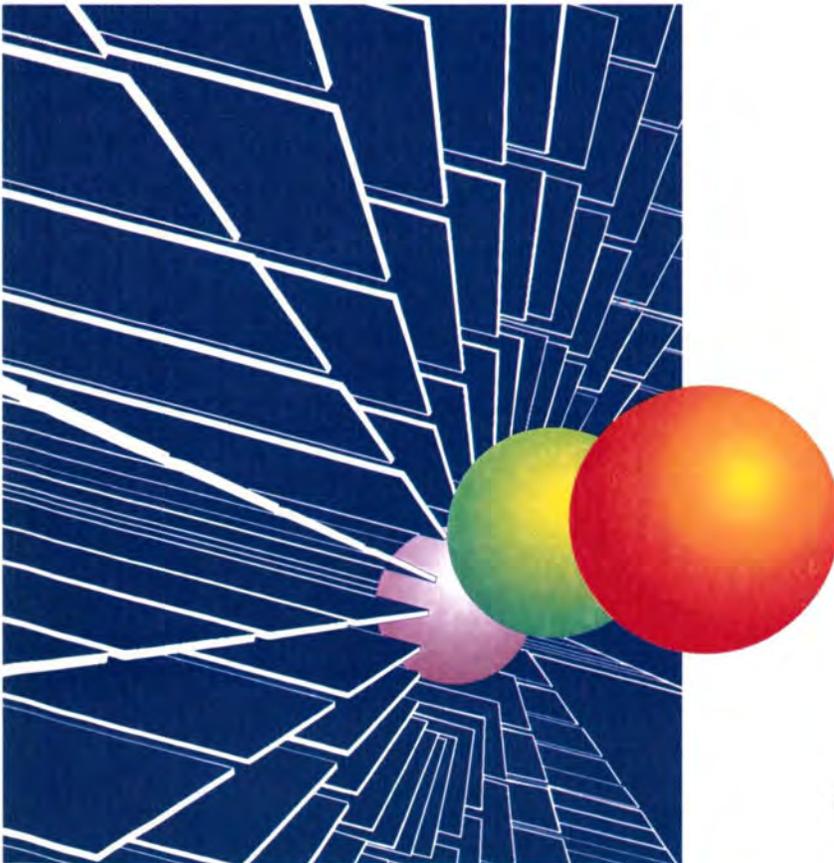


Research, Development and Technology

RDT 00-012

Pavon[®] Indeck Crack Sealer Evaluation

RI 96-005



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Addendum to Research Investigation 96-05

Pavon[®] Indeck Crack Sealer Evaluation

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TECHNICAL REPORT DOCUMENTATION PAGE

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16. Abstract Field evaluation over four years of the performance of Pavon® Indeck on badly map cracked bridge deck surfaces. The product is an emulsified asphalt which will fill very small cracks down to 0.4 mm or smaller. The product was found to penetrate down into the crack as deep as 1 3/8 inches. It is very cost effective versus other sealers for decks with a large amount of cracking such as on latex or low slump concrete overlays experiencing shrinkage cracking. The product has a life of 3-4 years before it needs re-applied.			
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In the April 1996 report it was recommended to use PAVON^R Indeck Crack Sealer on badly cracked decks and possibly even as a substitute for polymer asphalt and traprock seal coats. We wanted to do some additional testing, mainly chloride permeability, of the deck concrete before and after application of PAVON^R Indeck Crack Sealer. This report covers this additional testing. PAVON^R Indeck Crack Sealer is being used more and more across the state.

The following is rapid chloride permeability (AASHTO T277) testing done before and after sealing Bridge A-226R, Rt. 67 (Lindbergh Road) / I-270 in St. Louis. Bridge A-226R had a low slump concrete overlay applied in 1990. At the last bridge inspection (before being sealed) on 10/27/98 the deck had "Many random cracks, rt. lane especially cracked (open), spalled" (open cracks were up to 0.4 mm wide). Cores were obtained from the same locations for all three rounds of testing: first just before sealing (11/19/98), next just after sealing with the product (4/8/99) and last, approximately one year after the product was applied (2/23/00). Each time three cores were taken from non-cracked areas and three were taken directly over a crack (0.4± mm wide).

It can be seen in Table 1 that on the non-cracked concrete the Pavon Indeck had a slight affect at reducing the permeability. The test showed an average of 599 coulombs charge was passed through the specimens, which dropped to 421 after sealed, and then up to 503 after a year. These are very good numbers for a low slump overlay, AASHTO T-277 equates this to very low permeability, typical of Latex Modified Concrete or Internally sealed (100-1,000 coulombs). Low slump usually ranges from 1,000-2,000 coulombs.

The testing over the cracks following sealing showed a larger and a significant difference from the before sealing tests as seen in Table 2. Before the product was applied the average coulombs passed was 1348, after it dropped to less than half, 598**, and a year later 741 (still nearly half of original). **The test sample 3C was thrown out because not only was the Pavon Indeck cracked off the top but the finished surface of the concrete was also cracked off about half of the top surface area. This made the sample itself more porous whether sealed or not.

The above data indicates, as we speculated in the first study, that the product stays pliable and stuck to the sides of the crack for a short time. However, after the crack moves a few times the bond fails and lets a little more water in. The product does stay pliable for a year or longer and does remain in the crack to plug the cracks and keep permeability low. After several years it becomes less pliable and starts to loose its ability to seal out moisture. Some of the district maintenance forces have foreseen this, especially District 5. On two twin bridges on US 54 near Jefferson City (A-1415R and A-2552R), they have applied a second coating, which is doing a good job of resealing the decks and keeping the permeability low.

Referenced photos are attached.

TABLE 1 – Chloride Permeability on surface with No Cracks

Bridge A-226R1N, Rt. 67/I-70 – low slump concrete overlay, no cracks, tested 11/19/98			
Sample 1	Sample 2	Sample 3	Average
551	637	609	599
Bridge A-226R1N, Rt. 67/I-70 – low slump concrete overlay with Pavon ^R Indeck, no cracks, re-tested 4/8/99			
Sample 1	Sample 2	Sample 3	Average
557	304	402	421
Bridge A-226R1N, Rt. 67/I-70 – low slump concrete overlay with Pavon ^R Indeck, no cracks, re-tested 2/23/00			
Sample 1	Sample 2	Sample 3	Average
611	492	405	503

TABLE 2 – Chloride Permeability on Cracked Surface

Bridge A-226R1N, Rt. 67/I-70 – low slump concrete overlay, over crack, tested 11/19/98			
Sample 1C	Sample 2C	Sample 3C	Average
828	1727	1489	1348
Bridge A-226R1N, Rt. 67/I-70 – low slump concrete overlay with Pavon ^R Indeck, over crack, re-tested 4/8/99			
Sample 1C	Sample 2C	Sample 3C	Average
479	716	2425*	1207 (598)**
* This reading so much higher than others because about ½ of the coating had been chipped off			
** Average of all three samples, (Average of sample 1C & 2C only)			
Bridge A-226R1N, Rt. 67/I-70 – low slump concrete overlay with Pavon ^R Indeck, over crack, re-tested 2/23/00			
Sample 1	Sample 2	Sample 3	Average
683	726	813	741

Conclusions and Recommendations

It was shown in the earlier study that Indeck could fill cracks from 0.20 mm to 0.4 mm wide and larger. This meets ACI recommendations that cracks less than 0.18 mm are tolerable on a deck exposed to deicing chemicals and wouldn't necessarily have to be filled. It was noticed in the cores that when Indeck was applied in the cooler weather of October there was much better penetration into the cracks than when applied in August. In addition, the use of a distributor seems to get a uniform and adequate coating to reach all the cracks. It appears that if the product is well worked into the deck and given time to get a good cure, it would have enough time to penetrate the cracks and fill surface voids. Friction properties of the cured surface have been good, but a sanding tack should be used if deemed necessary by the supervisor in the field.

Chloride permeability testing done in this study showed that the product does reduce the permeability substantially. The amount does decline as the product becomes less pliable but after one year in service, this was negligible. It is believed that the effectiveness will last up to three years or more before another application needs to be applied. Pavon Indeck Crack Sealer is relatively low cost and is easy for maintenance crews to apply. For badly cracked decks, such as shown by some of our low slump overlays, it is very cost effective, even if it may need reapplication in the future. It is not as hard to remove at a future date as polymer asphalt seal coats, which also may trap water and cause further deterioration of the deck.

From this additional testing, we recommend that this product be used on more bridge decks with cracking problems. In cases where cracking is severe, such as some low slump concrete overlays, we recommend it be used in lieu of polymer modified AC and traprock seal coats. We again recommend applications be limited to cooler weather in the spring or fall when the cracks will be more open and allow better penetration of the Indeck.

Photo No. 1



Non-cracked core 1 from 2/23/00, 1 year old Indeck, after chloride permeability test.

Photo No. 2



Cracked core 1C, typical crack size $0.4 \pm$ mm. Notice almost all Indeck worn off the surface.

Photo No. 3



Non-cracked core 2 from 2/23/00, 1 year old Indeck, after chloride permeability test. Notice a lot of Indeck still on surface.

Photo No. 4



Cracked core 2C, typical crack size $0.4 \pm$ mm. Notice several cracks with Indeck in them still visible at the surface.

Photo No. 5



Non-cracked core 3 from 2/23/00, 1 year old Indeck, after chloride permeability test. Note most of Indeck worn off the surface.

Photo No. 6



Cracked core 3C. Notice the orange staining we believe is from something contaminating the surface from traffic on the bridge, it didn't affect the Indeck.

Photo No. 1



Typical map cracking on a low slump overlay in bad shape and Indeck applied to adjacent lane.

Photo No. 2



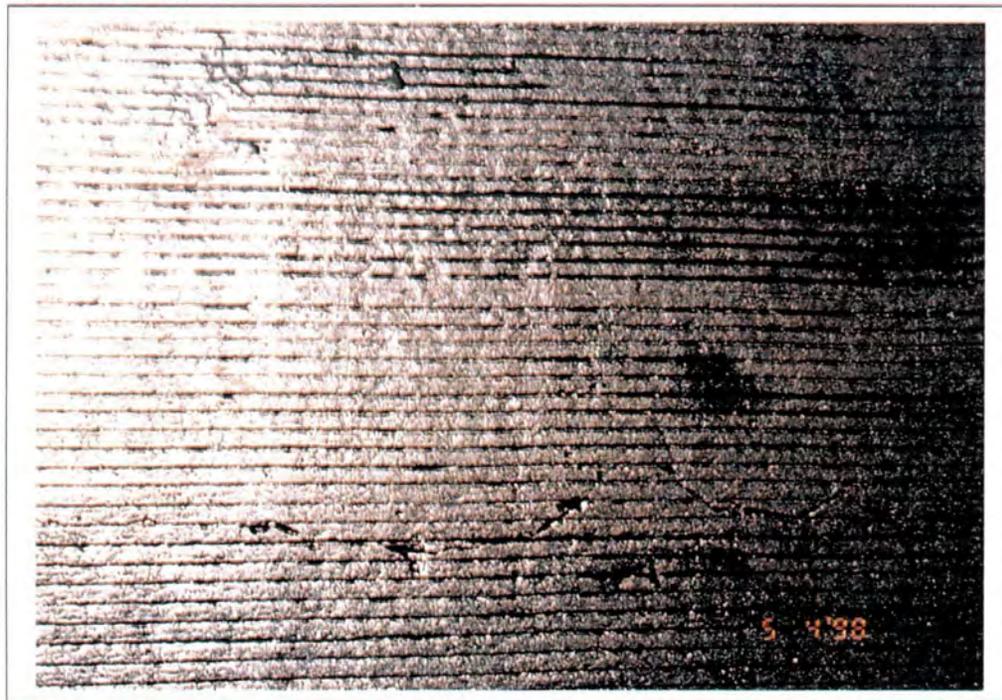
Patch also shown above near white line before Indeck applied. Product can not be expected to help areas like this, they need repaired before application.

Photo No. 3



Typical open crack, $0.4 \pm$ mm, which Indeck will fill, and open gap at construction joint (knife sticking out) which product will have more trouble effectively sealing.

Photo No. 4



Typical open crack with Indeck just applied and worked well into it by squeegeeing and brooming.

Photo No. 5



Indeck just applied to deck is brown colored before the emulsion breaks and turns black. Notice the good even coverage using squeegees.

Photo No. 6



Good application procedure using distributor and wand to apply and plenty of workers to squeegee and broom in. Foot tracks won't hurt effectiveness.

Bridge A-1756
96-005

Research Investigation No.
I-35/Grand River, Daviess County

Photo No. 7



Application on half of 1335 ft. long bridge done in 2 hours.

PAVON® INDECK CRACK SEALER EVALUATION

Research Investigation 96-05

Prepared By

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APRIL, 1996

PAVON® INDECK CRACK SEALER EVALUATION

History

The Research Section has looked at Pavon® products as far back as 1982 but we have never evaluated Indeck in the laboratory. The Maintenance and Traffic division has used Pavon patching material in the districts across the state for several years. Indeck has been tried in Districts 5 and 7 for sealing deck cracks the last two years.

Field Trials

District 5 applied the product on two bridges in Cole County, Route 54 in August, 1994, bridges A-1415R WB and A-2552R EB. The product was applied in August, 1994 when it was very hot and dry. The product was applied as per the manufacturers recommendations. It was poured on the deck because there was no distributor available, then it was brushed into the deck and the excess squeegeed off. Because it appeared very shiny, black and possibly slippery a sanding tack was applied over the entire bridge.

The cores taken from these bridges on November 13, 1995, showed only about 1/2 inch penetration into an open crack. Because of the hot conditions when applied, the cracks in the low slump overlay were probably closed because of thermal expansion of the concrete. This may account for the lack of penetration of the Indeck into the cracks. After a little over a year the Indeck has worn off the driving surface of the deck but it can be seen in the tining grooves and the large cracks. The sand used for a tack in the Indeck probably caused the wearing off of the top coating that can still be seen in spots on the shoulders.

District 7 applied Indeck on five decks, bridge J-619R, Route 39, Lawrence County, and to four in Jasper County, twin bridges A-4028 SB and A-4029 NB, Route 71, and a set of twin bridges A-541 EB & WB, Route I-44. Bridge J-619R had a badly map cracked low slump overlay and bridges A-541 EB & WB, A-4028, and A-4029 were continuous concrete slab spans with regular concrete which had map-cracking and transverse or T-cracking over the bents. The Indeck was applied on the bridges in October, 1995.

Testing

On March 21, 1996 cores were taken from bridges J-619R, A-4028 SB, and A-541 EB. Photos of this inspection are in the attached appendix. Two cores were taken on J-619R; they were drilled 3 1/4 inches and 3 3/4 inches deep into the low slump overlay and we still never reached the original deck. This bridge had a flat deck and we were drilling near the centerline. Because a crown was added to the deck the overlay was much deeper in the center than the 2 1/4 inches required.

The first core taken separated into two pieces at the crack. The surfaces were discolored and a dirty brown the full depth of the crack. This was probably from moisture and dirt and also carbonation of the concrete, however, there was evidence the Indeck had penetrated down 1 1/4 inches, coating the crack. The width of one crack was measured at 0.2 mm. The second core

was left with Randall Glaser, District Maintenance Engineer in District 7. At the time, we observed, with the naked eye, penetration of only 1/2 inch. The core was later cracked apart into two pieces and the Indeck extended 3/8 - 1/2 inch down on the sides of the crack. It was still tacky when the two halves of the core were put back together and it tended to try and hold the pieces back together.

On core # 2 from bridge A-541 EB, the core also split at the crack and there was only evidence on the face of 1/2 inch deep penetration but in another crack the Indeck penetrated the full depth of the core, 2 inches. The width of the crack was measured to be 0.25 mm. On core # 1, the crack on the surface was very fine, 0.10 mm, the Indeck did not fill the crack (bridge the gap between the two sides) when looked at under the microscope. According to the ACI Manual of Concrete Practice, Table 4.1 of Document 224R-18, a crack of 0.18 mm exposed to deicing chemicals is a tolerable crack width in reinforced concrete, so it would not be necessary to coat cracks as fine as in core #1 of 0.10 mm.

On core # 1 of bridge A-4028 SB, the Indeck penetrated 1 1/2 inches on one crack, 3/4 inch on a second crack and 3/8 inch on the third. The width measured 0.4 mm. Core # 2 showed penetration of the Indeck of 1 3/8 inch and 1 1/8 inch. Another crack extended to the bottom of the core, 2 1/4 inches, and evidence of Indeck could be seen, under the microscope, all the way through. At the surface this T-crack was very open, 2.75 mm at some locations, and it was coated completely with Indeck and where there was a small excess the material was still pliable. The cracks measured deeper in the core had a width of 0.25 mm.

Friction tests were taken on two of the three decks cored in District 7 where no sanding tack was applied. On the Indeck surface of bridge A-4028, Rt. 71SB the FN(40) = 49.4 compared to the leave pavement of PCCP with FN(40) = 62.4. On bridge A-541, Rt. I-44EB the Indeck had a FN(40) = 38.4 compared to the approach pavement FN(40) = 40.2 and the leave pavement FN(40) = 42.2 on PCCP. These are very acceptable numbers and in close range to the adjoining pavements.

Conclusions and Recommendations

It was noticed in the cores that when Indeck was applied in the cooler weather of October there was much better penetration into the cracks than when applied in August. Also the use of a distributor seems to get a more uniform and adequate coating to reach all the cracks. It was shown in the cores from the District 7 bridges that Indeck can fill cracks from 0.20 mm to 0.4 mm and larger. This meets ACI recommendations that cracks less than 0.18 mm are tolerable on a deck exposed to deicing chemicals and wouldn't necessarily have to be filled.

After over 1 1/2 years in the case of the Jefferson City bridges the Indeck is still pliable and still fills the tining grooves and open cracks even though it has worn off the surface. Friction numbers in District 7 showed that the Indeck surface was not slick when applied on well textured and even worn decks such as on I-44 if the excess was carefully removed. It appears, however, that if the product is well worked into the deck and given time to get a good cure, it would have enough time to penetrate the cracks and fill surface voids well enough that a sanding tack could be used if deemed necessary by the supervisor in the field.

From these trial applications we would recommend that this product be tried on more bridge decks with cracking problems, possibly in lieu of polymer modified AC and traprock seal coats. In some cases seal coats have been shown to hold moisture between them and the concrete deck causing additional deterioration. We do recommend applications be limited to cooler weather in the spring or fall when the cracks will be more open and allow better penetration of the Indeck. Since the applications tested are only 5 to 19 months old, we would like to see how pliable the Indeck stays as it ages since this would affect its ability to bridge the cracks and not allow ingress of moisture.

APPENDIX

Photo No. 1



Plan view looking east.

Photo No. 2



Profile showing continuous solid concrete slab deck.

Photo No. 3



Transverse crack (T-crack) near bent.

Photo No. 4



Longitudinal (L-crack) cracks in wheelpath filled with Indeck. Also, Indeck covering wearing off in wheelpath.

Photo No. 5



Core No. 2 north side of core hole. crack splits with one going down to left and other turns to right. Located in outer wheelpath of driving lane 24' from west abutment.

Photo No. 6



Core No. 1, west side hole has fine crack. Located 21' from west abutment in outer wheelpath. NOTE: When core inspected in lab, the crack measured 0.1 mm. The Indeck did not penetrate down the crack. It also didn't fill the crack at the surface.

Photo No. 7



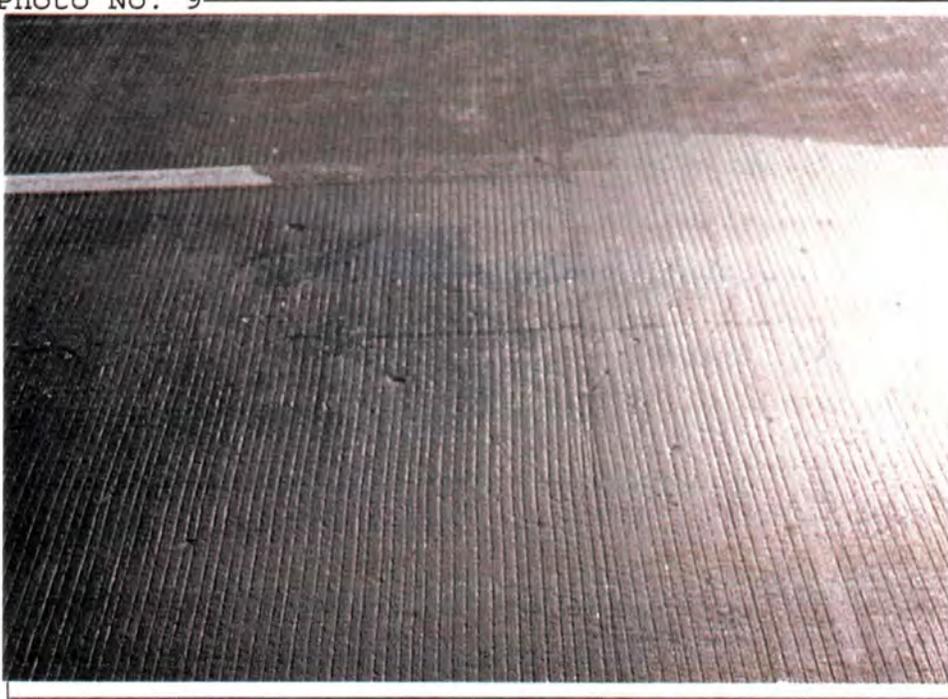
Plan view of deck looking south. Note good covering of Indeck still on surface.

Photo No. 8



Profile showing continuous solid concrete slab.

Photo No. 9



L-crack in driving lane. NOTE: Indeck covering looks shiny but district said was not a friction problem dry or in rain.

Photo No. 10



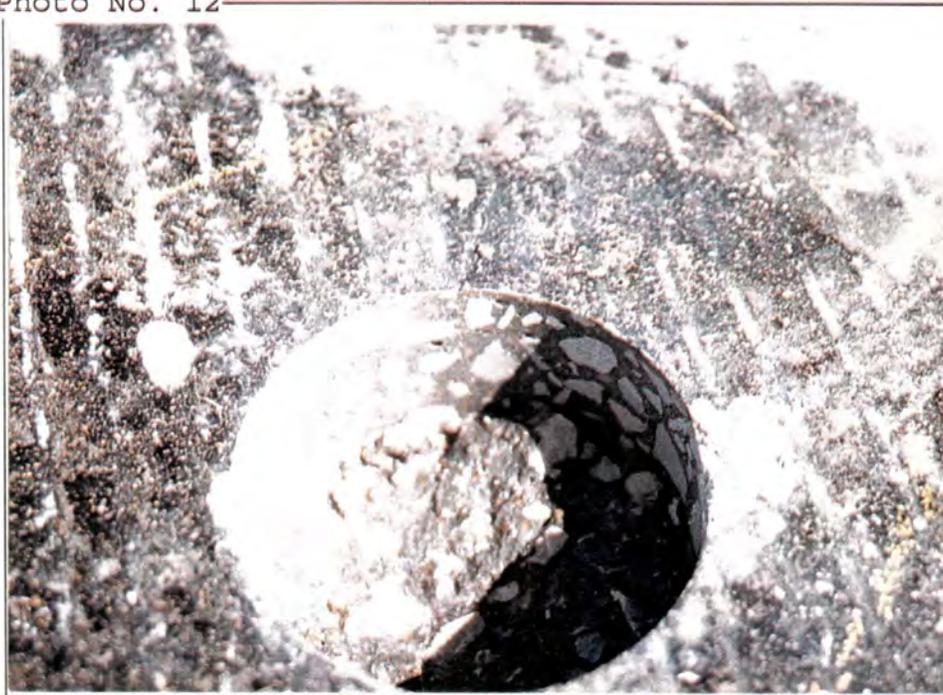
T-crack just north of Bent 1.

Photo No. 11



NE side hole of Core No. 1. Several cracks, one goes to bottom of core hole.

Photo No. 12



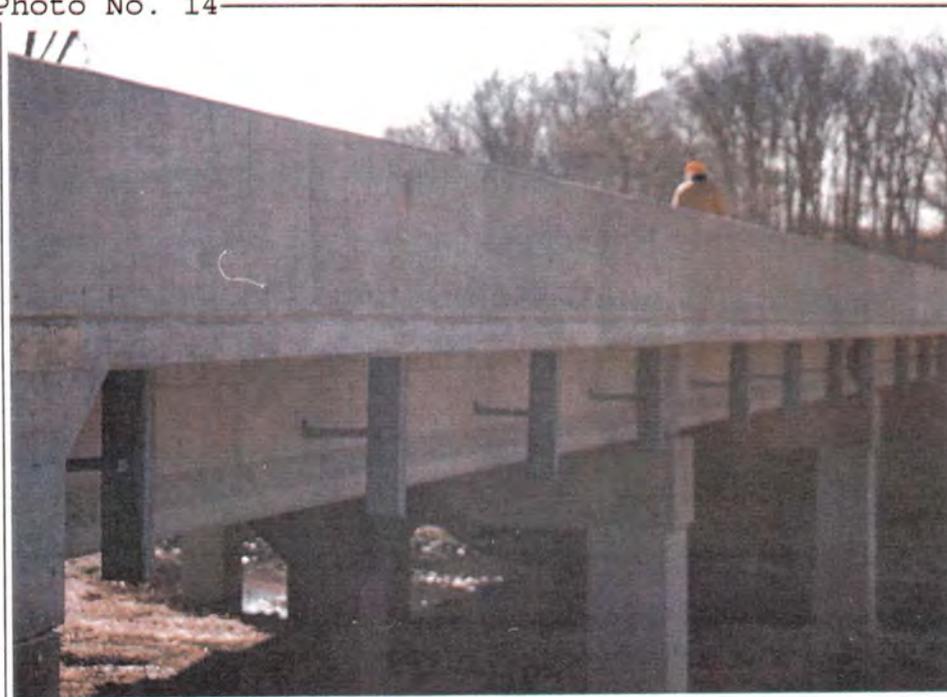
West side hole of Core No. 2. T-crack goes full depth of core hole. NOTE: This T-crack was very open (2.75 mm) but the Indeck completely coated it and was still pliable. Within the core, the crack was 0.25 mm and the Indeck penetrated to a depth of 1 1/8".

Photo No. 13



Plan view of deck looking south. NOTE: Heavier coverage of Indeck on northwest corner looks shiny.

Photo No. 14



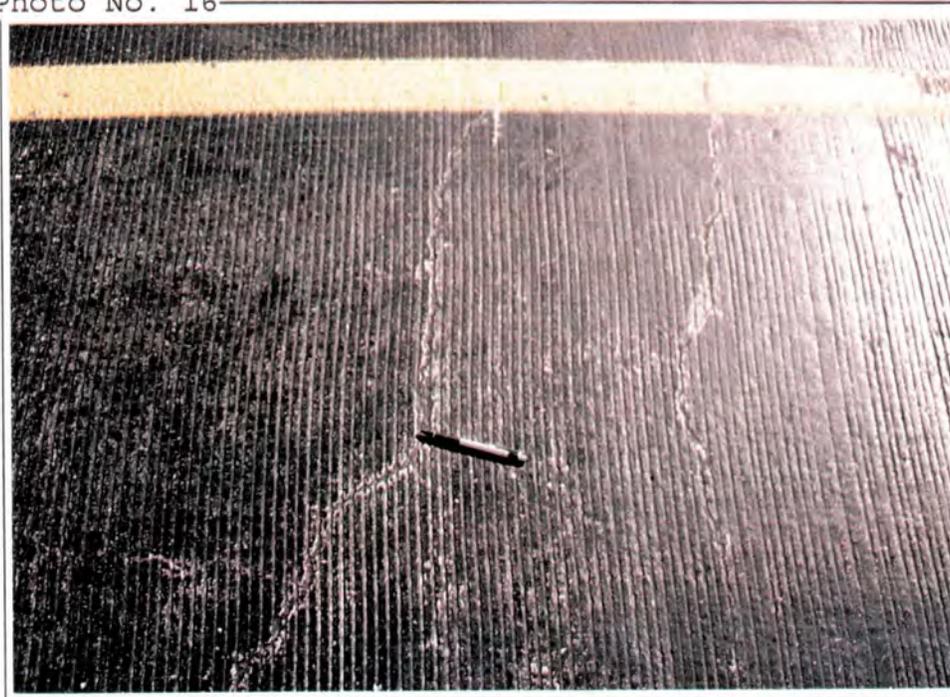
Profile showing concrete I-girder added on outside on each side of the bridge when widened, old structure is concrete deck or T-girders.

Photo No. 15



Northwest corner of deck shows several open T-cracks in low slump overlay. Also, good coverage of Indeck.

Photo No. 16



Close-up of T-crack showing how well the Indeck filled the crack.

Photo No. 17



West side of hole Core No. 1 showing crack to bottom of hole. NOTE: Drilled 3 1/4" deep and did not get to bottom of low slump overlay. Core located 2" from north abutment in inner wheelpath of southbound lane.

Photo No. 18



Core No. 2, located at center of southbound lane, 6' from north abutment over a large T-crack. West side of hole, crack to bottom of hole. NOTE: Some of excess Indeck peeled off when cored (foreground, right side). Drilled 3 3/4" deep and still within low slump. The bridge originally was flat, shoulders were added and a crown which accounts for low slump being so thick.