CONSTRUCTION OF BRIDGE DECKS WITH PRECAST, PRESTRESSED CONCRETE DECK PLANKS

PHYSICAL RESEARCH REPORT NO. 139
APRIL 2002

Illinois Department of Transportation
Bureau of Materials and Physical Research
126 East Ash Street / Springfield, Illinois / 62704-4766

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/IL/PRR-139		

4. Title and Subtitle

CONSTRUCTION OF BRIDGE DECKS WITH PRECAST PRESTRESSED DECK PLANKS

5. Report Date
April 2002

6. Performing Organization Code

7. Author(s)
Tessa H. Volle

8. Performing Organization Report No.
Physical Research No. ?

9. Performing Organization Name and Address

Illinois Department of Transportation
Bureau of Materials and Physical Research
126 East Ash Street
Springfield, Illinois 62704-4766

10. Work Unit (TRAIS)

11. Contract or Grant No.
IHR-104

12. Sponsoring Agency Name and Address

Illinois Department of Transportation
Bureau of Materials and Physical Research
126 East Ash Street
Springfield, Illinois 62704-4766

13. Type of Report and Period Covered
Construction Report
June 1998 – May 2000

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The purpose of this paper is to discuss the construction and early performance of two 1999 – 2000 bridge deck replacement state contracts in Illinois that included precast, prestressed concrete (PPC) deck planks. Metal stay-in-place forms used in one of the contracts will also be briefly addressed in this report.

In 1997, the department and the prestress industry agreed to construct a few demonstration projects. The following year, the department began looking for some bridge projects that would be good candidates for incorporating PPC deck planks. In 1999 – 2000, two state-funded projects with a total of three bridges were constructed with PPC deck planks.

The two PPC bridge deck projects were constructed as a deciding factor on lifting the moratorium on PPC deck planks. For these projects, the thickness of the planks was increased to 3.0 or 3.5 inches, instead of the 2.5-inch planks used in the past. The maturity of the planks was required to be a minimum of 60 days at the time of the deck pour. The seating method for the 1999 – 2000 PPC planks included pre-installing leveling screws for filet adjustment and using polystyrene forms to contain the concrete between the planks.

The construction and early performance of the two PPC bridge deck projects was evaluated. This report includes several conclusions and recommendations based on the findings.

17. Key Words	18. Distribution Statement
bridge deck replacement, precast prestressed deck planks, design, fabrication, construction, early performance	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	72	

CONSTRUCTION OF BRIDGE DECKS WITH PRECAST, PRESTRESSED CONCRETE DECK PLANKS

By:

Tessa H. Volle

Illinois Department of Transportation

Bureau of Materials and Physical Research

Springfield, Illinois 62704

April 2002

TABLE OF CONTENTS

ACKNOWLEDGMENTS

The author gratefully acknowledges the contributions of the following individuals: Jeffrey South of the Office of Planning and Programming; Mike Heitzig, District 8 Resident Engineer; Mark Riegel, District 6 Resident Engineer; and Kenneth Lang, Wayne Phillips, and Doug Woods, all with District 3 Materials. These individuals were helpful to the author in furnishing background information and vital data for this report.

DISCLAIMER

The content of this report reflects the views of the author, who is responsible for the facts and accuracy of the data presented herein. The content does not necessarily reflect the official views or policies of the Illinois Department of Transportation. This report does not constitute a standard, specification, or regulation.

EXECUTIVE SUMMARY

This paper documents the construction and early performance of two 1999 and 2000 bridge deck replacement contracts in Illinois that included precast, prestressed concrete (PPC) deck planks. Metal stay-in-place forms used in one of the contracts is also briefly addressed in this report.

PPC deck planks, a type of stay-in-place form used in construction of bridge decks, could speed construction of a bridge deck. Since PPC deck planks replace plywood forms, they eliminate the need to construct, and later strip, the forms. Also, the bottom layer of reinforcement required in a typical cast-in-place bridge deck is eliminated with PPC deck planks. This cuts down slightly on time and materials required for reinforcement installation.

In 1997, the department and the prestress industry agreed to construct demonstration projects. The following year, the department identified two bridge projects that were good candidates for incorporating PPC deck planks. In 1999 and 2000, the two state-funded projects, with a total of three bridges, were constructed with PPC deck planks.

The Department had a moratorium on the use of PPC deck planks due to severe cracking of decks constructed with an early plank design. The 1999 and 2000 bridge deck projects were constructed with improved PPC deck plank designs, with the ultimate goal of lifting the moratorium on PPC deck planks. For these projects, the thickness of the planks was increased to 3.0 or 3.5 inches, instead of the 2.5-inch planks used in the past. The age of the planks was required to be a minimum of 60 days at the time of the deck pour. The seating method for the 1999 and 2000 PPC deck planks included pre-installing leveling screws for fillet adjustment and using polystyrene forms to contain the concrete between the planks.

Deck planks were fabricated first for the bridge in District 8. The District 8 bridge, located at the Jersey-Greene county line, carries Hillview-Eldred Road over Macoupin Creek. The new deck incorporated 3-inch thick PPC deck planks in Spans 1, 2 and 3, and metal stay-in-place forms in Spans 4 and 5.

The second project constructed in 1999 and 2000 with PPC deck planks is located in District 6. This project, in Logan County, included two bridge replacements. Both bridges are located on Illinois Route 10 and 121, west of Lincoln, Illinois. The 6-span bridge over Kickapoo Creek was removed and replaced with a 3-span PPC I-beam bridge with 3.5-inch thick PPC deck planks. The 5-span bridge over the Kickapoo Creek Overflow was removed and replaced with a 3-span PPC I-beam bridge with 3-inch thick PPC deck planks.

A summary of the construction of the 1999 and 2000 PPC deck plank bridges is as follows:

1. Deck planks with cracks were initially subject to rejection if cracks were visible from arm's length and greater than 3 inches (75 mm) along the plank. This requirement resulted in a large number of rejected PPC deck planks. Once the load test based on American Concrete Institute (ACI) 318, chapter 20 was adopted, several of the rejected PPC deck planks were accepted and used in the projects.

2. A few modifications in the bridge deck reinforcement were necessary as a result of the PPC deck planks. Some of the modifications necessary on the Jersey-Greene county bridge included cutting the splice bars three to four inches shorter, and cutting the vertical bars on the parapet wall. The one modification necessary on the Logan County bridges was the change from L-shaped stirrup design for the girders to the loop stirrup design.

3. The expanded polystyrene strips used as forms under the edges of the PPC deck planks often did not hold up well during the concrete pours. Several "blow-outs" occurred during the Stage 1 pour on the Jersey-Greene county bridge and during the Stage 1 and 2 pours on the Logan county bridges. The only type of polystyrene that appeared strong enough to hold up against the concrete was the Type IV (ASTM C 578) extruded polystyrene.

4. The resident engineers and the contractors claimed that the PPC deck planks saved little in time and cost compared to conventional cast-in-place bridge decks.

5. Four cast-in-place bridges were surveyed for comparison. All the PPC deck plank bridges constructed in 1999 and 2000 contain more transverse cracks per foot than similar cast-in-place bridges that were surveyed.

6. One of the cast-in-place bridges contains longitudinal cracks, while all three PPC deck plank bridges contain longitudinal cracks. However, the three PPC deck plank bridges contain fewer longitudinal cracks per foot than the one cast-in-place bridge with longitudinal cracks.

Recommendations for using PPC deck planks in future IDOT contracts are as follows:

1. The load testing procedure eventually used for accepting PPC deck planks for the District 6 Logan county bridges or some other objective means of accepting PPC deck planks is recommended.

2. Pre-installation of leveling screws during the PPC deck plank fabrication process is recommended (before delivery of the PPC deck planks to the job site).

3. If polystyrene continues to be used as a form under the edges of the PPC deck plank, extruded polystyrene, Type IV or higher by ASTM C 578, should be used.

LIST OF FIGURES

LIST OF TABLES

LIST OF PHOTOGRAPHS

INTRODUCTION

This paper documents the construction and early performance of two 1999 and 2000 bridge deck replacement contracts in Illinois that included precast, prestressed concrete (PPC) deck planks. Metal stay-in-place forms used in one of the contracts is also briefly addressed.

PPC deck planks, a type of stay-in-place form used in construction of bridge decks, could speed construction of a bridge deck. Since PPC deck planks replace plywood forms, they eliminate the need to construct, and later strip, the forms. Also, the bottom layer of reinforcement required in a typical cast-in-place bridge deck is eliminated with PPC deck planks. This cuts down slightly on time and materials required for reinforcement installation.

PPC deck planks were first used by the Illinois Department of Transportation (IDOT) between 1980 and 1985. Due to some problems with longitudinal cracking in the bridge decks that incorporated PPC deck planks, IDOT discontinued use of the planks in 1985. In 1989, the department hired a consultant, Dr. Robert Klingner of the University of Texas, to evaluate the problems the department had experienced with the PPC deck planks. Dr. Klingner affirmed the moratorium unless recommended changes to PPC deck planks were made.

In the early 1990's, the prestressed concrete industry, through their trade group, Precast Prestress Producers of Illinois, proposed that the Department address some of the issues in Dr. Klingner's research, in order to include PPC deck planks as an option in bridge deck construction. In 1997, the department agreed to select demonstration projects in which PPC deck planks would be used. After careful consideration, the department and the prestressed concrete industry selected two demonstration projects, one in District 6 and one in District 8.

Also in 1997, a research study was conducted to measure shrinkage and creep strains in PPC deck planks. The data from the study were intended to help determine the need for a specified minimum plank age. This study was conducted by Jeffrey South of the Bureau of Materials and Physical Research (BMPR) with the cooperation of Prestress Engineering Corporation, who fabricated the planks in their Blackstone plant near Pontiac, Illinois.

CHANGES IN DESIGN

1980 - 1985

When planks were used during the early 1980's, planks were quite thin (2.5 inches), requiring tight tolerances for the height of the prestressing strand. When the tolerances were not met, the planks cracked and warped.

The methods of resting the planks on the beams included placing the planks in a mortar bed, placing the planks on cut PVC pipe set in grout, or placing the planks on flat polystyrene. Reportedly, the mortar bed often cracked soon after the bridge opened to traffic. Problems were experienced with air pockets, and honeycombing in the deck concrete, with the other methods for seating the planks.

The special provisions for the planks did not include an age requirement. In fact, planks were often shipped as soon as they met the strength requirement and used immediately upon shipment.

Between 1985 and 1998, the use of PPC deck planks was not allowed on IDOT porjects.

1998 – 2000

Based on Dr. Robert Klingner's recommendations, and further research by Jeffrey South of the BMPR, the special provisions for the two contracts discussed in this report required the thickness of the planks to be 3.0 or 3.5 inches. Due to the increase in thickness from 2.5 inches to at least 3.0 inches, placing the strands slightly out of tolerance was not expected to result in such severe cracking or warping in the plank.

The special provisions for the recent projects required a plank age of at least 28 days. This requirement was also a result of Dr. Klingner's and Mr. South's research. Provisions for both the contracts state the following: "The planks for stage I construction shall be at least 28 days old but not more than 35 days old at the time of pouring the remainder of the stage 1 deck. The planks for stage II shall be at least 60 days old but not more than 67 days old at the time of pouring the deck." Later, during a pre-production meeting held on February 25, 1999, it was agreed that the deck planks would be a minimum of four days old and achieve the final 28-day strength prior to shipment. The age of the deck planks was to be at least 60 days prior to the deck pour.

The method of resting the deck planks on the beams also changed. For the 1999 and 2000 construction contracts, leveling jacks were inserted in the plank during fabrication. The leveling screws placed in the jacks allowed the plank to be adjusted to the proper fillet height when planks were seated on the beams. Before planks were seated, polystyrene strips were placed underneath the planks. The polystyrene was to act as a dam for the concrete poured between the planks, which came up underneath the edges of the planks (see Photo 1).

Photo 1. PPC deck plank seated on polystyrene (July 1999 – District 6)

LOCATIONS AND DESCRIPTIONS OF PPC DECK PLANK BRIDGES (1999 – 2000)

In 1999 and 2000, two state-funded projects were constructed with PPC deck planks. The first project, located in District 8, was included in the July 31, 1998 letting. The second project, located in District 6, was included in the January 15, 1999 letting, and included two bridges. Table 1 summarizes the project information for both projects.

Table 1.

PPC Deck Plank Projects (1999 – 2000)

District	County	Contract Number	Letting Date	Completion Date	Contractor	Resident Engineer
8	Jersey - Greene	96936 1 bridge	7/31/98	11/15/99	Calhoun Co.	Mike Heitzig
6	Logan	92821 2 bridges	1/15/99	05/13/00	Halverson Construction Co. Inc.	Mark Riegel

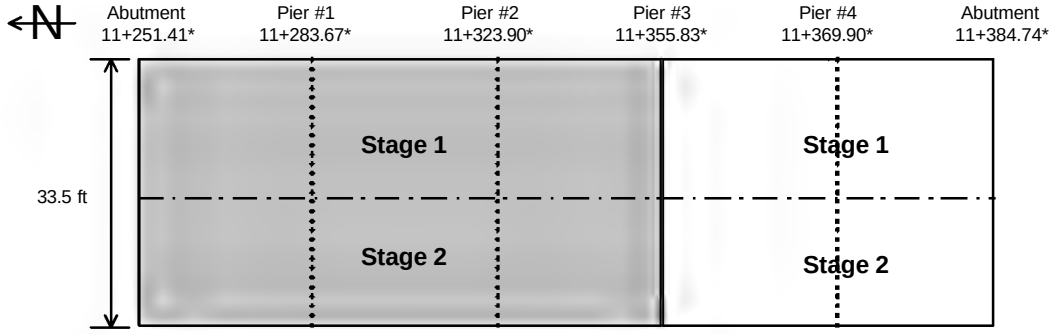
Jersey-Greene County (District 8) Bridge

Deck planks were fabricated first for the bridge in District 8. This bridge is located at the Jersey – Greene County line, approximately 6.5 miles south of Eldred, Illinois. The District 8 bridge (Structure No. 042-0009) carries Hillview-Eldred Road over Macoupin Creek. The project involved replacement of the concrete bridge deck, bearing, bridge approach pavements and guardrail, and repairs to the beams and slopewalls. The approach roadways were resurfaced to provide a transition to the new bridge deck and approach pavement. Three spans consist of riveted plate girders and two spans consist of wide flange beams. The new deck incorporated 3-inch thick PPC deck planks in Spans 1, 2 and 3 and metal stay-in-place forms in Spans 4 and 5 (see Figure 1).

Logan County (District 6) Bridge

The second project constructed in 1999 and 2000 with PPC deck planks is located in District 6. This project, in Logan County, included two bridge replacements. Both bridges, located on Illinois Route 10 and 121, west of Lincoln, Illinois, are PPC I-beam bridges. The 6-span bridge over Kickapoo Creek (Structure No. 054-0003) was removed and replaced with a 3-span PPC I-beam bridge with 3.5-inch thick PPC deck planks. The 5-span bridge over the Kickapoo Creek Overflow (Structure No. 054-0105) was removed and replaced with a 3-span PPC I-beam bridge with 3-inch thick PPC deck planks (see Figure 2). The project also included milling and resurfacing the pavement from 0.2 mile west of Kickapoo Creek to Elm Street in Lincoln. Right-turn lanes were constructed and new signals installed at Connolley Road. At IL Route 10 and the Zion Lutheran School entrance, new signals were installed.

Figure 1
District 8 PPC Deck Plank Bridge
Jersey-Greene County
Structure No. 042-0009
(Hillview-Eldred Road over Macoupin Creek)

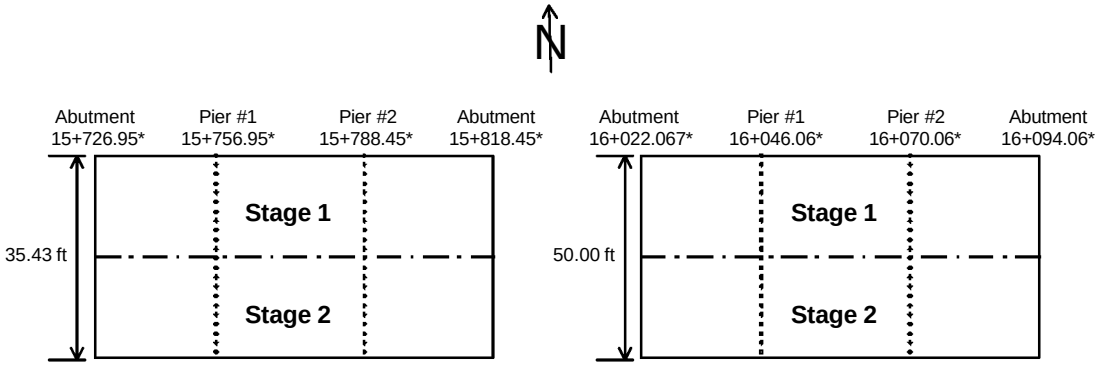


PPC Deck Planks
Spans 1, 2, & 3

Metal Stay-In-Place Forms
Spans 4 & 5

* Note: Stations at Centerline

Figure 2
District 6 PPC Deck Plank Bridges
Logan County
(IL 10 & 121 over Kickapoo Creek and Kickapoo Creek Overflow)



PPC Deck Planks
Kickapoo Creek Bridge
("Creek Bridge")
Structure No. 054-0003

* Note: Stations at Centerline

PPC Deck Planks
Kickapoo Creek Overflow Bridge
("Overflow Bridge")
Structure No. 054-0105

* Note: Stations at Centerline

PPC DECK PLANK FABRICATION

Process

The PPC deck planks for both projects were fabricated at the Prestress Engineering Corporation (PEC) Blackstone production plant. Planks were manufactured according to the applicable requirements of Section 504 of the *Illinois Department of Transportation Standard Specifications for Road and Bridge Construction (January 1997),* and the contracts' special provisions. Casting beds were set up for a lot size of 8 planks, each 4 feet wide and 5 to 6 feet long. Eleven prestressed strands were placed in headers with slots designed for individual strands. The planks were also reinforced with wire mesh. Leveling jack inserts were imbedded into the planks to allow for fillet height adjustment during deck plank seating. The surface of the plank lot was leveled off with a vibratory screed, as shown in Photo 2. Laborers then hand-finished and tined the surface.

Photo 2. Vibratory Screed

PPC deck planks were typically poured between 10:00 a.m. and 2:00 p.m. The planks were normally steam cured until the following morning, when the forms were stripped. This usually occurred between 6:00 a.m. and 10:00 a.m., depending on when the release strength was achieved. Planks were steam cured from the first pour on February 23, 1999 through the end of May 1999. No planks were steam cured from the beginning of June 1999 to the last pour on August 26, 1999. Under normal conditions, the release strength of 4061 psi was reached 15 to 18 hours after the pour. If cylinders did not reach the release strength by 11:00 a.m. the morning after the pour, the steam curing would remain on until 6:00 a.m. the following day (2 days after the pour). For about 80 percent of the pours, release strength was reached within 15 to 18 hours after the pours. For the remainder of the pours, steam curing was left on for up to 42 hours.

The required concrete compressive strength for releasing strands was 4061 psi. The final strength requirement was 5076 psi.

Inspection Criteria

The following were the dimensional tolerances:

- Thickness: +1/8 in., -0 in.
- Length: ±1/8 in.
- Width: ±1/8 in.
- Square Ends: ±1/4 in.
- Location of Strands (vertically): ±1/32 in.
- Strand Slippage (horizontal dislocation): 1/16 in.

Field Inspection

Inspection was performed according to the *Manual for Inspectors of Precast, Prestressed Concrete Products* and Section 504 of the *Illinois Department of Transportation Standard Specifications for Road and Bridge Construction (January 1997)*. Prior to each pour, casting beds were inspected for excess concrete buildup under the side forms. When excess concrete remained under the side forms, the top of the form would be too high, causing the plank to be too thick. Concrete would also build up along the edge of the chamfer strip on the pilot liner (bottom form), causing the planks to be too wide.

Deck planks were measured for proper thickness by inserting a probe into the plastic concrete behind the vibrating screed. Inspectors also measured the thickness of the completed planks (with the tined finish) but found that the tined top finish made accurate measurements very difficult. All planks were checked for proper lengths and widths by the P.E.C. Quality Control staff. IDOT inspectors checked at least 25 percent of the planks to ensure that the required tolerances for length and width were maintained.

All planks were closely monitored for proper vertical and horizontal locations of the strands. Every strand for every plank was measured on the bed prior to the pour so that it could be adjusted before the pour. If the thickness of the plank was more than ±1/16 inch from the target, the vertical strand placement was out of tolerance. One deck plank out of every lot (8 planks) was checked for strand slippage, as shown in Photo 3. If the slippage was greater than the allowable measurement, the entire lot of eight planks was rejected.

Mortar build-up of ±1/4 inches, often resulting from the tining process, had to be removed. Deck planks were also observed for any camber. If any camber was measured, it was to be noted and referred to the Bureau of Bridges and Structures (BB&S) for final acceptance. Any spalling as a result of cleaning out leveling jack inserts was not perceived as a problem unless a strand was exposed. Deck planks with cracks radiating from the strands were subject to rejection if cracks were visible from arm's length and greater than 3 inches along the length of the plank.

Photo 3. Checking vertical location of strand with micrometer

Problems with Deck Plank Rejections

A large number of deck planks were rejected due to longitudinal cracks radiating from the strands and exceeding acceptable limits. For all three bridges included in the two projects, an average of 31.7 percent of the planks were rejected due to hairline cracks greater than 3 inches in length. Table 2 is a summary of the evaluation results.

Table 2

PPC Deck Plank Evaluation Results

Contract Number	Thickness	Total # Planks Produced	Planks with Excessive Cracks	Planks with Strand Slippage	Planks with Miscellaneous Defects	Total # Rejected	Percent Rejected
96936	3 in.	384	78	0	12	90	23
92821	3.5 in.	344	13	13	0	26	8
92821	3 in.	336	79	8	8	95	28
Totals		1064	170	21	20	211	20 (average)

PEC developed a solution to the cracking by adding #3 reinforcing bars above and below the strands, 1.5 inches from each end of the plank, as seen in Photo 4. While the bars reduced a number of the cracks, a great number of planks were still rejected due to hairline cracks.

Due to the large number of rejected deck planks, PEC was going to be short of mesh necessary to complete the jobs. Since the mesh was a special production, the additional mesh would need to be ordered for fabricating more planks. In order to prevent this delay in production, a load testing procedure was proposed in order to approve the rejected deck planks.

Photo 4. #3 rebar above and below strands

Solution

The BB&S decided to evaluate the strength of the rejected planks. Beginning in July 1999, load tests were performed on 3-inch and 3.5-inch planks. The load tests were conducted according to American Concrete Institute (ACI) 318, Chapter 20. After a few alterations to the original test method, the final test method was performed as follows.

Previously rejected planks were grouped in lots of 10 according to similar cracking patterns. Out of every lot of 10, the IDOT inspector randomly selected one plank as the test plank. All strands on the test plank were cut flush at the ends of the plank. The test planks were set on steel I-beams to ensure flat, straight bearing. Three inches of each edge of the plank rested on the I-beams to simulate the bearing of the structure. The dunnage used on top of the test plank was 2-inch by 4-inch lumber. Two 2-inch by 4-inch pieces were stacked and placed in four locations on top of the test plank. The 2-inch by 4-inch pieces at the ends were placed no less than nine inches from the end of the plank. For the 3-inch thick planks, eleven planks were carefully stacked on top of the test plank with dunnage placed between each of the eleven planks. The eleven planks and dunnage weighed approximately 9900 lb. For the 3.5-inch thick planks, thirteen planks and the dunnage, weighing approximately 11,700 lb., were stacked on the test plank. Photo 5 shows the load test in progress.

Before loading the test plank, lines were marked on each end of the test plank at mid-depth. The center of the length of the plank was marked with a vertical line. A string line was pulled tight on the mid-depth marks at each end. At the center of the length of the plank, a horizontal line was marked on the vertical line for a straight-line reference. After the test plank was loaded, a string line was held on the end mid-depth lines and pulled tight. The distance from the horizontal line at the center of the plank to the string line was measured and recorded as the deflection, as shown in Photo 6. The load remained in place for 24 hours.

Photo 5. Load Test

Photo 6. Checking deflection with stringline

Deflection was measured a total of four times. First, deflection was measured immediately after the load was applied. Then, it was measured approximately 24 hours after the first measurement, just prior to the removal of the load. It was then measured immediately after the load was removed. Finally, deflection was measured 24 hours after the load was removed.

Prior to the load test, inspectors performed a complete visual inspection of the test plank. All cracks were marked and the lengths and locations were noted. All strands at the end of the test plank were cut flush with the end of the plank. Twenty-four hours after the load was removed and all deflection measurements were taken, a second visual inspection was performed. The inspectors looked for any increase in length of the noted cracks,

additional cracking, spalling of the concrete at the points of support under the plank, and strand slippage.

Results of the load testing were submitted to the BB&S for evaluation. Prior to shipping the accepted deck planks, the ends of the cracks were marked. If any of the cracks lengthened due to shipping or handling, the plank was to be rejected at the job site.

Table 3 summarizes the number of PPC deck planks shipped to each project, including the number of planks that were approved and shipped after load testing.

Table 3
PPC Deck Plank Shipment Summary

Contract Number	Thickness	Total # Planks Shipped	# Planks Approved by Inspection Criteria and Shipped	# Planks Approved By Load Testing	# Planks Shipped from Load Tests
96936	3 in.	348	294	70	54
92821	3.5 in.	331	318	13	13
92821	3 in.	293	241	60	52

PPC DECK PLANK SEATING

Jersey-Greene County (District 8) Bridge

Rate of Placement

An average of 25 PPC deck planks were seated in a given day on the Jersey-Greene County bridge. Photo 7 shows the seating of the deck planks. On some days, the laborers would finish unloading one truck and could not continue seating planks until another shipment arrived. Eleven working days were used to seat the deck planks. Six days were used for Stage 1 (the northbound lane) and five days were used for Stage 2 (the southbound lane). For Stage 1, the last PPC deck plank was set June 3, 1999; and the Stage 1 pour was twenty-one days later on June 24, 1999. For Stage 2, the last PPC deck plank was set September 10, 1999; and the Stage 2 pour was eighteen days later on September 28, 1999.

Photo 7. Deck plank seating (District 8 – Stage 2, Sept. 2, 1999)

Problems

When seating PPC deck planks for Stage 1, the laborers were slowed down while installing the leveling screws. Many of the imbedded inserts were slightly compressed, making screw installation very difficult. Furthermore, several of the planks developed spalls in one or more of the corners after the leveling screws were installed (see Photo 8). This was probably a result of the force applied when the leveling screws were installed.

Solution

PEC began installing the screws during fabrication. The laborers only had to adjust the screws during the seating process. This solution greatly reduced the time and effort required for seating the deck planks.

Photo 8. Spall at leveling insert (District 8 – Stage 1, June 24, 1999)

Logan County (District 6) Bridges

Rate of Placement

About 80 PPC deck planks (2 truckloads of 40) were typically seated in a given day on the Logan County bridge. For each stage, three working days were typically used to seat deck planks.

For Stage 1 (overflow bridge), deck plank seating was completed on August 2, 1999. The Stage 1 (overflow bridge) pour was 14 days later on August 16, 1999. For Stage 1 (creek bridge), deck plank seating was completed on August 6, 1999. The Stage 1 (creek bridge) pour on the creek bridge was 24 days later on August 30, 1999.

For Stage 2 (overflow bridge), deck plank seating was completed on December 2, 1999, as shown in Photo 9. Due to cold weather, the Stage 2 (overflow bridge) pour was not completed until March 13, 2000. The Stage 2 (creek bridge) deck plank seating was completed on December 14, 2000. The Stage 2 (creek bridge) pour on the creek bridge was on March 22, 2000.

Problems

Originally, deck plank seating was planned to begin on the creek bridge. Due to a high level of water under the creek bridge, it was decided that work should begin on the overflow bridge. However, the deck planks that were already fabricated for the creek bridge were not the correct thickness. Not only did the deck planks for the overflow bridge still need to be fabricated, they had to mature for 60 days. However, some of the waiting time was used for constructing the substructure. Overall, seating the deck planks for the overflow bridge was delayed for approximately 20 days.

Photo 9. Deck plank seating (District 6 – Stage 2, Dec. 1, 1999)

Since the problem with the leveling screws was resolved during the construction of the Jersey-Greene county bridge, laborers had no difficulty with leveling screw installation. In fact, the Resident Engineer reported that they had absolutely no problems during deck plank seating.

BRIDGE DECK CONSTRUCTION WITH PPC DECK PLANKS

Jersey-Greene County (District 8) Bridge

Changes in Reinforcement

Because of the deck planks, reinforcement bars had to be modified in some places. Splice bars had to be cut three to four inches shorter, because they were too long to accommodate the deck planks (see Photo 10). Some of the vertical bars for the parapet wall had to be cut shorter, since they had to rest on the deck planks (see Photo 11).

Photo 10. Bottom splice bars cut short
(District 8 – Stage 1, June 24, 1999)

Photo 11. Inside parapet wall bars resting on plank
(District 8 – Stage 1, June 24, 1999)

Plank Age

PPC deck planks were required to be at least 60 days old at the time of the concrete deck pour. Planks for Stage 1 were cast 63 to 118 days before the Stage 1 pour. Planks for Stage 2 were cast 69 to 215 days before the Stage 2 pour. The last load shipped for Stage 2, which contained 54 planks, was accepted by load testing. Plans called for 340 planks for Stage 1 and 2. While 384 planks were produced for Stage 1 and 2, only 348 planks were shipped.

Concrete Deck Pours

Stage 1 – June 24, 1999

Start Time	Stop Time	Air Temperatures	Concrete Temperatures	Volume of Concrete Poured
8:10 AM	2:00 PM	82° (8:30 AM) 86° (12:00 PM)	82° (8:30 AM) 88° (12:00 PM)	148 yd^3

Stage 2 – September 28, 1999

Start Time	Stop Time	Air Temperatures	Concrete Temperatures	Volume of Concrete Poured
7:30 AM	2:30 PM	61° (7:30 AM) 72° (12:00 PM)	73° (7:30 AM) 81° (12:00 PM)	176 yd^3

Problems

During Stage I paving, several “blow-outs” were reported. A blow-out occurs when the concrete either pushes out or breaks some sections of polystyrene, as shown in Photo 12. Without the polystyrene there to act as a dam, some concrete was lost in those areas. ASTM C 578 Type IV extruded polystyrene was used for both Stage I and 2. The movement and vibration of the bridge from the traffic may have caused the caulking bond to weaken between the polystyrene and the beams.

Reportedly, no blowouts occurred during Stage II construction. The Resident Engineer thought that the laborers were probably more careful in applying the caulking and setting the polystyrene when seating the planks on Stage II.

Logan County (District 6) Bridges

Changes in Reinforcement

Due to the overhang of the deck plank over the beams, the L-shaped stirrup design for the girders was changed to the loop stirrup design. This was the only modification necessary for the District 6 Logan County Bridges.

Photo 12. Blowout (District 8 - Stage I, June 28, 1999)

Plank Age

For the "overflow" bridge, planks were cast 63 days to 118 days before the Stage 1 pour and 237 days to 328 days before the Stage 2 pour. The last load shipped for Stage 2, which contained 13 planks, was accepted by load testing. Plans called for 330 planks for Stage 1 and 2. While 344 planks were produced for Stage 1 and 2, only 331 planks were shipped.

For the "creek" bridge, planks were cast 84 days to 132 days before the Stage 1 pour and 209 days to 327 days before the Stage 2 pour. The last load shipped for Stage 2, which contained 7 planks, was accepted by load testing. Plans called for 284 planks for Stage 1 and 2. While 336 planks were produced for Stage 1 and 2, only 293 planks were shipped.

Concrete Pours

Stage 1 (Overflow Bridge) – August 16, 1999

Start Time	Stop Time	Air Temperatures	Concrete Temperatures	Volume of Concrete Poured
6:40 AM	11:00 AM	85° (average)	76° (6:40 AM) 80° (9:00 AM) 80° (11:05 AM)	162 yd^3

Stage 1 (Creek Bridge) – August 30, 1999

Start Time	Stop Time	Air Temperature	Concrete Temperatures	Volume of Concrete Poured
6:40 AM	1:00 PM	80° (average)	82° (6:40 AM) 77° (9:00 PM) 77° (11:50 PM)	168 yd^3

Stage 2 (Overflow Bridge) – March 13, 2000

Start Time	Stop Time	Air Temperature	Concrete Temperature	Volume of Concrete Poured
7:30 AM	12:00 PM	40°(average)	65°	180 yd^3

Stage 2 (Creek Bridge) – March 22, 2000

Start Time	Stop Time	Air Temperature	Concrete Temperature	Volume of Concrete Poured
6:30 AM	11:30 AM	50° (average)	70°	170 yd^3

Problems During Construction

District 6 had even more blowouts during both Stage I and Stage II construction than District 8 (see Photo 13). The grade of polystyrene for the Stage II construction was changed to reduce the blowouts. For Stage 1, expanded polystyrene was used. ASTM C 578 Type IV extruded polystyrene was used for Stage 2. The extruded polystyrene did not appear to help in reducing the blowouts during the Stage II pour (see Photo 14).

Photo 13. Blowouts (District 6 – Stage 1, August 16, 1999)

Photo 14. Blowouts (District 6 – Stage 2, March 13, 2000)

EARLY PERFORMANCE OF PPC DECK PLANK BRIDGES

Jersey-Greene County (District 8) Bridge

December 1, 1999

On December 1, 1999, a distress survey was performed on the Jersey-Greene county bridge. Numerous transverse cracks were found in Stage 1 (the northbound lane). The transverse cracks extended across at least 50 percent of the lane and were typically spaced 3.5 to 5.0 feet apart. The majority of the cracks were hairline, as shown in Photo 15. Stage 2 (the southbound lane) looked better than Stage 1. Only two transverse cracks and no longitudinal cracks were found.

Photo 15. Longitudinal Crack (District 8 – Stage 1, Dec. 1, 1999)

Copies of most recent distress survey sheets are attached in Appendix C. Table 4 below summarizes the December 1999 distress survey information.

Table 4
Jersey-Greene County Bridge
December 1, 1999 Distress Survey

Jersey-Greene County Bridge	Length of Deck (Back to Back Abutments)	Transverse Cracks – Number	Longitudinal Cracks – Length
Stage 1	342.6 ft	34	4.9 ft
Stage 2	342.6 ft	2	0

January 28, 2000

Approximately two months later, on January 28, 2000, a quick survey was performed on the Jersey-Greene County bridge. In Stage 1, several longitudinal cracks were observed. In fact, a single longitudinal crack, mostly above the first interior girder, ran along at least 50 percent of the northbound lane. In this survey, cracks were possibly more visible due to salt residue covering the bridge deck surface. Several transverse cracks were also seen in

Stage 1 (see Photo 16). Like the December survey, no longitudinal cracks and only two transverse cracks were found in Stage 2.

Photo 16. Longitudinal Crack (District 8 – Stage 1, January 28, 2000)

The underside of the bridge was also examined during this survey. A few areas appeared to have possible leaching. No cracked planks and no visible leaks under the soffits were found.

April 7, 2000

On April 7, 2000, a distress survey was performed on the Jersey-Greene county bridge. More transverse cracks were found in Stage 1 (the northbound lane) than in any surveys before. However, the longitudinal cracks seen in previous surveys were not found during this survey. The pavement surface was very wet at the time of this survey, since there had been light showers on and off that morning and during the night before. The saturated surface may have made it more difficult to see some cracks. The longitudinal cracks seen in previous surveys had been very tight and barely visible.

Once again, Stage 2 looked excellent. No longitudinal or transverse cracks were found in the spans with PPC deck planks.

Table 5

Jersey-Greene County Bridge

April 7, 2000 Distress Survey

Jersey-Greene County Bridge	Total Length of Spans with PPC Planks	Transverse Cracks – Number	Longitudinal Cracks – Length
Stage 1	343 ft	68	0
Stage 2	343 ft	0	0

May 16, 2000

A final distress survey was performed on the Jersey-Greene County bridge on May 16, 2000. The purpose of this survey was to find the longitudinal cracks that were not seen in the April 7th survey. At the time of this survey, the skies were very clear and sunny. The pavement surface was completely dry. In order to see the cracks more clearly, the surveyors wetted down the pavement and waited for it to dry slightly. By doing this, the pavement surface away from the cracks dried quickly, while the cracks remained wet longer and were therefore more visible.

The surveyors did find longitudinal cracks in this survey. They also found six transverse cracks in Stage 2. Table 6 is a summary of the May 16th distress survey.

Table 6
Jersey-Greene County Bridge
May 16, 2000 Distress Survey

Jersey-Greene County Bridge	Total Length of Spans with PPC Planks	Transverse Cracks – Number	Longitudinal Cracks – Length
Stage 1	343 ft (104 m)	69	148 ft (45 m)
Stage 2	343 (104 m)	6	0

Logan County (District 6) Bridge

February 24, 2000 (Stage 1 – Overflow Bridge)

A distress survey was performed on the "overflow" bridge on February 24, 2000. Only Stage 1 (westbound lane) was surveyed, since Stage 2 pours on both the "creek" and "overflow" bridges had not yet been completed. Several transverse cracks were found between the west abutment and pier #2 (see Figure 2 for reference). No longitudinal cracks were found. However, just after the deck was uncovered after curing, several people stated that they saw some longitudinal cracks. (See Photo 17). Since the westbound lane (Stage 1) was the only lane open to traffic, the surveyors had to perform the survey from Stage 2, on the other side of the temporary concrete barriers. Surveyors found that the cracks were very difficult to see due to the dryness of the pavement and the grooves saw-cut into the surface. Since Stage 2 of the "creek" bridge did not have forms between the first interior girder and the fascia, the survey was only performed on the "overflow" bridge.

Copies of distress survey sheets are attached in Appendix D. Table 7 below summarizes the distress survey information for the "overflow" bridge.

Photo 17. Longitudinal, transverse, & diagonal cracks before traffic loading
(District 6 – Stage 1 "overflow" bridge, August 30, 1999)

Table 7

Logan County Bridges

February 24, 2000 Distress Survey

Logan County Bridges	Length of Bridge Deck (Back to Back Abutments)	Transverse Cracks – Number	Longitudinal Cracks – Length
Stage 1 – Overflow Bridge	236 ft (72 m)*	17	0

* measured at centerline

March 13, 2000 (Stage 1 – Creek Bridge)

On March 13, 2000, a distress survey was performed on Stage 1 of the "creek" bridge. Only Stage 1 (westbound lane) was surveyed, since the Stage 2 pour on the "overflow" bridge was in progress and the Stage 2 pour on the "creek" bridge was set for a later date. The surveyors again had to perform the survey from Stage 2, on the other side of the temporary concrete barriers.

Like Stage 1 of the "overflow" bridge, cracks were difficult to see due to the distance the surveyors stood from the pavement and the dryness of the pavement. Again, the surveyors did not find any longitudinal cracks. However, the surveyors noticed a large number of short, hairline transverse and longitudinal cracks (possibly plastic shrinkage cracks) on the edge of the lane next to the centerline. The pavement happened to be slightly damp in that area. It is possible that the shrinkage cracks extended across the entire lane but were not visible to the surveyors.

The more severe and visible transverse cracks were located directly above the piers. Two cracks in an hourglass shape were located above Pier #1 in Stage 1 of the "creek" bridge (see Photo 18) Two fairly straight transverse cracks were located above Pier #2. The survey notes for the 1999 PPC deck plank bridges previously surveyed indicate that similar cracks were located over most of the piers.

Photo 18. Transverse cracks above Pier #2

(District 6 – Stage 1 "creek" bridge, March 13, 2000)

The underside of both the bridges (Stage 1) was also examined during this survey. No areas appeared to have any leaching. No cracked planks and no visible leaks under the soffits were found.

Table 8

Logan County Bridges

March 13, 2000 Distress Survey

Logan County Bridges	Length of Bridge Deck (Back to Back Abutments)	Transverse Cracks - Number	Longitudinal Cracks – Length
Stage 1 – Creek Bridge	300 ft (92 m)*	17	0

* measured at centerline

May 30, 2000 ("Overflow" & "Creek" Bridge – Stages 1 & 2)

A final distress survey was performed on the Logan County bridges on May 30, 2000. Stage 1 on both bridges contained significantly more transverse cracks than Stage 2. However, Stage 2 contained a number of transverse cracks, usually starting at the longitudinal joint between Stage 1 and 2 and continuing to about the middle of the lane. Stage 1 on both bridges also contained more longitudinal cracks than Stage 2. Again, at least 95 percent of the cracks were hairline and barely visible from arm's length away. Stage

2 was just opened to traffic a few weeks before this survey, while Stage 1 had been opened to traffic since October 1999.

Unusual patterns of cracking (a combination of transverse, longitudinal, and diagonal cracks) were found in the decks over the piers. In fact, the cracks in Stage 2 of the "overflow" bridge over Pier #1 looked like an outline of a PPC deck plank.

Table 9

Logan County Bridges

May 30, 2000 Distress Survey

Jersey-Greene County Bridge	Length of Deck (Back to Back Abutments)	Transverse Cracks – Number	Longitudinal Cracks – Length
Stage 1 – Overflow Bridge	236 ft (72 m)	53	69 ft (21 m)
Stage 2 – Overflow Bridge	236 ft (72 m)	34	7 ft (2 m)
Stage 1 – Creek Bridge	300 ft (92 m)	42	3 ft (1 m)
Stage 2 – Creek Bridge	300 ft (92 m)	20	0

The surveyors examined the underside of both bridges. While they were able to look at all three spans of the "overflow" bridge, they were only able to look at one span of the "creek" bridge due to the water level. They found only one plank in the "overflow" bridge that appeared to have some cracking (see Photo 19). Even the cracking they saw was minor. The rest of the planks appeared to be in good condition.

Photo 19. Crack on underside of PPC deck plank

(District 6 – "overflow" bridge, May 30, 2000)

COMPARISONS TO CAST-IN-PLACE BRIDGES

Time

According to Mike Heitzig, the R.E. for the District 8 PPC bridge, the use of deck planks cut the time to form the deck by 50 percent, as compared to a cast-in-place bridge. With the deck planks, some of the form construction time and all of the form stripping time was eliminated. However, in Mr. Heitzig's opinion, the bridge was actually opened to traffic only about a month earlier than it would have been with the cast-in-place method. Several factors unrelated to the deck planks contributed to the delays, such as the contractor changing the superintendent four times during the project's duration.

According to Mark Riegel, the R.E. for the District 6 PPC bridges, the deck planks allowed the bridges to be completed a couple of days earlier than a cast-in-place bridge. In Mr. Riegel's opinion, the iron workers saved a couple of days by not putting in the bottom layer of steel. However, forming the solid diaphragms for the piers and abutments still took a lot of time.

According to one of the Resident Engineers, the contractors are accustomed to the conventional cast-in-place method and have developed a very efficient system for constructing a cast-in-place deck. Since contractors are not as familiar or knowledgeable about PPC deck planks, the Resident Engineer feels that contractors may need some time to become efficient in utilizing the planks. He feels that efficiency will be improved once bridge deck construction with PPC deck planks is refined.

Halverson Construction Company, the contractor for the District 6 Logan county bridges, commented that PPC deck planks are not good for projects with an early completion date. Based on their experience, Halverson believes that the 60-day age requirement may cause a delay in seating the PPC deck planks. This could be especially detrimental to a project with an early completion date. It could also be costly to the contractor once the planks are available due to the probability that overtime will be needed later on in the project to meet the deadline.

Cost

Calhoun Company, the contractor for the District 8 Jersey-Greene county bridge, believed that the PPC deck planks saved them very little, if anything, in cost. The PPC deck plank system was used to replace the specified bottom reinforcement and the bottom 3 inches of concrete superstructure. It also eliminated the need for forms in the areas between the beams. According to Calhoun Company, the cost of the PPC deck planks was equivalent to the cost savings in concrete superstructure and reinforcement.

Halverson Construction Company, the contractor for the District 6 Logan county bridges, believed that the PPC deck planks did save them in labor by eliminating most of the forming and stripping. Halverson estimated that the elimination of forming and stripping saved them approximately one week. However, Halverson said that they had about four weeks of down-time while waiting for the 60-day age on the PPC deck planks for the "overflow" bridge. The four-week delay resulted in some overhead costs. For this reason, Halverson claimed that it would be hard to calculate a quantitative cost comparison between PPC deck planks and the conventional cast-in-place method.

Performance Comparison

In order to compare the performance of the PPC deck plank bridges constructed in 1999 and 2000 to similar bridges constructed in the same time period, four bridges using traditional forming in District 6, constructed in 1998, were surveyed in April - May 2000. Table 10 summarizes the distress surveys of those bridges. Contract #92927, #92670 and #72008 include 3-span bridges. Contract #92452 includes a 5-span bridge. All bridges listed in Table 10 have two lanes.

The transverse cracks value (number/foot) was calculated by dividing the total number of transverse cracks in both lanes by the total length from abutment to abutment (in feet) of both lanes. For example, the transverse cracks value for contract #92927 was calculated by dividing 19 (the total number of transverse cracks) by 2 x 148 ft (2 multiplied by the length from abutment to abutment). Longitudinal cracks (length/foot) were calculated by dividing the total length of longitudinal cracks in both lanes by the length from abutment to abutment (in feet) of both lanes. For example, the longitudinal cracks value for contract #92670 was calculated by dividing 89 (the total length of longitudinal cracks) by 2 x 89 (2 multiplied by the length from abutment to abutment).

Table 10

Concrete Bridge Deck with Traditional Forms

Distress Surveys

April – May 2000

Contract #	County	Letting Date	Length from Abutment to Abutment	Transverse Cracks – (Number / Foot)	Longitudinal Cracks – (Length / Foot)
92927	Pike	1/15/99	148 ft	0.06	0
92452	Logan	11/16/98	509 ft	0.07	0
92670	Sangamon	4/23/99	89 ft	0	0.50
72008	Scott	1/15/99	259 ft	0.07	0

For comparison, Table 11 summarizes the latest distress surveys of the 1999 and 2000 PPC deck plank bridges. The latest surveys were completed on May 16 & 30, 2000. Like the bridges in Table 10, these bridges have two lanes. The transverse and longitudinal crack values were calculated by the same method as the values in Table 10.

All the PPC deck plank bridges contain more transverse cracks per foot than the cast-in-place bridges included in Table 10. One cast-in-place bridge contains no transverse cracks. The other three cast-in-place bridges contain no more than 0.07 transverse cracks per foot. All three of the PPC deck plank bridges contain at least 0.10 transverse cracks per foot. The Logan County “overflow” bridge contains the highest number of transverse cracks per foot (0.18). Three of the four cast-in-place bridges contain no longitudinal cracks. While all three of the PPC deck plank bridges contain some longitudinal cracking, they all contain less longitudinal cracking than the Sangamon County bridge, which was the only cast-in-place bridge with longitudinal cracking.

Table 11

PPC Deck Plank Bridge Deck

Distress Survey Final Summary

May 2000

Contract #	County	Letting Date	Length from Abutment to Abutment	Transverse Cracks – (Number / Foot)	Longitudinal Cracks – (Length / Foot)
96936	Jersey - Greene	07/31/98	343 ft	0.11	0.22
92821 “Creek” Bridge	Logan	1/15/99	300 ft	0.10	0.01
92821 “Overflow” Bridge	Logan	1/15/99	236 ft	0.18	0.16

METAL STAY-IN-PLACE FORMS

Jersey-Greene County (District 8) Bridge

Metal stay-in-place forms were incorporated into two spans of the Jersey-Greene county bridge in District 8. The permanent metal deck forms were placed between the exterior girders in spans 4 & 5 (see page 7 and Photos 20 and 21).

Photo 20. Seating metal stay-in-place forms (District 8 – May 1999)

Photo 21. Polystyrene fillers in metal stay-in-place forms (District 8 – May 1999)

Distress surveys of the spans with metal stay-in-place forms were conducted in conjunction with the distress surveys of the spans with PPC deck planks. The following tables summarize the distress surveys on December 1, 1999; April 7, 2000; and May 16, 2000.

Table 12

Jersey-Greene County Bridge

Spans with Metal Stay-in-Place Forms

Distress Survey Summary

Jersey-Greene County Bridge	Total Length of Spans with Metal Forms	Date of Survey	Transverse Cracks – Number	Longitudinal Cracks – Length
Stage 1	95 ft	12-01-99	0	0
		04-07-00	4	0
		05-16-00	4	0
Stage 2	95 ft	12-01-99	0	0
		04-07-00	1	0
		05-16-00	1	0

SUMMARY

Three bridges were constructed in 1999 and 2000 with PPC deck planks. The first bridge was constructed in District 8 at the county line between Jersey and Greene counties. In this report, the District 8 bridge is referred to as the Jersey-Greene county bridge. The last two bridges were included in one contract. They are located in District 6 in Logan county. These bridges are referred to as the Logan county "creek" and "overflow" bridges.

In 1985, the Department placed a moratorium on the use of PPC deck planks for bridge deck construction due to longitudinal cracking in the completed decks. The 1999 and 2000 PPC deck plank projects were constructed with improved PPC deck plank designs. For these projects, the thickness of the planks was increased to 3.0 or 3.5 inches, instead of the 2.5-inch planks used in the past. The age of the planks was required to be a minimum of 60 days at the time of the deck pour. The seating method for the 1999 and 2000 PPC deck planks included pre-installing leveling screws for fillet adjustment and using polystyrene forms to contain the concrete between the planks.

Conclusions

Conclusions based on the construction of the 1999 and 2000 PPC deck plank bridges are as follows:

1. Deck planks with cracks were subject to preliminary rejection if cracks were visible from arm's length and greater than 3 inches (75 mm) along the plank. This requirement resulted in a large number of rejected PPC deck planks. Once the load test based on American Concrete Institute (ACI) 318, Chapter 20 was adopted, several of the rejected PPC deck planks were accepted and used in the projects.

2. A few modifications in the bridge deck reinforcement were necessary as a result of the PPC deck planks. Some of the modifications necessary on the Jersey-Greene county bridge included cutting the splice bars three to four inches shorter, and cutting the vertical bars on the parapet wall. The one modification necessary on the Logan County bridges was the change from the L-shaped stirrup design for the girders to the loop stirrup design.

3. The polystyrene strips used as forms under the edges of the PPC deck planks often did not hold up well during the concrete pours. Several blow-outs occurred during the Stage 1 pour on the Jersey-Greene county bridge and during the Stage 1 and 2 pours on the Logan county bridges. The only grade of polystyrene that appeared strong enough to hold up against the concrete was the ASTM C 578 Type IV extruded polystyrene.

4. The resident engineers and the contractors claimed that the PPC deck planks saved little in time and cost compared to conventional cast-in-place bridge decks.

5. Four cast-in-place bridges were surveyed for comparison. All the 1999 and 2000 PPC deck plank bridges contain more transverse cracks per foot than similar cast-in-place bridges that were surveyed.

6. One of the cast-in-place bridges contains longitudinal cracks, while all three PPC deck plank bridges contain longitudinal cracks. However, the three PPC deck plank bridges contain less longitudinal cracks per foot than the one cast-in-place bridge with longitudinal cracks.

Recommendations

Recommendations for using PPC deck planks in future IDOT contracts are as follows:

1. The load testing procedure eventually used for accepting PPC deck planks for the District 6 Logan county bridges or some other objective means of accepting PPC deck planks is recommended.

2. Pre-installation of leveling screws during the PPC deck plank fabrication process is recommended (before delivery of the PPC deck planks to the job site).

3. If polystyrene continues to be used as a form under the edges of the PPC deck plank, extruded polystyrene, ASTM C 578 Type IV or higher, should be used.

APPENDIX A

Special Provisions for 3” and 3.5” PPC Deck Planks

APPENDIX B

Special Provisions for Metal Stay-in-Place Forms

APPENDIX C

Distress Surveys of District 8 PPC Bridge

APPENDIX D

Distress Surveys of District 6 PPC Bridges