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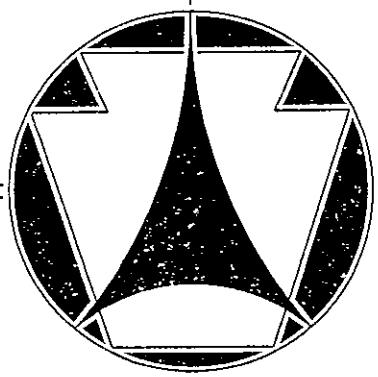
OFFICE OF PLANNING AND RESEARCH



RESEARCH PROJECT

No. 96-09-04

MATERIAL-RELATED FORENSICS
ANALYSIS AND SPECIAL TESTING

"Drying Shrinkage Evaluation of Bridge Decks
with Class AAA & Class AA w/wo Type K cement"

FINAL REPORT

JULY 2001

MICHAEL BOYLE

VALLEY FORGE LABORATORIES

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13. ABSTRACT (Maximum 200 words)
SUBJECT: Final Report July 2001

"Drying Shrinkage Evaluation of Bridge Decks with Class AAA & Class AA with/without Type K Cement"

This work pertains to preparation of concrete drying shrinkage data for proposed concrete mixtures during normal concrete trial batch verification. Selected concrete mixtures will include PennDOT Classes AAA and AA and will also include the use of Type K Cement. Concrete mixtures will be evaluated for use in each of 18 bridge deck construction.

14. SUBJECT TERMS Concrete volume change; drying shrinkage; bridge decks; trial batch verification; Type K cement.	15. NUMBER OF PAGES 143
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TITLE: Materials-Related Forensic Analysis and Special Testing, Pennsylvania Department of Transportation Research Project No. 96-09-04; Final Report

"Drying Shrinkage Evaluation of Bridge Decks with Class AAA and Class AA Concrete with or without Type K Cement"

RESEARCH REPORT NUMBER: FHKA - PA - 2001 - 001 - 96-09(4)

PREPARED BY: MICHAEL BOYLE, VICE PRESIDENT, P.I.
VALLEY FORGE LABORATORIES, INC.

DATE: July 9, 2001

This work was sponsored by the Pennsylvania Department of Transportation and the U. S. Department of Transportation, Federal Highway Administration.

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Work Order No. 96-09-04

Final Report:

"Drying Shrinkage Evaluation of Bridge Decks with Class AAA and Class AA Concrete with or without TYPE K Cement"

Introduction

Since the late 1980's PENNDOT has maintained a concerted effort to reverse the bridge deck cracking problems that, in hindsight, are believed to have resulted from a convergence of factors in the early 1970's. It has been shown[1] that many factors affect cracking of concrete structures. Higher specified compressive strengths for concrete bridge deck construction, the use of epoxy-coated reinforcing steel and finer cement particles producing earlier strength gain characteristics are only three of the four dozen or more factors refereed to in NCHRP Report 380.

Changes made in design criteria in the late 1980's accounted for the needed improvement in bond-development characteristics of epoxy-coated reinforcing steel. The results were significant but not a panacea for crack control durability issues. Early seven day compressive strength development is generally targeted to benefit acceptance of structure by purchaser and for payment of the contractor. A consequence of this is the significant increase in 24, 48 and 72 hour compressive modulus. The resulting large modulus of elasticity typically produced proportionally larger tensile stresses due to restrained shrinkage and thermal effects[1].

The current Research Project conducted by Valley Forge Laboratories, Inc. (VFL), Research Project Number 96-09-04 pertains to sampling and testing of proposed concrete mixtures for recording of potential concrete drying shrinkage contraction during concrete trial batch verification. Selected concrete mixtures include PennDOT Classes AAA and AA concrete and the use of TYPE K Cement. Concrete mixtures were evaluated for use in up to 18 bridge deck projects. The initial scope was modified to provide the opportunity to implement the findings of Wilber Smith Associates[2], (WSA), R P No. 89-01. To accommodate the scope change, the early temperature history of the concrete and supporting elements were recorded as part of a second Pennsylvania Research Project, "Alternative Concrete to Prevent Bridge Deck Cracking," PR No. 96-053 and the results provided to VFL.

The WSA recommendations consisted of targeting a maximum differential of deck and beam temperatures (22 ° F) and a maximum (free) drying shrinkage of 400 micro-strain at 28 days age. The latter assumes that the concrete will be wet cured for seven days and air dried for 21 days. By combining the records from RP No. 96-053 and RP No. 96-09-04 a comparison between the WSA "Prediction" and observed deck cracking of newly constructed bridge decks can be made.

Changes in construction specification for acceptable temperature of materials and ambient conditions and use of combinations of admixture were also incorporated into R P No. 96-053.

BACKGROUND

Research[2] conducted by Wilbur Smith Associates, through Research Project 89-01 suggested that drying shrinkage characteristics of concrete could be limited by selecting materials which have been qualified by test. The WSA research plan included assessment of the shrinkage characteristics of concrete sampled from new bridge deck construction operations. The scope of the WSA work included an attempt to assess the drying shrinkage of older (1987, 1988, 1989, and 1990) decks with and without serious deterioration by re-creating the concrete from records. Additional efforts by WSA were applied to assess the effects of certain aggregate and cement sources, including TYPE K cement on concrete drying shrinkage. The WSA work included one attempt was made to assess the effects of fly ash on concrete drying shrinkage.

The WSA results suggested that the unrestrained drying shrinkage (see Figure 1) of AAA bridge deck concrete was extremely variable throughout the state. The local combination of materials or market influence in selection of materials could result in a range of drying shrinkage values from 0.04% to 0. 15%. Furthermore, by accounting for the drying shrinkage (free-shrinkage[1]) of the concrete as delivered to the site and estimating the thermal strains, it was proposed that a strong correlation could be made between the data and the observed bridge deck cracks. WSA TABLE 3, “Comparison of Cracks Predicted and Cracks Observed for 8 Newly Constructed Bridge Decks,” was found to correctly predict the outcome in all eight case studies.

Where WSA’s discussion of drying shrinkage and thermal contraction on cooling was generally a comparison of the individual and combined strains, WJE’s discussion[1] focused on stress development. Both approaches are interchangeable for a given modulus of elasticity. And while WSA minimized the role of early creep, WJE suggests that early creep may hold the solution to the early transverse cracking problem. Both researchers demonstrate that the structural response is a combination of strains and where restrained, the accompanying stresses, which sometimes cause transverse cracking. Since all factors were unavoidably active in the 200,000 decks reported in response to the WJE surveys and 50% developed early transverse cracking, one can infer that the "average" state of a newly cast concrete deck is either crack resistant or not crack resistant.

METHODS

For each bridge deck selected for use of an "Alternative Concrete," a control bridge deck with Class AAA was also selected. A total of 18 drying shrinkage evaluations were eventually scheduled. Concrete mixtures proportioned with TYPE K cement require adherence to ASTM C 878 procedures for preparation of sample molds, casting, demolding time and initial measurement time. The steel molds are assembled with a steel all-thread attached to end plates used as confinement steel (0.0012" elongation at 6301b -force).

During the witnessing of the trail batches three test prisms (3"x 3"x 10") were cast. Applicable provisions of ASTM C 157 and ASTM C 878 were followed. Upon fabrication of the test prisms, the assemblies were scaled and clamped in steel molds and transported in a foam rubber lined chest.

The initial cure after casting and prior to demolding is 23½ (+/-) ½ hours for ASTM C 157 and 6 hours for ASTM C 878 (TYPE K cement concrete). Initial length of each sample is recorded at time of demolding. Use of retarding admixtures in TYPE K cement concrete mixtures delayed the initial measurement of some samples for an additional 2 to 6 hours. Wet curing in lime-water was began after the initial measurements were recorded. Wet curing was consistent with field operations. All bridges were wet cured 7 days except for TYPE K cement concrete where wet cure was extended to 10 to 14 days as per field arrangements.

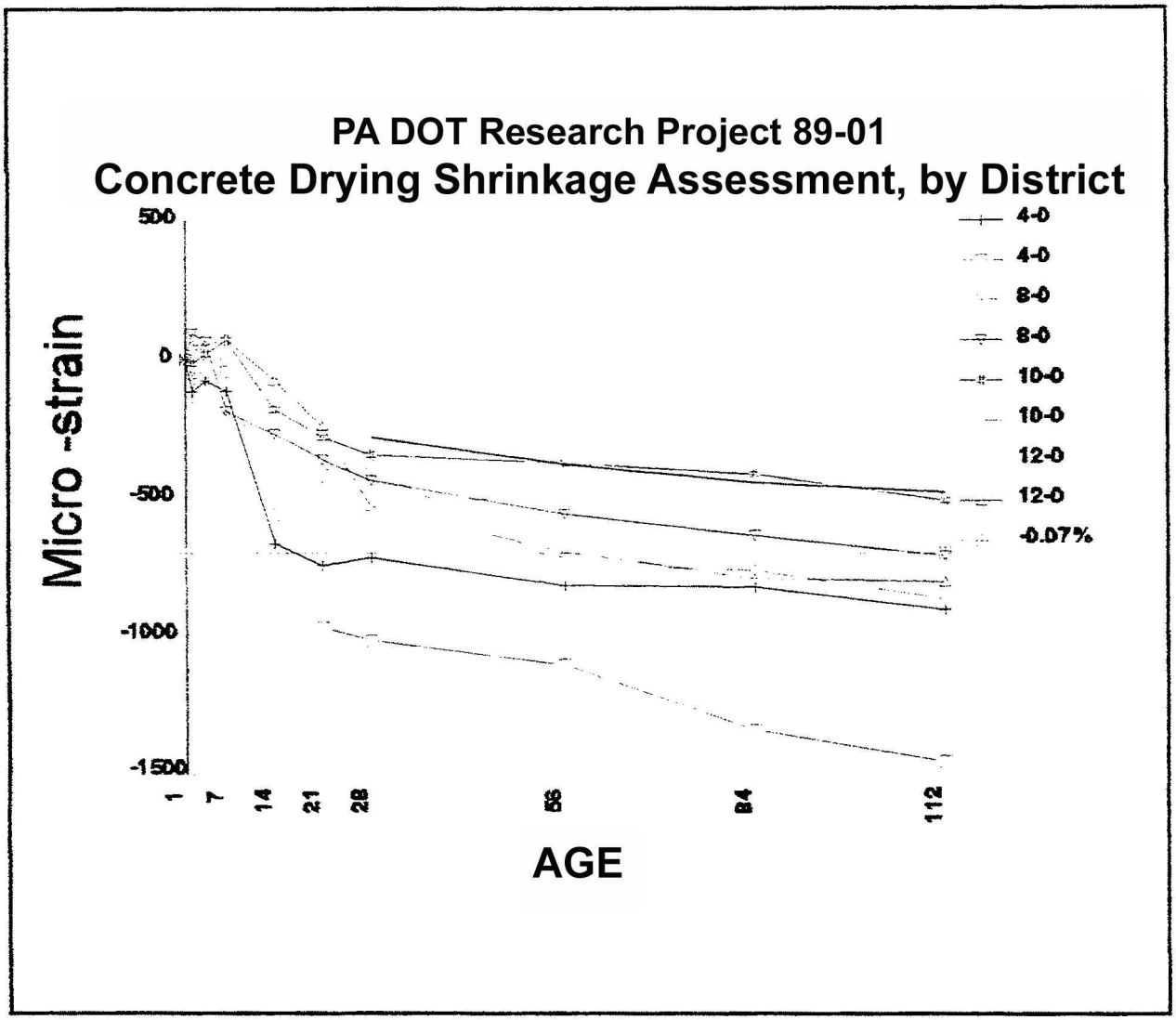


FIGURE 1

Figure 1 combines the results from eight bridge decks evaluated during part of the research conducted by Wilbur Smith Associates and Valley Forge Laboratories through PENNDOT Research project 89-01, Task 8. A data line at (-)0.07% was added for clarity and comparison to prevailing ASTM specifications.

Ambient conditions were monitored for temperature and relative humidity at the time of length measurements. Initial sample mass was recorded after 24 hours of wet cure. Both length and mass measurements were recorded three times during the first 4 days, weekly for the first month and monthly for 4 months.

BRIDGE DECK SAMPLING PROGRESS

The initial work on R P No. 96-09-04 commenced at Glen Redi-Mix Concrete, District 10-0 in Brookville, Pennsylvania on May 7, 1997. Class AAA concrete with TYPE K cement was sampled and evaluated but the mix failed to achieving the required 6.0% air content. On May 20, 1997 the concrete trial batching at Glen Redi-Mix Concrete, Brookville, resumed with two batches of concrete needed to produce an acceptable level of entrained air. The second batch was sampled and again the ASTM C 878 test bars were molded. At 8:00 pm on May 20, 1997 the initial lengths of the demolded test bars were recorded. Based on the 7 day compressive strength results the Glen Redi-Mix Concrete, Brookville, Class AAA w/ TYPE K cement was approved for use at SR 0322-503, Jefferson County.

By May 29, 1997 three bridge deck placements had been included in the program. The number of bridge decks sampled, monitored and subjected to an initial bridge deck condition survey amounted to nine as of October 9, 1997. One of nine was subsequently rejected for finishing problems and replaced.

Concurrently on May 20,1997, VFL was present at the New Enterprise Stone & Lime Co. job site in District 3-0, for sampling of the Class AAA concrete at the concrete batch plant during production for placement on SR 6015. Based on the early experience gained in May 1997, it was determined that with the exception of the TYPE K mix design trial batches the concrete sampling for ASTM C 157 drying shrinkage would be conducted on the day of the bridge deck pour.

Progress in 1998 was limited to the sampling of one bridge deck in District 8-0, which was subsequently replaced, one bridge deck placed in District 8-0 in June 3, 1998 and one bridge deck in District 2-0 on the same day, June 3, 1998, and the apron to a bridge on October 9, 1998 in District 3-0. The Class AA concrete mixture proportions for the apron were the same as used on three bridge deck pours in September 1998. The apron data was applied to the bridge decks representing a single drying shrinkage data source.

The program included 13 sets of data representing 11 bridge decks at the end of 1998. Four, District 8-0 bridge decks were added to the program in 1999 and one District 10-0 bridge deck was included as of June 30, 2000 for a total of 16 bridge deck and 18 sets of data. An additional trial batch verification for AAA concrete with TYPE K cement was attempted on May 25, 2000 in District 10-0 but the compressive strength levels were less then specified. The second attempt was unsuccessful due to material source documentation problems. The end date for inclusion of the data in Research Project No. 986-09-04 passed prior to the third attempt. The May 25, 2000 data is included as the 19th set of ASTM C 157 or C 878 free-drying shrinkage test results.

MONITORING CONSTRUCTION

Independent observations, as part of the R P No. 96-09-04 program, were recorded for the concrete batching operations and bridge deck construction. Details included monitoring of the following on the day of the bridge deck placement:

- Ambient temperature
- Concrete temperature
- Deck temperature
- Wind velocity
- Relative humidity

Site specific conditions such as the movement of sun light and shading from direct sun light, construction irregularities and the post-pour details were part of the R P No. 96-053 program administered by the District and reported to the MTD for subsequent transmittal to VFL.

BRIDGE DECK CONDITION SURVEYS

The initial survey was conducted after the deck has been cleared of obstructions but before the new construction is open to traffic. The specific concrete deck, which was initially monitored during construction was photographed and any discernable transverse cracking was mapped and measured for record. The second visit to each site was conducted at 6 months to 1 year after the deck was poured. The protocol was restricted to a "*Walk-By*" survey when traffic safety issues do not permit otherwise. Design of traffic safety measures, permitting and implementation were included in this work order for cases where the "*Walk-By* " survey is not permitted for safety reasons. Charles Fong & Associates, Roadway Safety Inc., and Whale Publishing are D.B.E. participants in the PENNDOT Research Project No. 96-09. Charles Fong and Associates and VFL shared responsibility for conducting the bridge deck condition surveys.

FINDINGS

The finding of this Research Project No. 986-09-04 are focused in three areas. The summary of records and observations collected on the dates that concrete bridge deck were constructed, the observations and measurements recorded on the dates of site visits during the condition surveys and the summary of free-drying shrinkage data for samples cast on-site or at the concrete production facilities. The samples were returned to VFL for monitoring of length changes and the gaining or loss of moisture during the wet curing and air drying periods. The compiled laboratory data records are presented in FIGURES 2, 3, 4, and 5. The data is organized by District and by date cast.

The compendium of records are provided in Appendix A and include the following:

- Compressive Strength from the R P NO.96-053
- Deck Temperatures from the R P NO.96-053
- Batcher/Mixer Tickets copied by VFL
- Ambient and Bridge Deck Temperature and Concrete Data recorded on the date of the concrete placement by VFL.

- Bridge Deck and Structural Details recorded on the date of the concrete placement by VFL
- 28 Day & 112 Day Free-Drying Shrinkage Data Points
- Initial and 2nd Site Condition Surveys conducted by C. Fong & Associates and/or VFL

The condition survey reports issued by Charles Fong & Associates are provided in Appendix B.

ANALYSIS

The initial scope as-modified provided the opportunity to implement the findings of Wilber Smith Associates as reported in the Research Project No. 89-01, March 1996 final report. The WSA recommendations consisted of targeting a maximum differential of deck and beam temperatures (22 ° F) and a maximum (free) drying shrinkage of 400 micro-strain at 28 days age after 21 days of air drying. WSA TABLE 3, "Comparison of Cracks Predicted and Cracks Observed for 8 Newly Constructed Bridge Decks," was found to correctly predict the outcome in all eight case studies. The WSA "Prediction Methods and Assumptions" were used here to compare the observed deck cracking of 16 newly constructed bridge decks in this study to the WSA predicted crack spacing values. To accomplish the comparison the WSA format was followed.

The information necessary for the exercise can be summarized as per the WSA report by organizing the data in accordance with WSA TABLES 1 and 3. WSA analytical approach found that a restrained thermal contraction strain of 228 micro-strain may produce initial cracking in the concrete in its early age. The compounded results of temperature contraction and long-term, free-drying shrinkage, which includes the autogenous volume change due to cementitious activity, were found to describe a cracking-threshold of 400 micro-strain. The "creep" properties of the concrete account for the larger strain accommodated by the concrete at the latter age. The definitions employed for the terms used in the tables are as follows:

- Effective Thermal Shrinkage: Thermal contraction in excess of the cracking threshold strain of 228 micro-strain where restrain is due to differential thermal movement between the deck and the structural frame assuming a 5.5 micro-strain for coefficient of thermal expansion.

- Residual Thermal Shrinkage: Uncracked concrete decks hold the differential thermal contraction strain as a residual condition unless acted upon by creep.

- Specimen Drying Shrinkage: (3" x 3" x 10") Length changes captured at 24 hour to 112 days for concrete with conventional cementitious materials and length changes captured at 6 hour and up to 12 hours after casting when strong retardation is used, to 112 days for TYPE K cement concrete

Data Consolidation for Graphics Support: ASTM C 157 & C 878

Research Project No. 96-09-04

Date Cast:	8/27/97		8/28/97		1/06/98		04/22/99		05/28/99		06/11/99		9/03/99	
District:	Dist 8 AAA,Mix #3		Dist 8 AAA, Mix#4		Dist 8 AAA, Mix#2		Dist 8 AAA, Mix#C1060, K		Dist 8 AAA, Mix#C1142		Dist 8 AA Mix#3		Dist 8 AAA Mix#2 K	
SR:	0030-009 over 272 EB		0030-009 over 272 EB		0030-009 over 741, WB		0022- Sec. 2, over Market St. EB		Dauphin Bridge over Stony Creek		0030 over WB, 272 Oregon Pike		0030 over 741, -EB,	
Producer:	RMC Lancaster		RMC Lancaster		RMC Lancaster		Pennsy Supply		Pennsy Supply		RMC Lancaster		RMC Lancaster	
	Measured Length		Measured Length		Measured Length		Measured Length		Measured Length		Measured Length		Measured Length	
	Inches/Inch	Wt. Change	Inches/Inch	Wt. Change	inches/inch	Wt. Change	Inches/Inch	Wt. Change	inches/inch	Wt. Change	Inches/Inch	Wt. Change	Inches/Inch	Wt. Change
limewater							12hr	0	0				0	0
24 Hr.	0	0	0	0	0	0	29.1hr	0.00029	0.03%	0	0	0	0.00030	0.78%
2 Days	-0.00011	0.53%	0.00003	0.35%	-0.00001	0.56%	4 days	0.00048	0.28%	0.00009	0.81%	0.00002	0.71%	0.00042	1.06%
	-0.00009	0.86%	0.00004	0.83%	-0.00000	0.99%	5	0.00048	0.35%	0.00004	0.86%	0.00001	0.90%		
7	-0.00012	0.88%	0.00002	0.88%	-0.00001	1.01%	7	0.00048	0.44%	0.00005	0.98%	0.00002	1.01%	0.00041	1.17%
Air Cure														
14	-0.00040	0.12%	-0.00019	0.15%	-0.00035	-0.21%	14	0.00027	-0.73%	-0.00021	0.67%	-0.00023	-0.28%	0.00024	-0.05%
21	-0.00049	0.01%	-0.00030	-0.06%	-0.00046	-0.46%	21	0.00019	-0.94%	-0.00026	-0.35%	-0.00030	-0.44%	0.00016	-0.36%
28	-0.00061	-0.13%	-0.00040	-0.22%	-0.00052	-0.61%	28	0.00016	-1.07%	-0.00030	-0.47%	-0.00035	-0.58%	0.00011	-0.50%
56	-0.00072	-0.33%	-0.00051	-0.58%	-0.00061	-0.96%	56	0.00007	-1.35%	-0.00038	-0.73%	-0.00044	-0.92%	0.00000	-0.95%
84	-0.00079	-0.62%	-0.00056	-0.74%	-0.00062	-1.10%	84	0.00004	-1.48%	-0.00042	-0.94%	-0.00049	-1.00%	-0.00004	-1.16%
112	-0.00083	-0.72%	-0.00060	-0.83%	-0.00067	-1.17%	112	0.00002	-1.68%	-0.00044	-0.94%	-0.00051	-0.98%	-0.00014	-1.38%

District 8
Drying Shrinkage Data

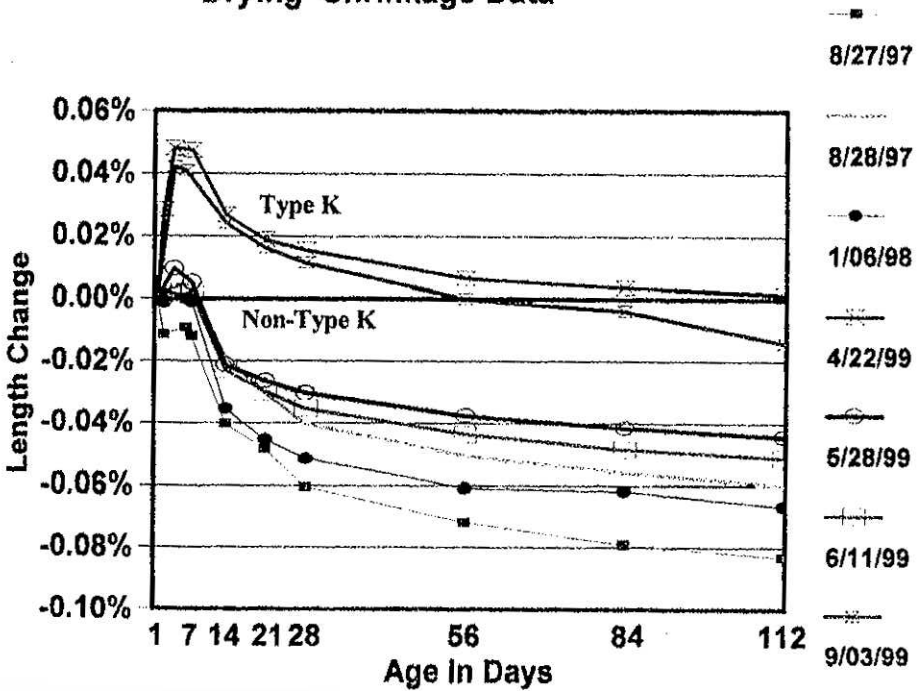


FIGURE 2

ita Consolidation for Graphics Support: ASTM C 157 Research Project No. 96-09-04

ite Placed:	5/20/97		7/02/97		9/16/97		10/09/97		10/21/97		6 /03/98		10/09/98	
strict:	Dist 3 AAA		Dist 3 AA		Dist 3 AAAMod#3		Dist 3 AAAMod#3		Dist 3 AAAMod#3		Dist 3 AAAMod#3		Dist 3 AA	
t:	SR6015		SR973-004		SR0015 B42, Over 414		SR0015 Over 284		SR0015 -B42/003 Blockhouse Creek		SR0220 -053 Over Pine Creek,SB		SR0220 -053, Over Pine Creek, NB	
ducer:	New Enterprise S & L		Susquehanna Supply Co		J & F Ready Mix:		J & F Ready Mix:		J & F Ready Mix:		Wild Rose, Inc.		Wild Rose, Inc.	
ewater	Inches/inch	Wt. Change	Inches/inch	Wt. Change	Inches/inch	Wt. Change	Inches/inch	Wt. Change	Inches/inch	Wt. Change	Inches/inch	Wt. Change	Inches/inch	Wt. Change
Days	-0.00003	0.27%												
2	-0.00007	0.49%	-0.00003	0.67%	-0.00003	0.67%	0.00000	1.33%	0.00009	1.52%	0.00000	0.37%	0.00003	0.51%
3	-0.00007	0.62%	-0.00004	0.73%	-0.00004	1.04%	0.00002	1.45%	0.00010	1.80%	0.00001	0.60%	0.00002	0.63%
7	-0.00007	0.88%	-0.00006	0.76%	-0.00005	1.10%	-0.00001	1.42%	0.00007	1.83%	0.00001	0.69%	0.00003	0.73%
r Cure														
14	-0.00046	-1.07%	-0.00042	-1.01%	-0.00035	-0.18%	-0.00033	-0.47%	-0.00029	-0.32%	-0.00033	-0.55%	-0.00028	-1.16%
21	-0.00062	-1.52%	-0.00059	-1.44%	-0.00048	-0.49%	-0.00047	-1.03%	-0.00048	-0.74%	-0.00043	-0.77%	-0.00039	-1.51%
28	-0.00071	-1.70%	-0.00066	-1.60%	-0.00059	-0.68%	-0.00065	-1.23%	-0.00061	-1.04%	-0.00048	-0.92%	-0.00042	-2.20%
56	-0.00081	-2.05%	-0.00074	-1.95%	-0.00078	-1.16%	-0.00086	-1.73%	-0.00073	-1.41%	-0.00057	-1.35%	-0.00055	-2.27%
84	-0.00086	-2.23%	-0.00085	-2.02%	-0.00086	-1.39%	-0.00094	-1.98%	-0.00074	-1.54%	-0.00061	-1.52%	-0.00063	-2.56%
112	-0.00087	-2.24%	-0.00087	-2.08%	-0.00088	-1.50%	-0.00098	-2.02%	-0.00080	-1.71%	-0.00068	-1.60%	-0.00065	-2.74%

DISTRICT 3
DRYING SHRINKAGE DATA

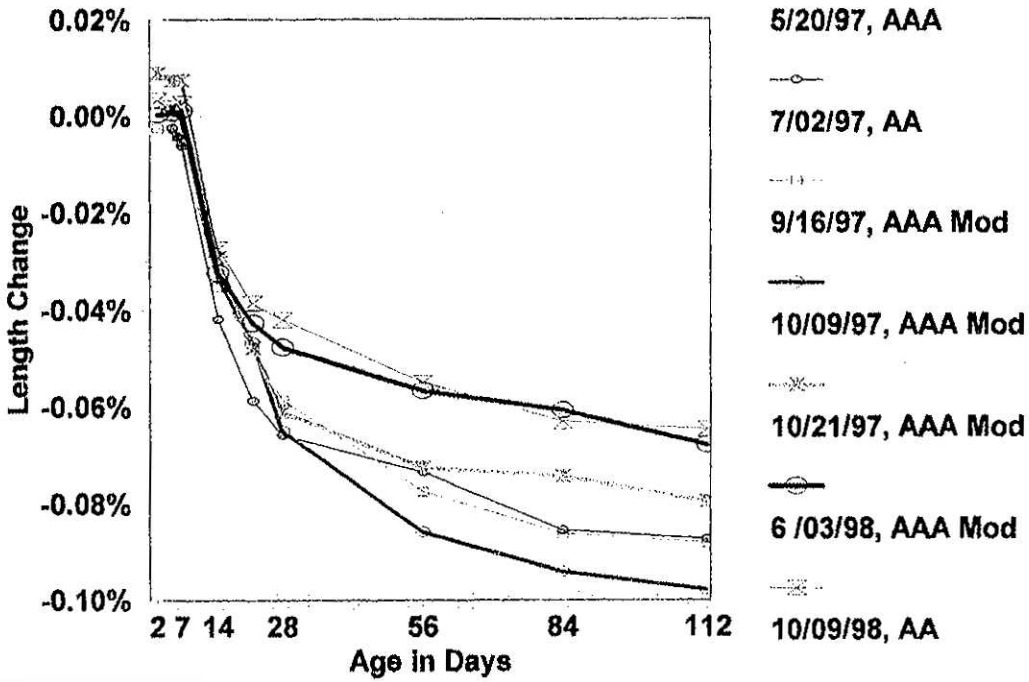


FIGURE 3

Date Placed:	6 /03/98	AAPump.ret
District:	Dist 2-0	
SR:	0322-B1	

Producer:	Juniata Concrete, Co.	
	inches/inch	Wt. Change
in limewater	0	0
2 Days	0.00000	0.67%
5	0.00002	0.96%
7	0.00000	1.09%
In Air at 7 days		
14	-0.00024	-0.33%
21	-0.00036	-0.68%
28	-0.00041	-0.82%
56	-0.00053	-1.27%
84	-0.00061	-1.44%
112	-0.00065	-1.52%

DISTRICT 2
DRYING SHRINKAGE DATA

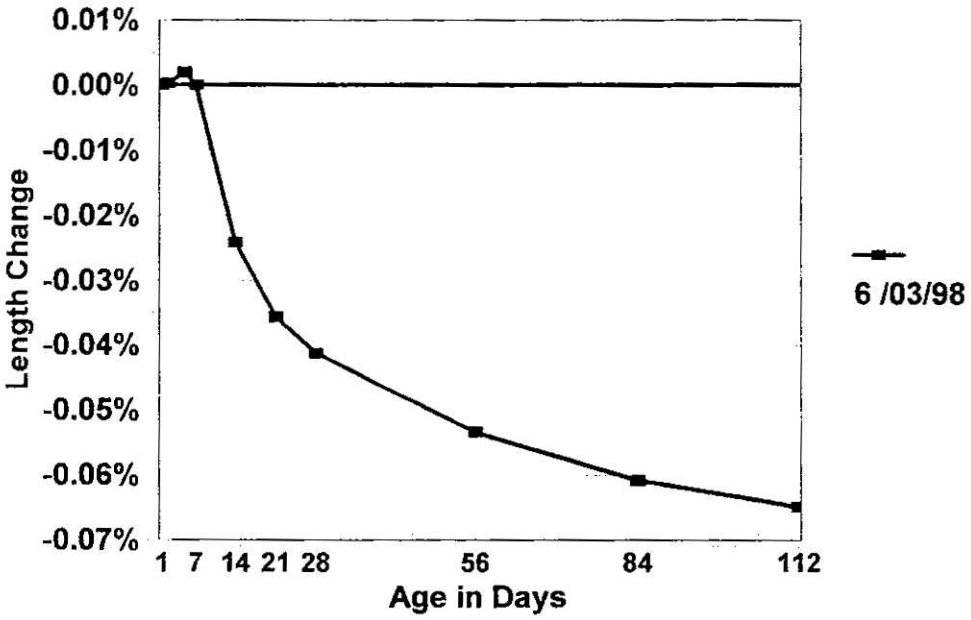


FIGURE 4

Data Consolidation for Graphics Support: ASTM C 157 & C 878 Research Project No. 96-09-04

Date Placed:	**5/20/97 AAA, K**	**5/29/97 AAA**	**5/25/00 AAA, K**	**6/30/00 AAA**
District:	Dist 10 trial	Dist 10	Dist 10 trial	Dist 10
SR:	SR0322, 503	SR0322, 505	Garret Run	Garret Run

MIX REJECTED for Strength

Producer:	Glenn Sand & Gravel		Glenn Sand & Gravel		Age	Merion Center Concrete		Merion Center Concrete	
	inches/inch	Wt. Change	inches/inch	Wt. Change		inches/inch	Wt. Change	inches/inch	Wt. Change
In limewater	0	0.00%			6hr	0	0.00%		
1 Day	0.00033	0.58%	0.00000	0.00%	18hr	0.00000	0.00%	0.00000	0.00%
1.21	0.00038	0.62%	0.00003	0.54%					
2	0.00049	0.73%	-0.00001	0.62%					
3	0.00054	0.83%	-0.00001	0.65%	5	0.00045	0.72%	0.00002	0.81%
7	0.00058	0.99%	-0.00003	0.68%	7	0.00046	0.82%	0.00003	0.89%
In Air at 7 days									
14	0.00034	-0.56%	-0.00031	-0.66%	14	0.00022	-0.58%	-0.00037	-0.82%
22	0.00026	-0.91%	-0.00042	-0.93%	21	0.00016	-0.81%		
28	0.00020	-1.06%	-0.00047	-1.06%	28	0.00011	-0.94%	-0.00050	-1.25%
56	0.00009	-1.39%	-0.00056	-1.38%	56	0.00000	-1.23%	-0.00065	-1.62%
84	0.00004	-1.57%	-0.00060	-1.51%	84	nr	nr	-0.00075	-1.83%
112	0.00004	-1.63%	-0.00061	-1.54%	112	nr	nr	-0.00078	-1.91%

DISTRICT 10

DRYING SHRINKAGE DATA

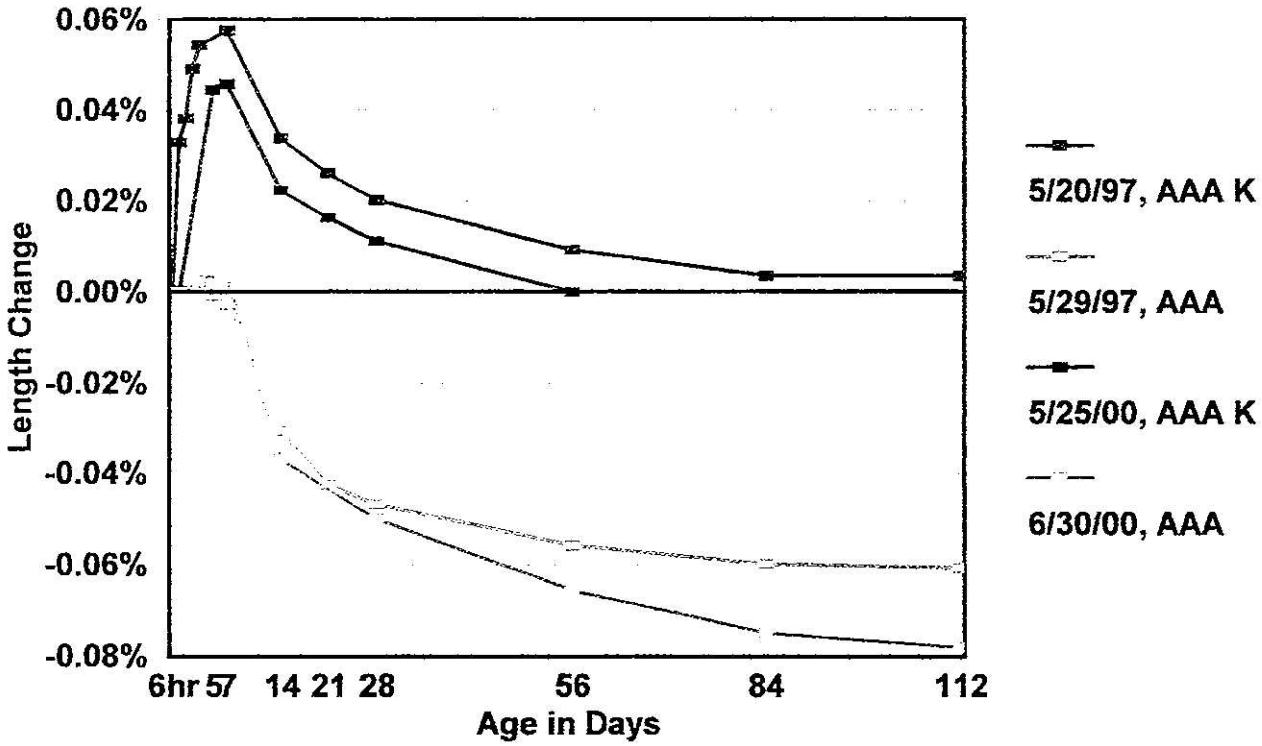


FIGURE 5

- Deck Drying Shrinkage: Assumed to be 40% of the specimen free-drying shrinkage due to volume-to-surface ratio differences.

- Effective Long-Term Shrinkage: Total net strain after cracking or in strain in excess of 400 micro-strain

- Predicted Crack Spacing: Crack spacing in feet[2, 3] = 833.33 / "Effective Long-Term Shrinkage," micro-strain

To compile the same types of information used in WSA TABLE 3, "Comparison of Cracks Predicted and Cracks Observed for 8 Newly Constructed Bridge Decks[2]," the WSA TABLE 1, "Thermal And Drying Shrinkage Information of 8 Newly Constructed Bridge Decks[2]," format was also used here. The following tables are identified as WSA TABLES 1 (a, b, & c) for clarity as to the origin of the table format. The condition survey information relied on in the WSA work was provided in WSA TABLE 2 in the earlier work. No corresponding WSA TABLE 2 was generated here. Both Appendix A and Appendix B in this report include the observed cracking information for the bridge deck sites. The detailed information related to the WSA findings including the derivation of the assigned values used in the tables, were provided in WSA , "Prevention of Cracks in Concrete Bridge Decks: Report On Observations of Bridge Deck Constructions and Concrete Shrinkage Measurements in the Field[3] "

The comparison of cracks predicted and cracks observed for 16 newly constructed bridge decks during R P No. 96-09-04 is as follows.

DISTRICT 3-0 OBSERVATIONS & PREDICTIONS

CONDITION A - PREDICTION AND OBSERVATIONS SIMILAR

Six bridge decks, cast with concrete produced by three suppliers, were available for calculation of predicted crack spacing values for comparison to the observed results. Only one bridge deck was correctly predicted. The predicted crack spacings for the Wild Rose Inc., concrete deck was 16 ft (10 & 19 ft. observed) for a "Control" Class AAA.

CONDITION B - PREDICTION AND OBSERVATIONS INCONSISTENT

Two bridge decks were observed with longitudinal crack spacing values of 5, 6, and 8 feet respectively for the three deck sections involved. The predicted transverse crack spacings for the two, J. & F. Ready Mix Concrete decks, were 4 ft. (5 & 6 ft. observed) for a "Control" Class AAA concrete and 14 ft (8 ft. observed) for a Temperature Modified Class AAA specification. Including the longitudinal cracking over the piers is arguably not the intention of the WSA prediction method but from the concrete's perspective, restraint of movement causes cracking and the WSA method does seem to apply. Three of the bridge decks cast with concrete from three different concrete suppliers were found to have no observed deck cracks.

The predicted crack spacings for the J. & F. Ready Mix Concrete deck, cast on 10/21/97, were 4 ft. for a "Control" Class AAA concrete but no cracking was observed. The predicted crack spacings for the Wild Rose Inc., concrete deck, cast on 10/9/98, were 23 ft. for a Class AA concrete but no cracking observed. Likewise, the predicted crack spacings for the Susquehanna Supply Co., concrete deck, cast on 7/02/97, were 5 ft. for a Class AA concrete and no cracking was observed.

WSA TABLE 1(a) DISTRICT 3-0

VFL Bridge # Date Cast:	1, Control 5/20/97*	2, AA 7/02/97	3, Mod#3 9/16/97	4, Control 10/09/97	5, Control 10/21/97	6, Control 6/03/98	7, AA 10/09/98
SR: Over:	6015,NB*	973-004 Larry's Creek	0015-B42 SR 414	0015 SR 284	0015-B42 Blockhouse Creek	0220-053SB Pine Creek	0220-053NB Pine Creek
District:	3-0	3-0	3-0	3-0	3-0	3-0	3-0
Weather:	Clear, Sunny	Overcast Cloudy	Clear	P. Cloudy w/ fog	Cool Clear	Clear, Sunny	Clear, Sunny
Air Temp., ° F	44 - 70	45 - 70	53 - 78	50 - 80	35 - 55	50 - 62	48 - 70
(Initial) Concrete & ~ Max Cure Temp., ° F	(62), est. 95	(80), est 112**	(80), est. 102	(74), est. 90	(62), est. 100	(75), est. 100	(78), est. 100
Assumed Beam Temp., ° F	69	70	82	54	54	68	68
Differential Conc. /Beam, Temp., ° F	95 -69 = 26	112 - 70 = 42	102 - 82 = 20	90 - 54 = 36	100 - 54 = 46	100 - 68 = 32	100 - 68 = 32
Deck Thermal Shrinkage, Micro-strain	26 x 5.5 = 143	42 x 5.5 = 231	20 x 5.5 = 110	36 x 5.5 = 198	45 x 5.5 = 248	32 x 5.5 = 176	32 x 5.5 = 176
Specimen Drying Shrinkage, Micro-strain	870	870	880	980	800	680	650
Deck Drying Shrinkage, Micro-strain	870/2.5 = 348	870/2.5 = 348	880/2.5 = 352	980/2.5 = 392	800/2.5 = 356	680/2.5 = 272	650/2.5 = 260

(*) Note: Finishing problems resulted in rejection of deck. See condition survey summary.
(**) Note: Maximum cure temperature of concrete deck per R P #96-053.

WSA TABLE 3(a) DISTRICT 3-0

VFL Bridge # Date Cast:	1, Control 5/20/97*	2, AA 7/02/97	3, Mod#3 9/16/97	4, Control 10/09/97	5, Control 10/21/97	6, Control 6/03/98	7, AA 10/09/98
SR: Over:	6015,NB	973-004 Larry's Creek	0015-B42 SR 414	0015 SR 284	0015-B42 Blockhouse Creek	0220-053SB Pine Creek	0220-053NB Pine Creek
District:	3-0	3-0	3-0	3-0	3-0	3-0	3-0
Deck Thermal Shrinkage, from WSA TABLE 1(a) Micro-Strain	143	231	110	198	248	176	176
"Effective" Thermal Shrinkage, Micro-Strain	(143-228) per WSA = 0	(231-228) = 3	(110-228) = 0	(198-228) = 0	(248-228) = 20	(176-228) = 0	(176-228) = 0
Residual Thermal Shrinkage, Micro-Strain	143	231	110	198	248	176	176
Deck Drying Shrinkage, from WSA TABLE 1(a) Micro-Strain	348	348	352	392	356	272	260
"Effective" Long-Term Shrinkage, Micro-Strain	(143+348 -400) per WSA = 91	(231+ 348-400) = 179	(110+352 -400) = 61	(198+392 -400) = 190	248+356 -400) = 204	(176+272 -400) = 51	(176+260 -400) = 36
Predicted Crack Spacing (0.01" wide)	9 ft.	5 ft.	14 ft.	4 ft.	4 ft.	16 ft.	23 ft.
Observed Average Crack Spacing	NA	None	** 8 ft.	*** 5 ft. & 6 ft. (48 ft)	None	10 ft. 19 ft.	None

(*) Note: Finishing problems resulted in rejection of deck.

(**) Note: Cracks are in the longitudinal direction over beams. Spacing calculated by 42' 6" / 5 cracks.

(***) Note: (15) Cracks are in the longitudinal direction in the negative moment in-fill over Piers #1 and #2. Span #1 crack free, Span #2 has one crack and Span #3 has 6 cracks with a calculated WSA spacing factor of 48 ft.

DISTRICT 8-0 OBSERVATIONS & PREDICTIONS

CONDITION A - PREDICTION AND OBSERVATIONS SIMILAR

Six bridge decks representing five bridges were available for calculation of predicted crack spacing values for comparison to the observed results. Three and possibly four of the five bridges could be considered as positive examples of the WSA method. The concrete was produced by two suppliers, RMC Lancaster and Pennsy Supply. The predicted crack spacing was nil in five of the six bridge deck pours evaluated. Since the two "Control" Class AAA decks placed in August 1997 SR 0030 over SR 0272 (E B) were cast on two successive days, they are here combined for this discussion. The bridge developed cracking in the negative moment area in the 30 ft. central area of the deck slabs. The predicted crack spacing was 60 ft. for the first deck placed and nil for the second deck placed.

The two concrete suppliers produced "Control" Class AAA concrete decks without observed deck cracking. Three of the bridge decks were cast with "Alternate Materials". One TYPE K cement concrete placement of a 60 ft (deck joint to deck joint) deck had no observed cracks and none were predicted. A second TYPE K cement concrete bridge deck was one of three deck pours totaling 250 ft.(deck joint to deck joint). Two cracks were observed and none were predicted.

CONDITION B - PREDICTION AND OBSERVATIONS INCONSISTENT

The third "Alternate Materials" concrete mixture was a Class AA poured on June 11, 1999, for a 146 ft.(joint to joint) deck. Two cracks were observed and none were predicted. Generally, considering the minor number of deck cracks observed, the predicted performance was consistent with the outcome. The results are also consistent with the lower free-drying shrinkage found in the District 8-0 work.

WSA TABLE 1(b) DISTRICT 8-0

VFL Bridge # Date Cast:	8, Control 8/27/97*	9, Control 8/28/97	10, Control 1/06/98	11, Type K 4/22/99	12,Control 5/20/99*	13, AA 6/11/99	14, Type K 9/03/99
SR: Over:	0030-009 0272E B(2)	0030-009 0272E B(1)	0283-0030 0741W B	0022-002 Market EB	0022-002 Market WB	0030 0272 WB	0283-0030 0741EB
District:	8-0	8-0	8-0	8-0	8-0	8-0	8-0
Weather:	P. Cloudy	Over Cast	Over Cast	Over Cast	Sunny	Sunny	P. Cloudy
Air Temp., ° **F**	67 - 75	68 - 80	57 - 63	54 - 71	57 - 64	60 - 67	65 - 79
(Initial) Concrete ~ Max Cure Temp., ° **F**	(80), est. 112	(76), est. 112	(61), est. 85	(66), est. 90	(68), est. 92	(68), est. 92	(72), est. 112
Assumed Beam Temp., ° **F**	78	87	66	59	62	65	78
Differential Conc. /Beam Temp., ° **F**	112 - 78 = 34	112 - 87 = 25	85 - 66 = 21	90 - 59 = 31	92 - 62 = 30	92 - 65 = 27	112 - 78 = 34
Deck Thermal Shrinkage, Micro-strain	34 x 5.5 = 187	25 x 5.5 = 138	19 x 5.5 = 105	31 x 5.5 = 171	30 x 5.5 = 165	27 x 5.5 = 149	34 x 5.5 = 187
Specimen Drying Shrinkage, Micro-strain	810	600	670	(+) 20	440	510	140
Deck Drying Shrinkage, Micro-strain	810/2.5 = 324	600/2.5 = 240	670/2.5 = 268	20/2.5 = (+) 8	440/2.5 = 176	510/2.5 = 204	140/2.5 = 56

(*) Note: Shrinkage data is for samples cast on 5/28/99 during placement of the Dauphin Bridge over Stoney Creek

WSA TABLE 3(b) DISTRICT 8-0

VFL Bridge # Date Cast:	8, Control 8/27/97	9, Control 8/28/97	10, Control 1/06/98*	11, Type K 4/22/99	12,Control 5/20/99	13, AA 6/11/99	14, Type K 9/03/99
SR: Over:	0030-009 0272E B(2)	0030-009 0272E B(1)	0283-0030 0741W B	0022-002 Market EB	0022-002 Market WB	0030 0272 WB	0283-0030 0741E B
District:	8-0	8-0	8-0	8-0	8-0	8-0	8-0
Deck Thermal Shrinkage from WSA TABLE 1(b), Micro-strain	187	138	105	171	165	149	187
"Effective" Thermal Shrinkage, Micro-strain	(187-228) per WSA = 0	(138-228) = 0	(105-228) = 0	(171-228) = 0	(165-228) = 0	(149-228) = 0	(187-228) = 0
Residual Thermal Shrinkage, Micro-strain	187	138	105	171	165	149	187
Deck Drying Shrinkage, from WSA TABLE 1(b),Micro-Strain	324	240	268	(+) 8	176**	204	56
"Effective" Long-Term Shrinkage, Micro-Strain	(187 +324 -400) per WSA = 14	(138+240 -400) = 0	(105+268 -400) = 0	(171-8 -400) = 0	(165+176 -400) = 0	(149+204 -400) = 0	(187+56 -400) = 0
Predicted Crack Spacing (0.01" wide)	60 ft.	None	None	None	None	None	None
Observed Average Crack Spacing	None in Span II, 7 cracks 1st 30 ft. of Span I, negative moment area		NA, Deck replaced	None	None	(2 cracks) 22 ft.	(2 cracks) 67 ft.***

(*) Note: Fire Damaged. 42 surface crack in east and middle span pours at initial condition survey.
(**) Note: Shrinkage data is for samples cast on 5/28/99 during placement of the Dauphin Bridge over Stoney Creek
(***) Note: Two cracks in the full 250 ft (3 pour) deck. Spacing 62' 6" and 100' from west abutment. These cracks could be avoided if the full deck was poured monolithically with TYPE K.

DISTRICTS 10-0 & 2-0 OBSERVATIONS & PREDICTIONS

CONDITION A - PREDICTION AND OBSERVATIONS SIMILAR

Four bridge decks were available for calculation of predicted crack spacing values for comparison to the observed results. The predict crack spacing was nil in the two bridge deck pours. In District 10-0 one TYPE K cement concrete placement, produced by Glenn Redi Mix Concrete, of a 26 ft (deck joint to deck joint) deck had no observed cracks and none were predicted. The "Control" Class AAA concrete placement, which was also a 26 ft deck had no observed cracks and none were predicted.

CONDITION B - PREDICTION AND OBSERVATIONS INCONSISTENT

The other two decks were predicted to have crack spacing values of 8 ft. and 12 ft. The "Alternate Materials" Class AA deck, produced by Juniata Concrete Co., placed in District 2-0, as part of a 434.5 ft.(deck joint to deck joint) bridge deck, was predicted to have transverse crack spacing of 12 ft. No transverse cracking was observed but five short longitudinal cracks over the piers were measured 13 ft, and 20 ft. crack spacing. The predicted crack spacings for the Class AAA "Control" concrete place June 30, 2000 in District 10-0 was 8 ft. but no cracking was observed during the initial condition survey.

WSA TABLE 1(c) DISTRICT 10-0 & DISTRICT 2-0

VFL Bridge # Date Cast:	15, Type K 5/29/97	16, Control 5/29/97	17, Control 6/30/00		18, AA 6/03/98
SR: Over:	0322-503	0322-505	Garrett's Run		0322-B01 WB
District:	10-0	10-0	10-0		2-0
Weather:	Cloudy Lt. Rain	P. Cloudy Rain ending	Fog Lifting Sunny		Wind, 10 - 25 mph
Air Temp., °F	46 -60	46 - 60	53 - 63		50 - 66
(Initial) Concrete & ~Max Cure Temp., ° F	(72), est. 83	(68), est. 82	(75), est. 100		(80), est. 104
Assumed Beam Temp., °F	57	57	64		65
Differential Conc. /Beam, Temp., °F	82 - 57 = 25	82 - 57 = 25	100 - 64 = 36		104 - 65 = 39
Deck Thermal Shrinkage, Micro-strain	25 x 5.5 = 138	25 x 5.5 = 138	36 x 5.5 = 198		39 x 5.5 = 215
Specimen Drying Shrinkage, Micro-strain	Trial Batch (+) 40	610	780		650
Deck Drying Shrinkage, Micro-strain	(+) 40/2.5 = (+) 16	610/2.5 = 244	780/2.5 = 312		650/2.5 = 260

WSA TABLE 1(c) DISTRICT 10-0 & DISTRICT 2-0

VFL Bridge # Date Cast:	15, Type K 5/29/97	16, Control 5/29/97	17, Control 6/30/00		18, AA 6/03/98
SR: Over:	0322-503	0322-505	Garrett's Run		0322-B01 WB
District:	10-0	10-0	10-0		2-0
Deck Thermal Shrinkage from WSA TABLE 1(c) Micro-Strain	138	138	198		212
"Effective" Thermal Shrinkage, Micro-Strain	(138-228) per WSA = 0	(138-228) = 0	(198-228) = 0		(212-228) = 0
Residual Thermal Shrinkage, Micro-Strain	138	138	198		212
Deck Drying Shrinkage, from WSA TABLE 1(c) Micro-Strain	(+)16	244	312		260
"Effective" Long-Term Shrinkage, Micro-Strain	(138-16-400) per WSA = 0	(138+244-400) = 0	(198+312-400) = 110		(212+260-400) = 72
Predicted Crack Spacing (0.01" wide)	None	None	8 ft.		12 ft.
Observed Average Crack Spacing	None	None	None		13 ft. over pier #1 * 20 ft. over pier #2

(*) Note: Cracks are in the longitudinal direction in the negative moment in-fill over Piers #1 and #2.

SUMMARY

Since 50 % of the 200,000 decks reported in response to the WJE[1] surveys developed early transverse cracking, one can infer that the "average" state of a newly cast concrete deck is either crack resistant or not crack resistant. This study identified a 75-80% occurrence of crack free decks. TABLE A summarizes the observed and predicted finding:

TABLE A - TRANSVERSE CRACK SPACING PREDICTIONS

VFL Bridge No.*:	District:	WSA Prediction:	Observed Results:	WSA Prediction (Pass/Fail)	Remarks:
2	3-0	5 ft.	None	Fail	
3	3-0	14 ft.	None	Fail	Longitudinal, 8 ft.
4	3-0	4 ft.	None	Fail	Longitudinal, 5 ft. & 6 ft.
5	3-0	4 ft	None	Fail	
6	3-0	16 ft.	10 ft, 19 ft.	Pass	
7	3-0	23 ft.	None	Fail	
8	8-0	60 ft.	None	Pass	Due to deck interaction, two considered as one
9	8-0	None	4 to 12 ft.		
11	8-0	None	None	Pass	
12	8-0	None	None	Pass	
13	8-0	None	22 ft.	Fail	
14	8-0	None	67 ft.	Fail	Negligible, TYPE K
15	10-0	None	None	Pass	
16	10-0	None	None	Pass	
17	10-0	8 ft.	None	Fail	
18	2-0	12 ft.	None	Fail	Longitudinal, 13 ft. & 20 ft.

(*) Note: See TABLES 3 (a, b, and c)

The WSA method for prediction of transverse crack spacing for 15 bridges scored as follows:

- 40% correct and with modification of the definition, up to 67% correct. The results were tabulated as 6 correct, 5 incorrect, 3 decks with longitudinal cracks consistent with the transverse crack spacing predicted by WSA and one deck with very negligible cracking.
- On face value the WSA method scored 40% correct and 33 % incorrect with 27% possibly counted as correct due to the mitigating issues.

DISCUSSION

The use of TYPE K cement concrete for crack control of bridge decks has been an established fact for many years. The only problem observed in this study was in the incremental placement approach rather then the monolithic placement approach, which we would expect to eliminate the 2 cracks observed in VFL Bridge No. 14.

In the cases studied in this research it was observed that for lower than average (610 micro-strain at 4 months) free-drying shrinkage concrete mixtures, the predicted crack spacing values and the observed cracking characteristics were relatively nil. The exception was the "Alternate Materials" Class AA concrete with 2 transverse cracks. For relatively high (820 micro-strain at 4 months) free-drying shrinkage concrete mixtures, the predicted crack spacing values were relatively accurate (if longitudinal cracking is also considered). The exception was the crack free concrete resulting from the "Alternate Materials" namely, Class AA concrete with a lower cement content.

Treating each bridge as single bridge deck cases, 15 bridges were evaluated in this program.

- No transverse cracking was observed in 11 of the bridges. A TYPE K cement concrete bridge could be added as the 12^{th} bridge as discussed below.

- Six bridge decks were consistent with the WSA predicted crack spacing method.

- Four bridges were successfully predicted by the WSA method to be free of transverse cracks by the WSA model. Two of the decks were TYPE K cement concrete.

- Only two bridges of nine receiving WSA predicted crack spacings did actually develop transverse cracks.

- Four bridges with WSA predicted crack spacings did not crack. Three of these were Class AA concrete. Use of Class AA concrete in bridge decks resulted in no transverse cracking in three of the four cases where Class AA concrete was used.

- The 2 transverse cracks in a TYPE K cement concrete deck are recognized as avoidable.

- Longitudinal cracking over piers was observed in 3 of the 15 bridges. In each case the crack spacing was consistent with the WSA prediction model.

CONCLUSIONS

Since the "average" state of a newly cast concrete deck is either crack resistant or not crack resistant, the nearly 80% (11 or 12 of 15) non-cracked bridge decks in this study is a definite, positive statement as to the direction of bridge deck construction in Pennsylvania. The key components, which alter the chance outcome in a positive way, are the selection of concrete with average or low levels of free-drying shrinkage and the mitigation of high early stress by modifying the early strains with lower compressive modulii concrete. The latter is achieved with lower cement factors. Mitigation of early differential thermal strains by specification as per the R P No. 96-053 work was also a positive contribution to the desired outcome of crack free bridge decks.

To further the cause of crack free bridge decks, the knowledge of the drying shrinkage characteristics of the proposed concrete mixture is essential. Recognizing when local combinations of materials or market influences result in materials with high drying shrinkage characteristics and/or recognizing ambient conditions with unavoidably high risk for differential thermal stresses is necessary to avoid constructing crack prone bridge decks. With the proper understanding of the potential problems, the use of TYPE K cement concrete can be the solution for a crack free bridge deck on large projects.

The progress achieved to date is positive but not “performance guaranteed”. Future work is needed in the development of materials such as “coarse grained cements” for slower development of compressive modulus (early compressive strength). Revisiting of placement techniques such as monolithic bridge deck placement in bridge deck construction to eliminate longitudinal cracking over piers with materials of proven success in eliminating transverse deck cracks.

In conclusion, the knowledge gained in this research clearly shows that the element of chance can be greatly reduced for transverse cracking of bridge decks by proper selection of materials and application of prudent judgment with respect to ambient condition for concrete placement. Use of the WSA method for transverse crack spacing prediction is useful and with practice it can be used as a decision making tool for accepting or rejecting concrete mixtures or ambient conditions for bridge deck concrete placement.

SITED REFERENCES

1.Krauss, P. D., and Rogalls, E. A., "Transverse Cracking in Newly Constructed Bridge Decks," *NCHRP* Report 380, Transportation Research Board, Washington, D.C., 1996

2.Babaei, K., and Purvs, R. L., "Prevention of Cracks in Concrete Bridge Decks-Summary Report," Pennsylvania Department of Transportation, Research Project No. PA-FHWA-95-006+89-01, March 1996

3.Babaei, K., and Purvs, R. L., "Prevention of Cracks in Concrete Bridge Decks: Report On Observations of Bridge Deck Constructions and Concrete Shrinkage Measurements in the Field," Pennsylvania Department of Transportation, Research Project No. PA-FHWA-95-004+89-01, November 1995

APPENDIX A

DISTRICT 3 **5/20/97** **Designation: Control**

New Enterprise Stone & Lime; SR6015,D51						**AAA.39**
Northbound lanes starting at south end						
RP #96-053 details: 3953, 5640 psi(7 & 28 day)					Site Cast Prisms	
Mix from batcher/mixer slip:					PCY/SSD	% Moisture
cement	Hercules Type I				658	
fly ash	National Mineral				116	
fine aggregate	Milestone, Montoursville				1072	na
coarse aggregate	Pine Creek				1700	na
WRA Polyheat 997	Master Builders, oz's	3.5 oz./100#cem.	27			
AEA, MBVR	Master Builders, oz's					
Retarder, 122N	Master Builders, oz's	3.5 oz./100#cem.	27			
Water:		Fine/Coarse MC		na		
		Metered Water		na		
Total Water:			**34.3 gal**		286.0	
Total Batch Weight:					3832.0	
Bridge Deck Field Data:		Slump 4.5", Air Content 8.6%			At plant	
Time: 10:05 AM		Air Temperature		45	At plant	
Deck: 46'9"x200'		Concrete Temp.		59	At plant	
Location:	Relative Humidity	Concrete Temp.	Air Temp.		Deck Form Temp.	
10:30	65%	60	44		60	55 in shade
11:00		62			61	
11:30		62	50		70	box beam
Bridge Deck Structure Type:		one span,w/ 4 W shape steel girders, 9.5" on metal deck				
		Girder: flanges 2'(5/16"); web 11/16"x96"				
Rebar Details:	Top & Bottom long ways: #6's @ 6"					
Deck 40'2.4"x61'6"	Bottom long ways (61'6"): #6's @ 8"					
	Top cross ways : #4's@ 12"					
	Bottom cross ways : #5's@ 7.5"					

Prism Data:	Inches/inch	% Wt. Change
28 day :	0.00071"	2.05%
4 month:	0.00087"	2.24%

Initial site condition survey: **06/10/97** By VFL

Surface defects include 7 to 10 tares / foot, due to poor finishing

Second site condition survey: By VFL

Deck was subsequently rejected and replaced

DISTRICT 3 **7/02/97** **Designation: AA**

Susquehanna Supply Co.: SR0973-004, Over Larrys Creek Salladasburg bridge						**AA**
RP #96-053 details: 4180, 5170 psi(7 & 28 day)			Site Cast			
Mix from batcher/mixer slip:					PCY/SSD	% Moisture
cement	Hercules Type I				525	
fly ash	PPL, Sunberry				99	
fine aggregate	Milestone, Montoursville				1216	na
coarse aggregate	Pine Creek				1751	na
WRA Polyheat 997	Master Builders, oz's	3 oz./100#cem.	18.7			
AEA, MBVR	Master Builders, oz's					
Retarder, 100XR	Master Builders, oz's	4 oz./100#cem.	25			
Water:		Fine/Coarse MC		na		
		Metered Water		na		
Total Water:			**31.4 gal**		262.5	
Total Batch Weight:					3853.5	
Bridge Deck Field Data:		Slump 4.5", Air Content 8.6%			At plant	
Time: 6:20\ AM		Air Temperature		45	At plant	
Deck: 50'x110'6", w/ 43' skew aprons		Concrete Temp.		59	At plant	
Location:	Relative Humidity	Concrete Temp.	Air Temp.		Deck Form Temp.	
10:30	65%	60	44		60	55 in shade
11:00		62			61	
11:30		62	50		70	box beam
Bridge Deck Structure Type:		one span,w/ 6 W steel plate girders, 12" to 18" walk on metal deck				
Girder: flanges vary 13"to 17"(top flange 1.25-1.67" bottom flange 1.25-2.38"); web 34" (7/16")						
Rebar Details:	Top & Bottom long ways: #7's @ 6" and 10" each way					

Prism Data:	Inches/inch	% Wt. Change
28 day :	0.00066"	1.60%
4 month:	0.00087"	2.08%

Initial site condition survey: **7/22/97** By VFL & Fong & Associates
Second site condition survey: **2/10/98**
Remarks: No visible cracks found

DISTRICT 3 **9/16/97** **Designation: AAAMod#3**

J & F Ready Mix: SR0015 B42, Over 414						**AAAMod#3**
Northbound lanes starting at south end, s-21566 deck						**4000 psi**
RP #96-053 details: 14 day- 4386,4306,4262; 28 day-5058,5040,4669 psi						
Mix from batcher/mixer slip:		Plant Cast Prisms			PCY/SSD	% Moisture
cement	Type ILA Keystone				658	
fine aggregate	Milestone, Fairfield				1061	4.3%
coarse aggregate	Milestone, Salona				1885	1.5%
WRDA-HYCOL	W.R Grace, oz's	5.3 oz./100#cem.	35			
AEA, DARAVAIR	W.R Grace, oz's		8.4			
DARATARD	W.R Grace, oz's	4.25 oz./100#cem.	28			
Water:		Fine/Coarse MC	8.9 gal			
		ice, 2-40# bags	9.6 gal			
		Metered Water	14 gal			
		Added at bridge	1 gal			
Total Water:			**33.6 gal**		280.2	**32.6 gal max**
Total Batch Weight:					3884.2	
Bridge Deck Field Data:		Slump 6", Air Content 8%			At plant	
Time: 6:40 AM		Air Temperature		57	At plant	
Deck: 36'x135.94'	14 day cure	Concrete Temp.		74	At plant	
Location:	Relative Humidity	Concrete Temp.		Air Temp.	Deck Form Temp.	beam
8:30	89%		70	60	62	beam 62
9:30			72	64	65	72
12:25	72%		78	76	82	70

Deck Temperature:	High	Low		Air Temp.
09/17		73	65	80, 34
09/18		69	62	
09/19		72	59	

Bridge Deck Structure Type: 8"	one span,w/ 5 P/S concrete I-beams, 42"x96", w/metal deck 22gage
Rebar Details:	Top: #4's @ 12" long dir. and #5's @ 5.5", cross dir.
	Bottom: #5's, (9) between beams, #5's @ 5.5" cross dir.

Prism Data:	Inches/inch	% Wt. Change
28 day :	0.00059"	0.68%
4 month:	0.00088"	1.58%

Initial site condition survey: **03/25/98** By Fong & Associates
No cracking observed - visually obstructed - deck not clean
Second site condition survey: **06/02/98** By Fong & Associates
12 cracks, 0.002' to 0.003", 2' to 16'
All cracking in the N/S direction over beams.

DISTRICT 3 **10/09/97** **Designation: AAAMod#3**

J & F Ready Mix: SR0015 B42, Over 284					**AAA**	**#3**
Northbound lanes starting at south end, s-21888 deck, span #1					**4000 psi**	
	[Span 2 & 3 poured 10/08] Plant Cast Prisms					
RP #96-053 details:	21 day- [4899, 4580, 4589, 4192] 4129, 4625;					
QC	28 day- [5651, 5085, 4581, 4705] 4466, 4280;					
AT	28 day- [5651, 5200, 5483, 5023] 4475, 4625 psi					
Mix from batcher/mixer slip:				PCY/SSD	% Moisture	
cement	Type ILA Keystone			658		
fine aggregate	Milestone, Fairfield			1061		4.0%
coarse aggregate	Milestone, Salona			1885		1.3%
WRDA-HYCOL	W.R Grace, oz's	7.5 oz./100#cem.	49			
AEA, DARAVAIR	W.R Grace, oz's	1.9 oz./ 100#cem.	12.5			
DARATARD	W.R Grace, oz's	4.25oz./100#cem.	28			
Water:		Fine/Coarse MC	8.0 gal			
		ice, 3-40# bags	14.4 gal			
		Metered Water	10.2 gal			
		Added at bridge	1 gal			
Total Water:			**33.6 gal**	280.2	**32.6 gal max**	
Total Batch Weight:				3884.2		
Bridge Deck Field Data:		Slump 4.5", Air Content 8.2%		At plant		
Time: 7:20 AM		Air Temperature	57	At plant		
Deck: 42'x71'1.25"	22 day cure	Concrete Temp.	75	At plant		

Location:	Relative Humidity	Concrete Temp.	Air Temp.	Deck Form Temp.	beam
9:15	94%	72	56	55	57
10:20		70	59	62	62
12:10	85%	70	68	62	62

Deck Temperature:	High	Low	Air Temp.
10/10	90	71	78, 28
10/11	83	53	

Bridge Deck Structure Type: 9" (8.5"#2-3)	1 of 3 spans,w/4 P/S concrete I-beams, 28"x72", w/metal deck 22gage
Rebar Details:	Top: #5's @ 15" long dir. and #6's @ 6.5", cross dir.
	Bottom: #5's@ 6", #6's @ 6.5" cross dir.

Prism Data:	Inches/inch	% Wt. Change
28 day :	0.00059"	1.23%
4 month:	0.00098"	2.02%

Initial site condition survey: **03/25/98** By Fong & Associates

No cracking observed in 3 spans

Second site condition survey: **06/02/98** By Fong & Associates

No cracking in span #1

22 cracks, 0.002" to 0.007", 3' to 12.5', (6) in span #3, (1) in span #2, remainder "in-fill on piers"

All cracking of "in-fill" over piers in transverse direction

DISTRICT 3 **10/21/97** **Designation: AAAMod#3**

J & F Ready Mix: SR0015 -B42, Over Blockhouse Creek						**AAA #3**
Northbound lanes, starting at north end, s-21811 deck						**4000 psi**
		[Second pour 10/24]				
RP #96-053 details:	14 day- 4936,	[5447, 5226]				
QC	28 day- 5589,	[5615, 5474]				
AT	28 day- 5748,	[6137, 6570] psi				
Mix from batcher/mixer slip:				PCY/SSD	% Moisture	
cement	Type ILA Keystone			658		
fine aggregate	Milestone, Fairfield			1061		4.5%
coarse aggregate	Milestone, Salona			1885		1.5%
WRDA-HYCOL	W.R Grace, oz's	7.5 oz./100#cem.	49			
AEA, DARAVAIR	W.R Grace, oz's	1.5 oz./ 100# cem.	9.8			
DARATARD	W.R Grace, oz's	4.25oz./100#cem.	28			
Water:		Fine/Coarse MC	9.1 gal			
		Metered Water	23.5 gal			
		Added at bridge	1.4 gal			
Total Water:			**34 gal.**	271.9	**32.6 gal max.**	
Total Batch Weight:				3875.9		
Bridge Deck Field Data:		Slump 6.75", Air Content 7.8%		At plant		
Time: 6:50 AM		Air Temperature	36	At plant		
Deck: 57'6"x40"	14 day cure	Concrete Temp.	60	At plant		
Location:	Relative Humidity	Concrete Temp.	Air Temp.	Deck Form Temp.	beam	
8:10	86%	62	35	52	52	
10:00		60	44	55	54	
11:35	63%	62	61	64		
Deck Temperature:	High	Low	Air Temp.			
10/22	100	68	57, 26			
10/23	89	54				
10/24	102	82				
Bridge Deck Structure Type: 8" (10 on Beams)	1/2 of 1span,w/8 P/S concrete box beams, 48"x42", w/metal deck 22gage					
Rebar Details:	Top: #4's @ 12" long dir. and #6's @ 11", cross dir.					
	Bottom: #4's,(5) between box beams, #5's @ 11" cross dir.					
Prism Data:	Inches/inch	% Wt. Change				
28 day :	0.00073"	1.04%				
4 month:	0.00080"	1.71%				

Initial site condition survey: **03/25/98** By Fong & Associates

No cracking observed at 10/21 pour

Second site condition survey: **06/02/98** By Fong & Associates

(1) crack, 3', 0.003", in 10/24 pour

DISTRICT 3 **6 /03/98** **Designation: Control**

Wild Rose, Inc.: SR0220 -053, Over Pine Creek						**AAA #3**
Southbound lanes, negative moment areas over piers #1 and #2						**Control**
RP #96-053 details: na						
Mix from batcher/mixer slip:					PCY/SSD	% Moisture
cement	Hercules Type I				576	
fly ash	PPL, Sunberry				102	
fine aggregate	Rhinehart S+G, Corning, NY				1129.5	5.3%
coarse aggregate	P Stone inc., Jersey Shore				1850	1.1%
WRA Polyheat 997	Master Builders, oz's	8 oz./100#cem.	54.2			
AEA, MBVR	Master Builders, oz's					
Retarder, 100XR	Master Builders, oz's	3 oz./100#cem.	20.3			
Water:		Fine/Coarse MC	9.7 gal			
		Metered Water	20.6 gal			
Total Water:			**30.3 gal**		252.7	
Total Batch Weight:					3910.2	
Bridge Deck Field Data:		Slump 5", Air Content 8.5%			At plant	
Time: 7:15 AM		Air Temperature	57		At plant	Windy
Deck: 39'x37'7" and 37'5"		Concrete Temp.	69		At plant	

Location:	Relative Humidity	Concrete Temp.	Air Temp.	Deck Form Temp.	Beam
7:15	56%	72	57	58	53
8:20	59%	76	56	68	55
9:40	60%	74	59	78	68

Deck Temperature:	High	Low	Air Temp.
06/04	76	53	59, 42
06/05	86	56	
06/06	84	50	

Bridge Deck Structure Type: 8"	multi-span(5), on 6 W36"x182 & W18"x45 diaphragm, 22 gage deck
Rebar Details:	Top: #5's @ 6.5" each way
	Bottom: #5's @ 10.5" long direction and 6.5" cross ways

Prism Data:	Inches/inch	% Wt. Change
28 day :	0.00048"	0.92%
4 month:	0.00068"	1.60%

Initial site condition survey: **06/25/98** By VFL & Fong & Associates

No visible surface cracking found.

Second site condition survey: **09/22/98** By VFL & Fong & Associates

(9) transverse cracks, 0.002", in negative moment areas over piers #1 & #2.

Cracks observed in areas of deck not placed on 6/03/98:

Negative moment areas. (3) cracks over pier #3 and (1) crack over pier #4.
(14) transverse cracks were observed in the decks between negative moment areas.
The deck area between piers #2 & #3, which are fixed piers, was recorded with
(9) cracks , 0.002" to 0.005" and the deck between piers #3 & #4, span 4, recorded (3) cracks, 0.002"
Between the 4th pier and the abutment, span 5, (1) crack, 0.002" was observed.
No cracks were found from the south abutment to pier #1, span 1, nor between Pier #1
and Pier #2, span 2.

DISTRICT 3 **10/09/98** **Designation: AA**

Wild Rose, Inc.: Reference to SR0220 -053, Pours Over Pine Creek, AA #2					
Pavement Approach slabs Northbound lanes, Sta.505.89 to Sta.507.86. Sampled					
RP #96-053 details: 7 Day, Deck Data-4438 psi (11 sets); Road Data-3640 psi(5sets)					
Mix from batcher/mixer slip:				PCY/SSD	% Moisture
cement	Hercules Type I			525	
fly ash	PPL, Sunberry			100	
fine aggregate	Rhinehart S+G, Corning, NY			1217	na
coarse aggregate	P Stone inc., Jersey Shore			1770	na
WRA Polyheat 997	Master Builders, oz's	8 oz./100#cem.	50		
AEA, MBVR	Master Builders, oz's				
Retarder, 100XR	Master Builders, oz's	3 oz./100#cem.	18.8		
Water:		Fine/Coarse MC	na		
		Metered Water	na		
Total Water:				263.2	
Total Batch Weight:				3875.2	
Bridge Appron Field Data:		Slump 2", Air Content 7.4%		At plant	
Time: 8:00 AM		Air Temperature	51	At plant	
Apron, 45'6" x 200'		Concrete Temp.	65	At plant	

Bridge Deck Field Data for Spans 3 & 4:	09/10/98			
Location:	Relative Humidity	Concrete Temp.	Air Temp.	Deck Form Temp.	Beam
9:40	58% - 78%	75 -78	48 - 70	78	68

Deck Temperature:	High	Low	Air Temp.
09/11	85	55	90, 45
09/12	82	61	
09/13	88	54	

Bridge Deck Structure Type: 8"	Apron on 22 gage deck
Rebar Details:	Top: #5's @ 6.5" each way
	Bottom: #5's @ 10.5" long direction and 6.5" cross ways

Prism Data:	Inches/Inch	% Wt. Change
28 day :	0.00042"	2.20%
4 month:	0.00065"	2.74%

Initial site condition survey: No follow-up condition surveys were performed on the pavement approach slabs to the North Bound bridge deck.

Second site condition survey: Sampling was perfromed to chacterize the 9/10, 11 & 15/1998 pours with Class AA concrete.

Observed conditions in areas of deck not placed on 10/09/98: By VFL

No tranverse cracking for the 9/10, 11 & 15/1998 pours with Class AA concrete.
Longitudinal cracking found along parapets.

DISTRICT 8 **08/28/97** Designation: Added Adx's

R M C of Lancaster; SR0030-009 over SR0272, Span I, East End, East Bound					**AAA,Mix #4 DCI,ice & misc.**
RP #96-053 details: Not Provided	Plant Cast Prisms				
Mix from batcher/mixer slip:				PCY/SSD	% Moisture
cement	Keystone SP			705	
fine aggregate	York Blding Products, Belvedere MD			1195	4.7%
coarse aggregate	Binkley & Ober, E Petersburg PA			1812	0.90%
DCIS	W.R.Grace	51.2/94# cement	3 gal	10.98	291.0%
Daracem 100	W.R.Grace, oz's	6 oz./100# cement	42		
AEA	W.R.Grace, oz's	0.53 oz/100# cem.	3.7		
Daracem 55	W.R.Grace, oz's	3 oz/100# cement	21.2		
Daratard 17	W.R.Grace, oz's	2 oz/100# cement	14.1		
Water:		Fine/Coarse MC	8.64 gal		
		Metered Water	10.86 gal		
		Ice	7.8 gal		
Total Water w/ DCIS's ~2.5 gallons:			**29.8 gal**	248.5	
Total Batch Weight:				3971.5	
Bridge Deck Field Data:		Slump 5", Air Content 7.4%		At plant	
Time: 5:15 AM		Air Temperature	68	At plant	
		Concrete Temp.	74	At plant	

Location:	Relative Humidity	Concrete Temp.	Air Temp.	Deck Form Temp.	Beam°F
6:30	85%	70	68	-	-
7:35		74	70	68	69
8:41	77%	74	75	77	78
10:15		74	80	86	87

Bridge Deck Structure Type:	Precast/Prestressed Concrete Box Beam(48") w/ metal deck
Rebar Details:	Top long ways (73'): #7's @ 6", #4's@ 12" & #7's@ 6" from long joint to abutment
Deck: 32'x73'	Bottom long ways: #5's @ 11"
	Top/Bottom cross ways (32'): #5's@ 7.5", w/#4's at abutment

Prism Data:	Inches/inch	% Wt. Change
28 day :	-0.00040"	-0.22%
4 month:	-0.00060"	-0.83%

Initial site condition survey: **9/30/97** By Fong & Associates

Remarks: Deck surface - 7 surface cracks

Second site condition survey not performed due to traffic on bridge.

DISTRICT 8 **08/28/97** Designation: Control

R M C of Lancaster; SR0030-009 over SR0272					**AAA,Mix #3 DCI & '100',ice**
Span II, East End, East Bound					
RP #96-053 details: Not Provided		Plant Cast Prisms			
Mix from batcher/mixer slip:				PCY/SSD	% Moisture
cement	Keystone SP			705	
fine aggregate	York Blding Products, Belvedere MD			1160	4.0%
coarse aggregate	Binkley & Ober, E Petersburg PA			1812	0.70%
DCIS	W.R.Grace	51.2/94# cement	3 gal	10.98	291.0%
Daracem 100	W.R.Grace, oz's	6 oz./100# cement	42		
AEA	W.R.Grace, oz's	0.53 oz/100# cem.	3.7		
Water:		Fine/Coarse MC	7.08 gal		
		Metered Water	14.62 gal		
		Ice	7.2 gal		
Total Water w/ DCIS's ~2.5 gallons:			**31.4 gal**	261.88	
Total Batch Weight:				3949.9	
Bridge Deck Field Data:		Slump 5", Air Content 8.2%		At plant	
Time: 4:58 AM		Air Temperature	68	At plant	
		Concrete Temp.	72	At plant	
Location:		Concrete Temp.	Air Temp.	Deck Form Temp.	
6:00		72	67	-	
7:55		80	69	70	
8:10		80	69	71	
9:25		80	75	80	
Bridge Deck Structure Type:		Precast/Prestressed Concrete Box Beam(48") w/ metal deck			
Rebar Details:	Top long ways (73'): #7's @ 6", #4's@ 12" & #7's@ 6" from long joint to abutment				
Deck: 32'x73'	Bottom long ways: #5's @ 11"				
	Top/Bottom cross ways (32'): #5's@ 7.5", w/#4's at abutment				

Prism Data:	Inches/inch	% Wt. Change
28 day :	-0.00061"	-0.13%
4 month:	-0.00081"	-0.72%

Initial site condition survey: **9/30/97** By Fong & Associates

Remarks: No reported cracking

Second site condition survey not performed due to traffic on bridge.

DISTRICT 8 **01/06/98** Designation: Control

R M C of Lancaster; SR0283(0030) over SR741, **AAA,Mix #2**
West Bound, east end of deck **DCIS & misc.**

RP #96-053 details: Not Provided | Plant Cast Prisms

Mix from batcher/mixer slip:				PCY/SSD	% Moisture
cement	Keystone SP			705	
fine aggregate	York Blding Products, Belvedere MD			1121	4.7%
coarse aggregate	Binkley & Ober, E Petersburg PA			1812	0.80%
DCIS	W.R.Grace	51.2/94# cement	3 gal	10.98	291.0%
Daracem 100	W.R.Grace, oz's	5.7oz./100# cement	40		
AEA	W.R.Grace, oz's	0.6 oz/100# cem.	4.2		
Daracem 55	W.R.Grace, oz's	3 oz/100# cement	21.8		
Daratard 17	W.R.Grace, oz's	2 oz/100# cement	14.3		
Water:		Fine/Coarse MC	8.04 gal		
		Metered Water	22.66 gal		
Total Water w/ DCIS's ~2.5 gallons:			**33.2 gal**	276.9	
Total Batch Weight:				3925.9	

Bridge Deck Field Data:				
Slump 5", Air Content 7.8%				At plant
Time: 10:20 AM	Air Temperature		57	At plant
	Concrete Temp.		62	At plant
Location:	Relative Humidity	Concrete Temp.	Air Temp.	Deck Form Temp.
9:15	84%	61	54	-
11:00		61	60	60
12:00	79%	61	62	66
12:30		61	63	63

Bridge Deck Structure Type: Precast/Prestressed Concrete Beam(84") w/ metal deck diaphragm cip box beams cast with deck

Rebar Details: Top long ways (99'): #7's @ 12", for 12' tourd bulkhead, #5@ 12" remainder
Deck: 38'2.5"x99' Bottom long ways (99'): #7's @ 10", for 12' tourd bulkhead, #5@ 10" remainder
Top/Bottom cross ways (38'2.5"): #5's@ 5.5"

Prism Data:	Inches/inch	% Wt. Change
28 day :	-0.00052"	-0.61%
4 month:	-0.00067"	-1.17%

After the Wednesday pour the use of heated cure resulted in a fire on Thursday or Friday night.
Deck was condemned.

Initial site condition survey:

Remarks: Deck surface - 42 surface cracks in 240', (99' +42' +99'), mostly in the east end and middle pours. 9 crackes of 5 to 11 feet long in west section, which was poured before the east section.
C. Fong & Associates inspected full deck on 9/17/98.

DISTRICT 8 **04/22/99** Designation: Type K

Pennsy Supply; SR0022 over Market Street, Plant Cast Prisms					**AAA,C1060**
Section 2, 0 to 40' from west abutment, pour stopped due to plant shut down, EB					**Type K, 100 & ret**
RP #96-053 details: Not Provided					
Mix from batcher/mixer slip:				PCY/SSD	% Moisture
cement	Blue Circle Type K			712	
fine aggregate	Pennsy Supply - Dickinson			1013	6.6%
coarse aggregate	Pennsy Supply - Silver Springs			1773	1.40%
	W.R.Grace				
Daracem 100	W.R.Grace, oz's	4 oz./100#cement	29 oz.		
AEA	W.R.Grace, oz's	0.84 oz/100# cem.	6.0		
Daratard-17	W.R.Grace, oz's	6 oz/100#cement	43.0		
Water:		Fine/Coarse MC	11 gal		
		Metered Water	26.84 gal		
Total Water:			**37.8 gal**	315.6	
Total Batch Weight:				3813.6	

Bridge Deck Field Data:		Slump 6.25", Air Content 6%		At plant	
Time: 10:20 AM		Air Temperature	54	At plant	
		Concrete Temp.	65	At plant	
Location:	Relative Humidity	Concrete Temp.	Air Temp.	Deck Form Temp.	
9:20	50%	62	53	-	
10:20		64			
11:01			71	81	deck
11:26		66		59	box beam

Bridge Deck Structure Type:	one span, P/S Concrete Spread Box Beams(3'x4"), w/ metal deck
Rebar Details:	Top long ways (61'6"): #6's @ 8"
Deck: 40'2.4"x61'6"	Bottom long ways (61'6"): #6's @ 8"
	Top cross ways (½ of 40'2.4"): #4's@ 12"
	Bottom cross ways (½ of 40'2.4"): #5's@ ~ 12"

Prism Data:	Inches/Inch	% Wt. Change
28 day :	0.00004"	-1.48%
4 month:	0.00002"	-1.68%

(*) Note: 40 cubic yards of Type I cement concrete cast in diaphragm just ahead of the Type K deck concrete. Remainder poured 4/26/99.

Initial site condition survey: **05/19/99** By Fong & Associates

Remarks: Deck surface - no surface cracks

Second site condition survey: **10/05/99** By Fong & Associates

Remarks: Deck surface - no surface cracks

DISTRICT 8 **05/28/99** Designation: Control Deck

Pennsy Supply; SR0022 over Market Street, Plant Cast Prisms					**AAA,C1142**
Section 2, westbound, structure #21778 poured on 5/20/99 but not sampled.					**DCIS, wra,& ret**
RP #96-053 details: 5/28/99 Not Provided					
Mix from batcher/mixer slip:				PCY/SSD	% Moisture
cement	Allentown Cement Type I			635	
fly ash	Lehigh Cement - Woodsboro, Md			116	
fine aggregate	Pennsy Supply - Dickinson			1028	5.3%
coarse aggregate	Pennsy Supply - Hummelstown			1867	0.80%
DCIS	W.R.Grace	51.2/94# cement	3 gal	10.98	291.0%
AEA	W.R.Grace, oz's	0.84 oz/100# cem.	6.0		
Daracem 55	W.R.Grace, oz's	3 oz./100# cement	21.2		
Daratard-17	W.R.Grace, oz's	6 oz/100#cement	43.0		
Water:		Fine/Coarse MC	8.3 gal		
		Metered Water	22.78 gal		
Total Water: w/ DCIS's ~2.5 gallons:			**33.6 gal**	280.2	
Total Batch Weight:				3937.2	
Bridge Deck Field Data:		Slump 4.75", Air Content 6.5%		At plant	
Time: 10:20 AM		Air Temperature	58	At plant	
		Concrete Temp.	68	At plant	
Location:	Relative Humidity	Concrete Temp.	Air Temp.	Deck Form Temp.	
	na	na	na	na	deck
	na	na	na	na	box beam
Bridge Deck Structure Type:		one span, P/S Concrete Spread Box Beams(3'x4"), w/ metal deck			
Rebar Details:	Top long ways (61'6"): #6's @ 8"				
Deck: 40'2.4"x61'6"	Bottom long ways (61'6"): #6's @ 8"				
	Top cross ways (½ of 40'2.4"): #4's@ 12"				
	Bottom cross ways (½ of 40'2.4"): #5's@ ~ 12"				

Prism Data:	Inches/Inch	% Wt. Change
28 day :	0.000042	-0.94%
4 month:	0.000044	-0.94%

Initial site condition survey 5/20/99 pour: **06/03/99** By Fong & Associates
Remarks: Deck surface - no surface cracks
Second site condition survey: **10/05/99** By Fong & Associates
Remarks: Deck surface - no surface cracks

DISTRICT 8 **06/11/99** Designation: AA Deck

R M C of Lancaster; SR0030-009 over SR0272					**AA,Mix#3**
Structure #S-21527,west segment, westbound, (east segment to follow)					**DCI & '100',ice**
RP #96-053 details: Not Provided	Plant Cast Prisms				
Mix from batcher/mixer slip:				PCY/SSD	% Moisture
cement	Keystone SP			611	
fine aggregate	York Blding Products, Belvedere MD			1206	5.1%
coarse aggregate	Binkley & Ober, E Petersburg PA			1819	1.80%
DCIS	W.R.Grace	51.2/94# cement	3 gal	10.98	291.0%
Daracem 100	W.R.Grace, oz's	6 oz./100# cement	30.0		
AEA	W.R.Grace, oz's	0.53 oz/100# cem.	3.8		
Daracem 55	W.R.Grace, oz's	3 oz/100# cement	18.3		
Daratard 17	W.R.Grace, oz's	4.9oz/100#cement	18.3		
Water:		Fine/Coarse MC	11.4 gal		
		Metered Water	11.2		
		Ice variable, 20->10 bags	7.2		
Total Water w/ DCIS's ~2.5 gallons:			**32.4 gal**	270	
Total Batch Weight:				3917.2	

Bridge Deck Field Data:		Slump 7", Air Content 7.5%		At plant	
Time: 6:00 AM		Air Temperature	62	At plant	
		Concrete Temp.	67	At plant	
Location:	Relative Humidity	Concrete Temp.	Air Temp.	Deck Form Temp.	
7:45	77%	64	60	63	cloudy
8:30		64	60	65	
9:20	78%	68	67	86	w/sun

Bridge Deck Structure Type:	P/S Concrete Box Beam(48"), diafragms, w/ metal deck
Rebar Details:	Top long ways (73'): #7's @ 6", #4's@ 12" & #7's@ 6" from long joint to abutment
Deck: 30'x146'	Bottom long ways: #5's @ 11"
	Top/Bottom cross ways (61'): #5's@ 7.5", w/#4's at abutment

Prism Data:	Inches/Inch	% Wt. Change
28 day :	-0.00049	1.00%
4 month:	-0.00051	0.98%

Initial site condition survey: **06/23/99** By Fong & Associates
Remarks: Deck surface - no surface cracks
Second site condition survey: **10/05/99** By Fong & Associates
Remarks: Deck surface - 3 surface cracks, 3'-8.5', 0.002"
Cracks are transverse the long dimension.

DISTRICT 8 **09/03/99** Designation: Type K

R M C of Lancaster; SR0283(0030) over SR741					**AAA, Mix#2**
East Bound, middle (last of 3 Type K cement concrete deck pours)					**Type K, ice & misc.**
RP #96-053 details: Not Provided	Plant Cast Prisms				
Mix from batcher/mixer slip:				PCY/SSD	% Moisture
cement	Blue Circle Type K			714	
fine aggregate	York Blding Products, Belvedere MD			1103	4.0%
coarse aggregate	Binkley & Ober, E Petersburg PA			1722	1.40%
Daracem 100	W.R.Grace, oz's	2 oz./100#cement	14 oz.		
AEA	W.R.Grace, oz's	0.87 oz/100# cem.	6.2		
Daracem 55	W.R.Grace, oz's	3 oz/100# cement	21.5		
Daratard 17	W.R.Grace, oz's	4.9oz/100#cement	34.6		
Water:		Fine/Coarse MC	8.2 gal		
		Metered Water	20.0 gal		
		Ice	9.6 gal		
Total Water:			**37.8 gal**	315.3	
Total Batch Weight:				3854.3	
Bridge Deck Field Data:		Slump 7.75", Air Content 8%		At plant	
Time: 7:45 AM		Air Temperature	65	At plant	
		Concrete Temp.	70	At plant	

Location:	Relative Humidity	Concrete Temp.	Air Temp.	Deck Form Temp.
8:20	84%	72		-
8:50			76	92
9:24	79%	72	77	98 dry
10:07		72	79	88 wet surface

Bridge Deck Structure Type:	Precast/Prestressed Concrete Beams(84"), w/ metal deck diaphragm cip box beams cast with deck*
Rebar Details:	Top long ways (50'4"): #7's @ 6"
Deck: 50'2"x50'4"	Bottom long ways (50.4): #7's @ 9.5"
	Top/Bottom cross ways (50'2.5"): #5's@ 6"

Prism Data:	Inches/Inch	% Wt. Change
28 day :	0.00011	-0.50%
4 month:	-0.00014	-1.38%

(*) Note: 40 cubic yards of Type I cement concrete cast in diaphragm just ahead of the Type K deck concrete.

Initial site condition survey: **10/05/99** By Fong & Associates

Remarks: Deck surface - no surface cracks

Second site condition survey: **06/23/00** By Fong & Associates

Two cracks in the full 250' deck. One in west span 62.5' from west abutment.
and one near construction joint at 100' from west abutment at west edge of middle span.
No cracks in the east end pour 0 to 99' from east abutment.
West section poured 8/31/99.
East section poured 9/01/99.
Middle section poured 9/03/99.

DISTRICT 10 **5/29/97** **Designation: Type K**

Glenn Redi Mix Concrete; S.R. 0322, 503 Trial					**AAA**
Westbound lanes over Rathmel Run, Jefferson County					
RP #96-053 details: 3771, 4713 psi(7 & 28 day), AT 4669 psi					
Mix from batcher/mixer slip:				PCY/SSD	% Moisture
cement	Southdown Type K			715	
fine aggregate	Russell Mineral, Taylor Township			962	
coarse aggregate	Brady's Blend, Limestone			1762	
AEA, MBVR	Master Builders	Micro-air			
Retarder, 100XR	Master Builders	3 oz./100#cem.	21.45 oz.		
Water:		Fine/Coarse MC	na		
		Metered Water	na		
Total Water:			**40.3 gal**	336.0	
Total Batch Weight:				3775.0	
Bridge Deck Field Data:		Slump 7", Air Content 5.3%		At plant	
Time: 8 to 9:45 AM		Air Temperature	53	At plant	
Deck: 26'x28'		Concrete Temp.	68	At plant	
Location:	Relative Humidity	Concrete Temp.	Air Temp.	Deck Form Temp.	
8:00	100%	68	52	52	
8:30		68	53	53	
Slight rain at 1 PM					
Bridge Deck Structure Type: 8"		one span,w/ 4 Precast spread box beams, on metal deck			
Rebar Details:	Top & Bottom each way: #6's @ 6"				
Deck: 26'x28'					
Prism Data:	Inches/Inch	% Wt. Change			
28 day :	0.00020"	-1.06%			
4 month:	0.00007"	-1.63%			

Initial site condition survey: No visible cracking **06/11/97** By VFL

Second site condition survey: No visible cracking **06/23/98** By VFL

DISTRICT 10 **5/29/97** **Designation: CONTROL**

Glenn Redi-Mix; SR0322-0505					**AAA**
Westbound lanes over Soldiers Run, Jefferson County					
RP #96-053 details: 5438 psi(28 day), AT 5500 psi					
Mix from batcher/mixer slip:				PCY/SSD	% Moisture
cement	Essroc, Type I/LA			635	
fine aggregate	Glacial S&G, Kittanning, PA			1251	
coarse aggregate	New Enterprise S&G, Tyone, PA			1851	
997, WR	Master Builders, oz's	5 oz./100#cem.	31.75		
AEA, MBVR	Master Builders	Micro-air			
Retarder, 100XR	Master Builders, oz's	2 oz./100#cem.	12.7		
Water:		Fine/Coarse MC	na		
		Metered Water	na		
Total Water:			**29.9 gal**	249.0	
Total Batch Weight:				3986.0	
Bridge Deck Field Data:		Slump 3", Air Content 6.8%		At plant	
Time: 11 AM		Air Temperature	56	At plant	
Deck: 25'x31'		Concrete Temp.	65	At plant	
Location:	Relative Humidity	Concrete Temp.	Air Temp.	Deck Form Temp.	
11:30		65	56	56	
2:00		68	56	56	
Slight rain at 1 PM					
Bridge Deck Structure Type: 8"		one span,w/ 4 Precast spread box beams, on metal deck			
Rebar Details:	Top & Bottom each way: #6's @ 6"				
Deck: 25'x31'					

Prism Data:	Inches/Inch	% Wt. Change
28 day :	0.00047"	-1.06%
4 month:	0.00060"	-1.51%

Initial site condition survey: **06/11/97** By VFL

Four small cracks cracks visible on vertical slab edges, 5' to 15' from parapet at each apron.

Second site condition survey: **06/23/98** By VFL

No cracks observed.

DISTRICT 10 56/29/97 Designation: CONTROL

Marion Center Supply 2025-155 Over Garrett's Run, Armstrong County					**AAA, Mix #2**
RP #96-053 details: NA					
Mix from batcher/mixer slip:				PCY/SSD	% Moisture
cement	SouthDown-Kosmos, Type I/LA			682	
fine aggregate	Glacial, Tarrytown Hill, PA			1115	
coarse aggregate	PMA64C14			1762	
200N	Master Builders, oz's	5 oz./100#cem.	28		
AE-90	Master Builders	Micro-air			
Retarder, 100XR	Master Builders, oz's	4 oz./100#cem.	27		
Water:		Fine/Coarse MC	9.12		
		Metered Water	24.42		
Total Water:				279.7	33.5 gal
Total Batch Weight:				3838.7	
Bridge Deck Field Data:		Slump 3", Air Content 6.8%		At plant	
Time: 7 AM		Air Temperature	53	At plant	
Deck: 54'x32'		Concrete Temp.	69	At plant	
Location:	Relative Humidity	Concrete Temp.	Air Temp.	Deck Form Temp.	
8:15		73	59	64	
9:40		75	63	65	
Slight rain at 1 PM					
Bridge Deck Structure Type: 8"		one span,w/ 4 Precast spread box beams, on metal deck			
Rebar Details:	Top & Bottom each way: #6's @ 6"				
Deck: 25'x31'					

Prism Data:	Inches/Inch	% Wt. Change
28 day :	-0.0050"	-1.25%
4 month:	-0.00078"	-1.91%

Initial site condition survey: **07/17/00** By VFL
No cracks observed
Second site condition survey: **10/23/00** By VFL
No cracks observed.

DISTRICT 2 **6 /03/98** **Designation: AA**

Juniata Concrete Co.: SR0322 -B01, by-Pass, Structure s-21867					**AA pump**
Westbound lanes, Two spans: Sta 88+87 to 89+41 & Sta 89+62 to 90+67					**#3 mix**
RP #96-053 details: 7 Day - 5005, 4907, 4412, 4307, 4581 psi					
QC 28 Day - 7303, 7038, 6791, 6712, 6879 psi					
AT 28 Day - 7180, 7038, 6924, 6774, 7101 psi					
Mix from batcher/mixer slip:				PCY/SSD	% Moisture
cement	Allentown Type I			440	
GGBFS	Allentown AllCem			149	
fine aggregate	Central Builders, Point Twp.			1305	5.3%
coarse aggregate	Eastern Industries, Naginey			1733	1.1%
WRA Polyheat 997	Master Builders, oz's	5.9 oz./100#cem.	35		
AEA, MBVR	Master Builders, oz's		6.6		
Retarder, 100XR	Master Builders, oz's	3 oz./100#cem.	18		
Water:		Fine/Coarse MC	8.2		
		Metered Water	22.6		
		Site added water	0.5 to 1		
Total Water:			**30.8 gal**	256.9	
Total Batch Weight:				3883.9	
Bridge Deck Field Data:		Slump 4.75", Air Content 10.8%		At plant	Wind
Time: 5:15 AM		Air Temperature	63	At plant	10-25 mph
Deck: 39'x37'7" and 37'5"		Concrete Temp.	74	At plant	
Location:	Relative Humidity	Concrete Temp.	Air Temp.	Deck Form Temp.	Beam
7:30	66%	75	60	61	60
		80	61	63	65
		78	61	66	
Bridge Deck Structure Type: 8"		multi-span(4),on (4) concrete I-beams3'6"x8', 22 gage deck			
Rebar Details:	Top: #4's + @11", or #8's - @5.5", long direction, #6's @ 7.5", crossing				
	Bottom: #5's @ 7'5" over decking & 21" over beams, long direction and #6's @ 7.5" crossing				
Prism Data:	Inches/Inch	% Wt. Change			
28 day :	-0.00041	-0.82%			
4 month:	-0.00065	-1.52%			

Initial site condition survey: **02/18/99** By Fong & Associates

No early cracking as of 2/18/99

Second site condition survey: **05/19/99** By Fong & Associates

(2) cracks over Pier #1 and (3) cracks over Pier #2, 5' to 16' long, 0.003"

The cracks are in the longitudinal direction centered on the pier center line in negative moment areas.

APPENDIX B

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 973 over Larrys Creek

BRIDGE DECK CRACKING
1st Cycle

July 1997

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-1

Bridge Deck Survey

General Information

Bridge Name:	S.R. 973 over Larrys Creek
Bridge Type:	Simply supported, Composite, Multi Steel Plate Girders
Bridge Length:	110’-4” (deck joint to deck joint)
No. of Spans:	1 (108’ center bearing to center bearing)
Shoulder Width	N/A (Unmark)
Lane Width:	28’ (curb to curb)
Skew:	53°-30’

Survey Information

Date:	7-23-97
Inspectors:	KFL & PMH
Temperature:	68° F
Weather :	Overcast and partly cloudy
Humidity:	Moderate
Sun Intensity:	Low

Bridge Deck Survey

Photo 1: Bridge Looking East.

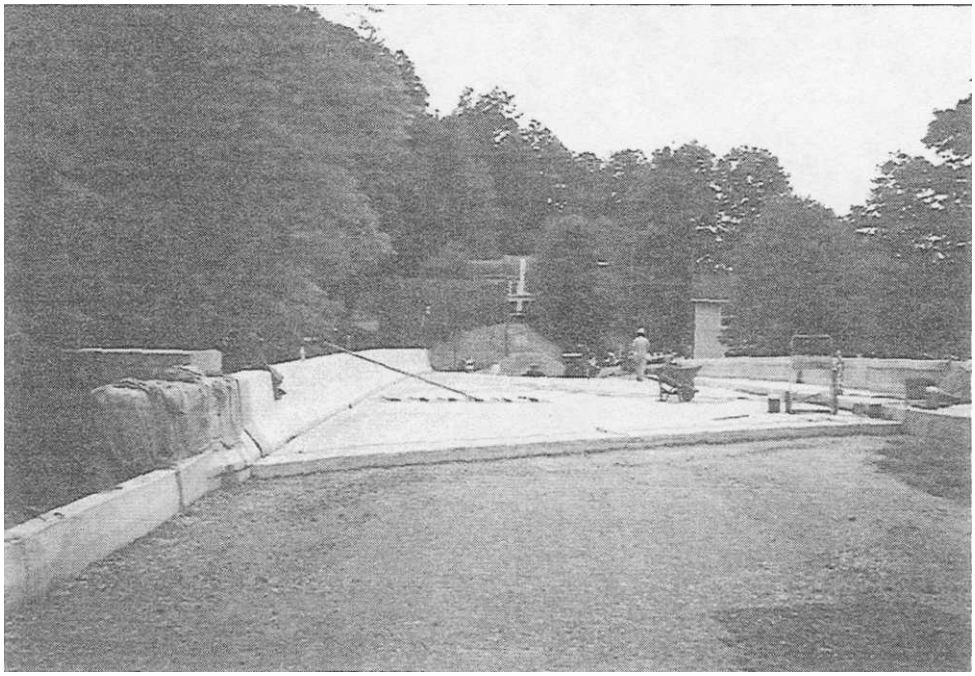
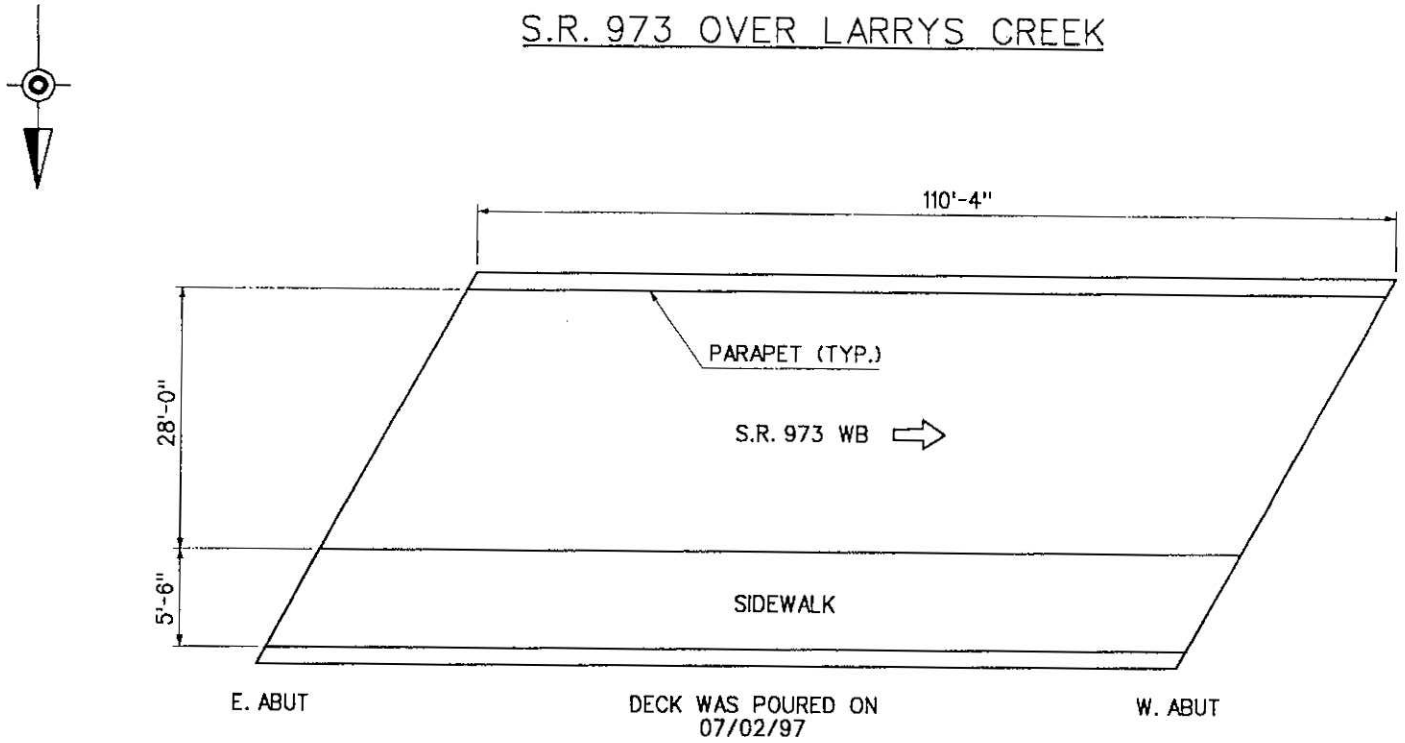


Photo 2: Bridge deck looking West

ROUTE	CYCLE	DATE
973	1	7-23-97

S.R. 973 OVER LARRYS CREEK



NO VISIBLE DECK SURFACE CRACK WAS FOUND

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 973 over Larrys Creek

BRIDGE DECK CRACKING
2nd Cycle

February 1998

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-5

Bridge Deck Survey

General Information

Bridge Name:	S.R 973 over Larrys Creek
Bridge Type:	Simply supported, Composite, Multi Steel Plate Girders
Bridge Length:	110’-4” (deck joint to deck joint)
No. of Spans:	1 (108’ center bearing to center bearing)
Shoulder Width	0” (5’-6” sidewalk in west bound)
Lane Width:	14’-0” (2 lanes)
Skew:	53°-30’

Survey Information

Date:	2-10-98
Inspectors:	YWL & BM
Temperature:	55° F
Weather:	Sunny
Humidity:	Moderate
Sun Intensity:	Moderate

Bridge Deck Survey

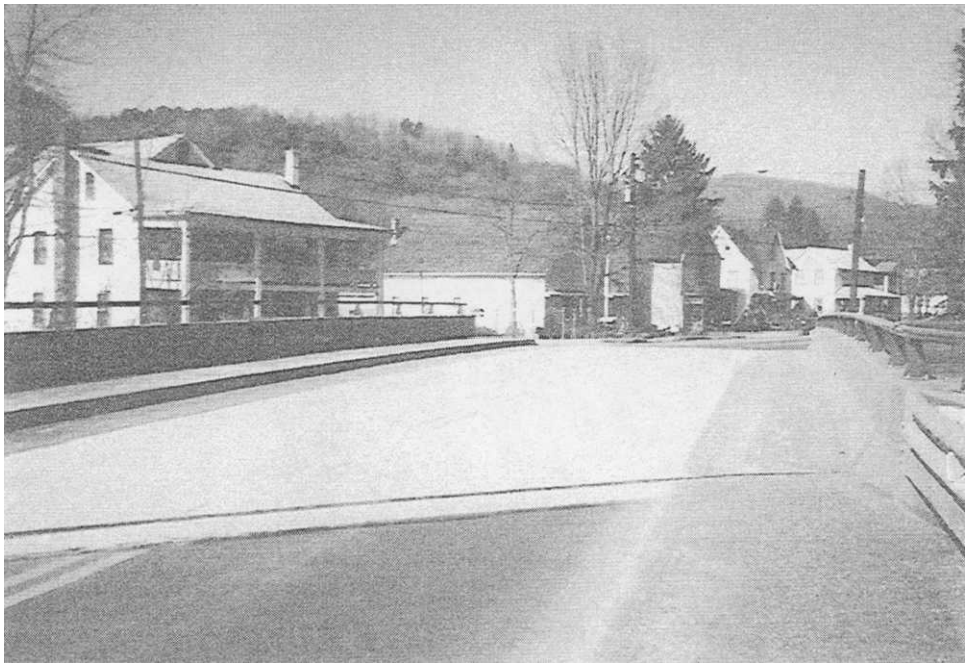


Photo 1: Bridge deck looking East.

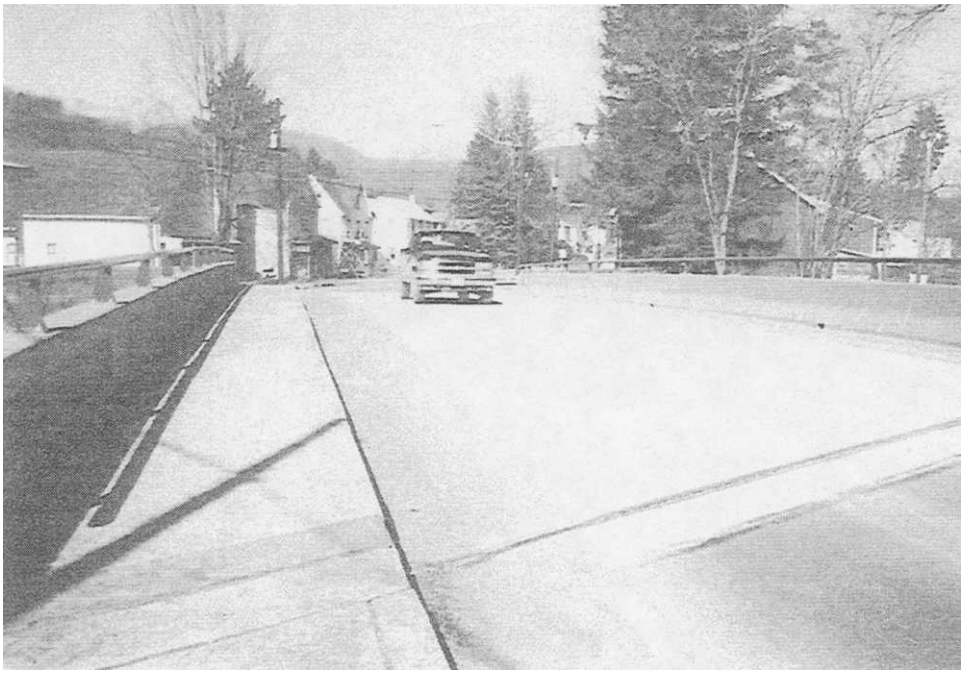
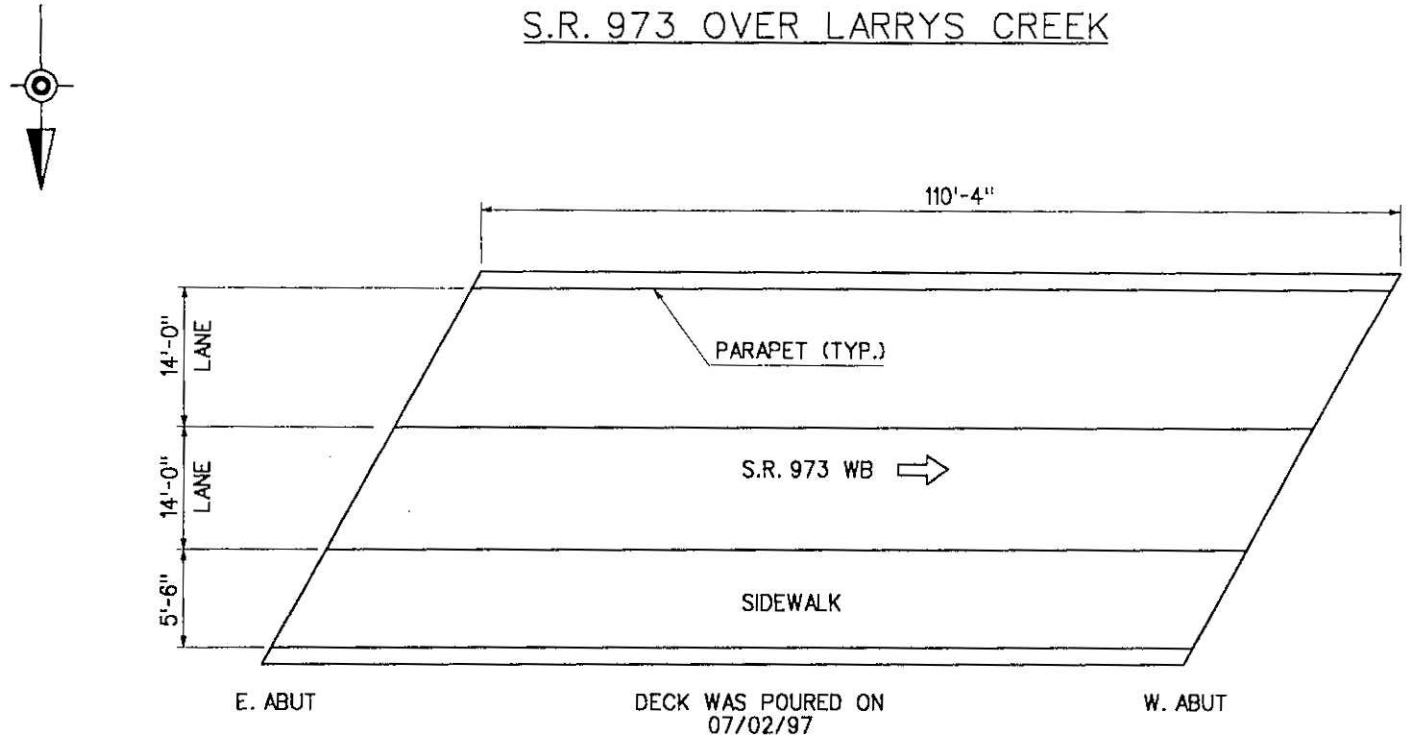


Photo 2: Bridge deck looking West

ROUTE	CYCLE No.	DATE
973	2	2-10-98

S.R. 973 OVER LARRYS CREEK



NO VISIBLE DECK SURFACE CRACK WAS FOUND

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 15 Northbound over S.R. 414

BRIDGE DECK CRACKING
1st Cycle

March, 1998

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-9

Bridge Deck Survey

General Information

Bridge Name:	S.R. 15 Northbound over S.R. 414
Bridge Type:	Single Span Prestressed Concrete I-Beams
Bridge Length:	l37’-6” (deck joint to deck joint)
No. of Spans:	1
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 42'-6" curb to curb)
Skew:	90° ±

Survey Information

Date:	3-25-98
Inspectors:	YWL & GH
Temperature:	50° F
Weather:	Sunny, windy
Humidity:	Moderate
Sun Intensity:	Moderate

Bridge Deck Survey

Photo 1: Bridge Deck Looking North.

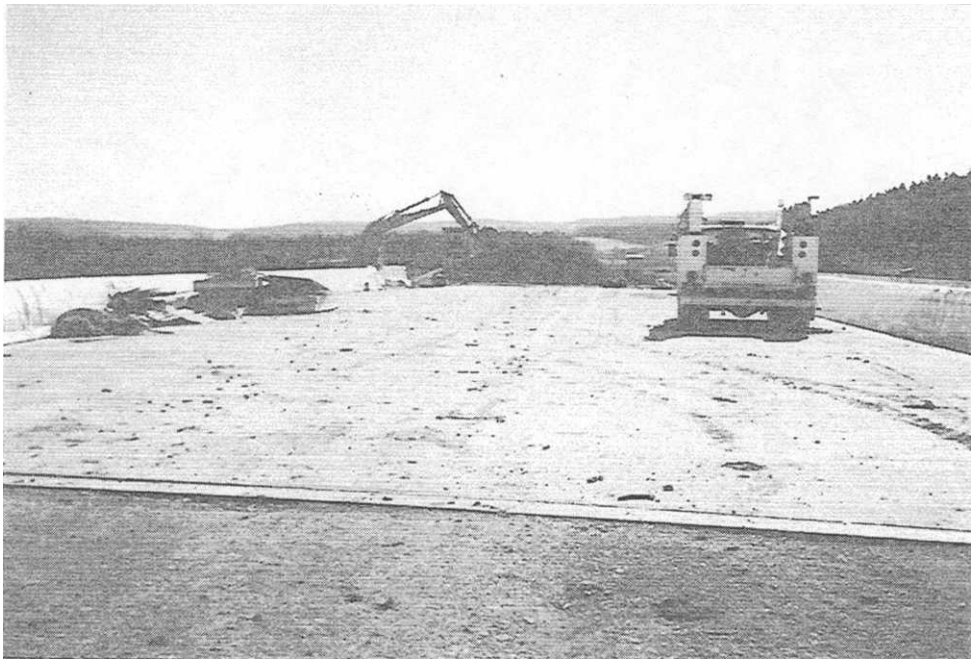
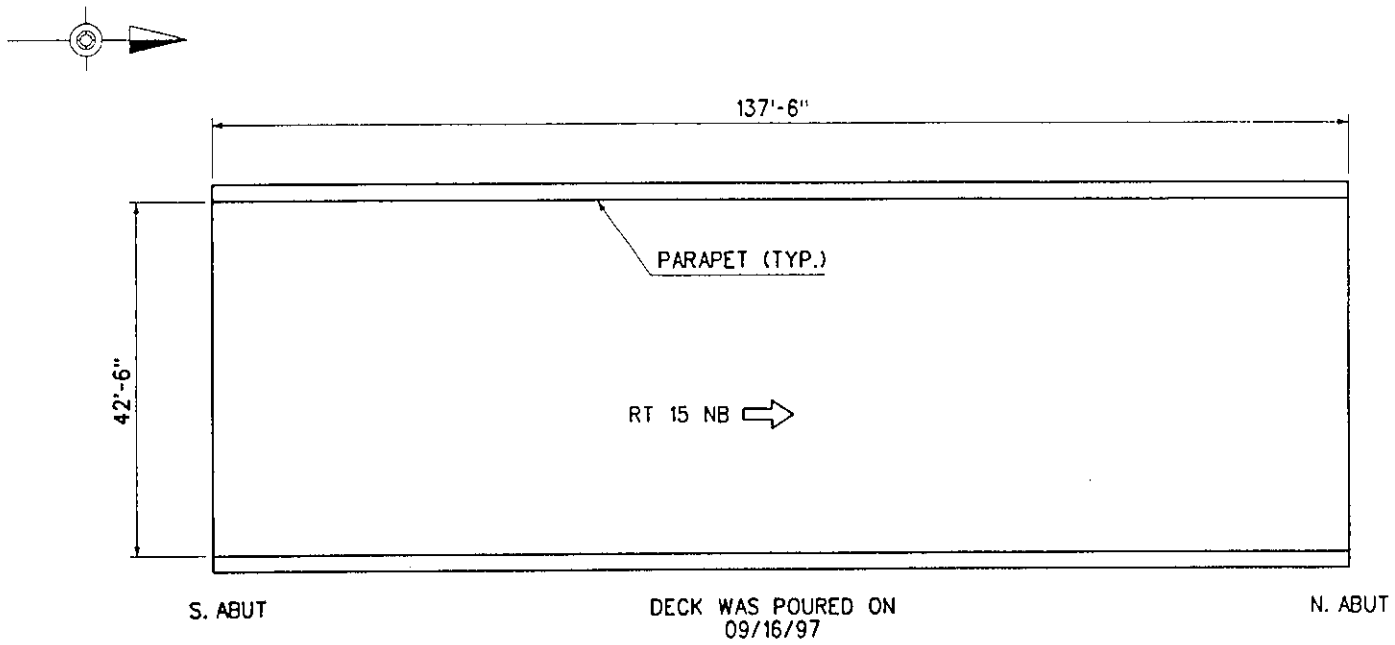


Photo 2: Bridge Deck Looking South.

ROUTE	CYCLE NO.	DATE
15	1	03/25/98

R.T. 15 NB OVER R.T. 414



NO VISIBLE DECK SURFACE CRACK WAS FOUND

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 15 Northbound over S.R. 414

BRIDGE DECK CRACKING
2nd Cycle

June, 1998

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-13

Bridge Deck Survey

General Information

Bridge Name:	S.R. 15 Northbound over S.R. 414
Bridge Type:	Single Span Prestressed Concrete I-Beams
Bridge Length:	137’-6” (deck joint to deck joint)
No. of Spans:	1
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 42'-6" curb to curb)
Skew:	90° ±

Survey Information

Date:	6-02-98
Inspectors:	YWL & PH
Temperature:	70° F
Weather:	Sunny, windy
Humidity:	Moderate
Sun Intensity:	Moderate

Bridge Deck Survey

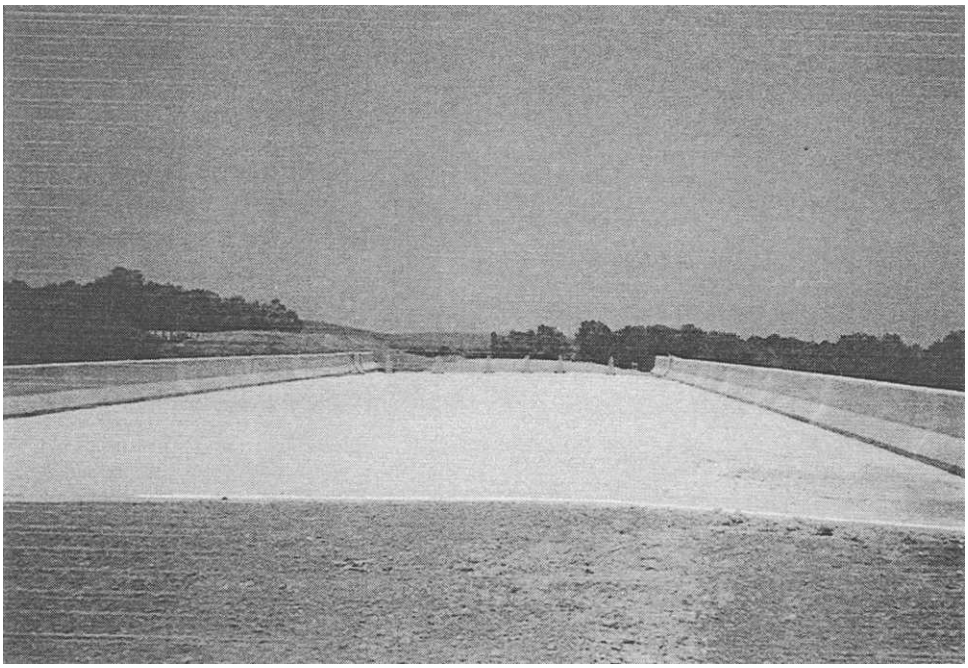


Photo 1: Bridge Deck Looking North.

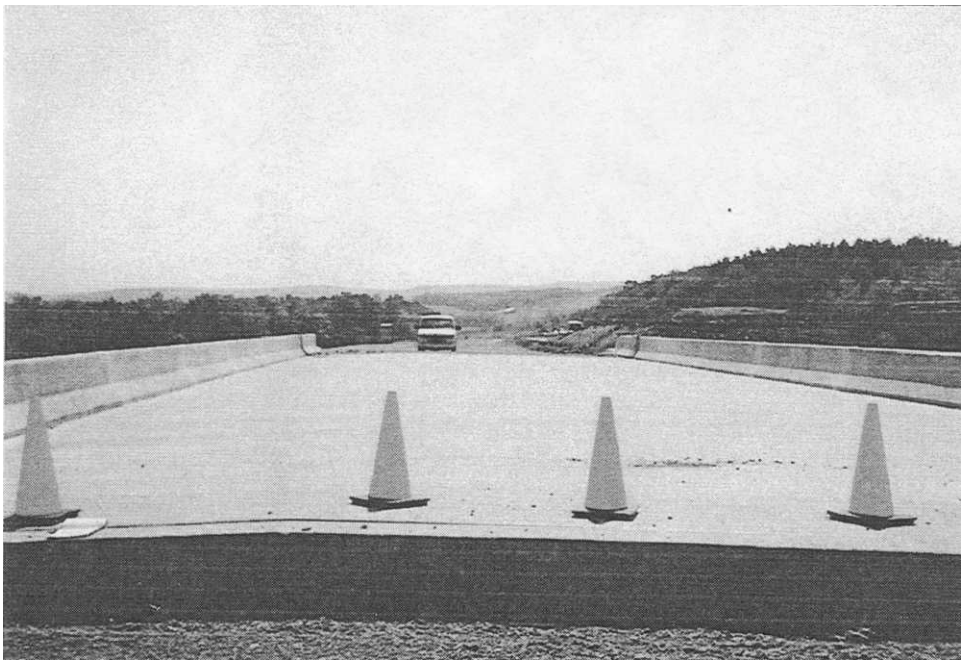
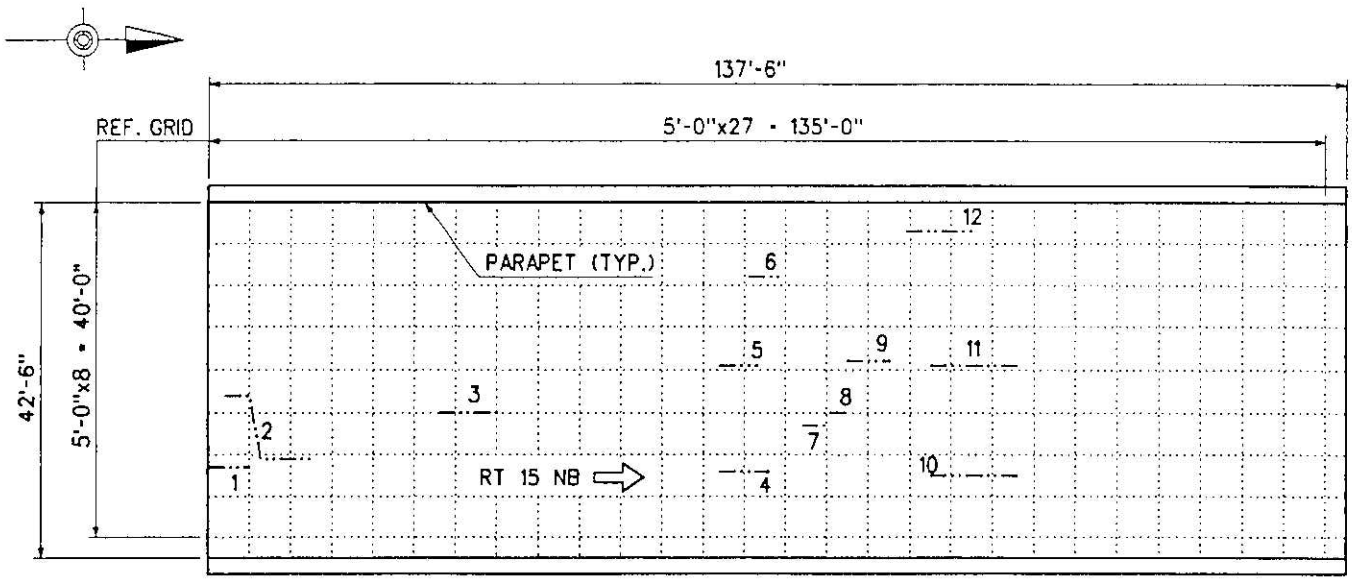


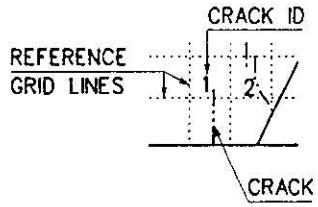
Photo 2: Bridge Deck Looking South.

ROUTE	CYCLE NO.	DATE
15	2	06/02/98

R.T. 15 NB OVER R.T. 414



LEGEND:



CRACK	LENGTH (FT)	WIDTH (IN)	CRACK	LENGTH (FT)	WIDTH (IN)
1	5.0	0.002	7	3.0	0.002
2	16.5	0.003	8	2.0	0.002
3	7.5	0.002	9	5.0	0.002
4	6.0	0.002	10	11.0	0.002
5	4.5	0.002	11	13.0	0.002
6	4.0	0.002	12	8.0	0.002

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 15 Northbound over S.R. 284

BRIDGE DECK CRACKING
1st Cycle

March, 1998

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-17

Bridge Deck Survey

General Information

Bridge Name:	S.R. 15 Northbound over S.R. 284
Bridge Type:	Three-Span Continuous Prestressed Concrete I-Beams
Bridge Length:	225’-4” (deck joint to deck joint)
No. of Spans:	3 (70'-4", 95’-0” & 60'-0")
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 42'-6" curb to curb)
Skew:	45° ±

Survey Information

Date:	3-25-98
Inspectors	YWL & GH
Temperature:	50° F
Weather:	Sunny, windy
Humidity:	Moderate
Sun Intensity:	Moderate

Bridge Deck Survey

Photo 1: Bridge Deck Looking North.

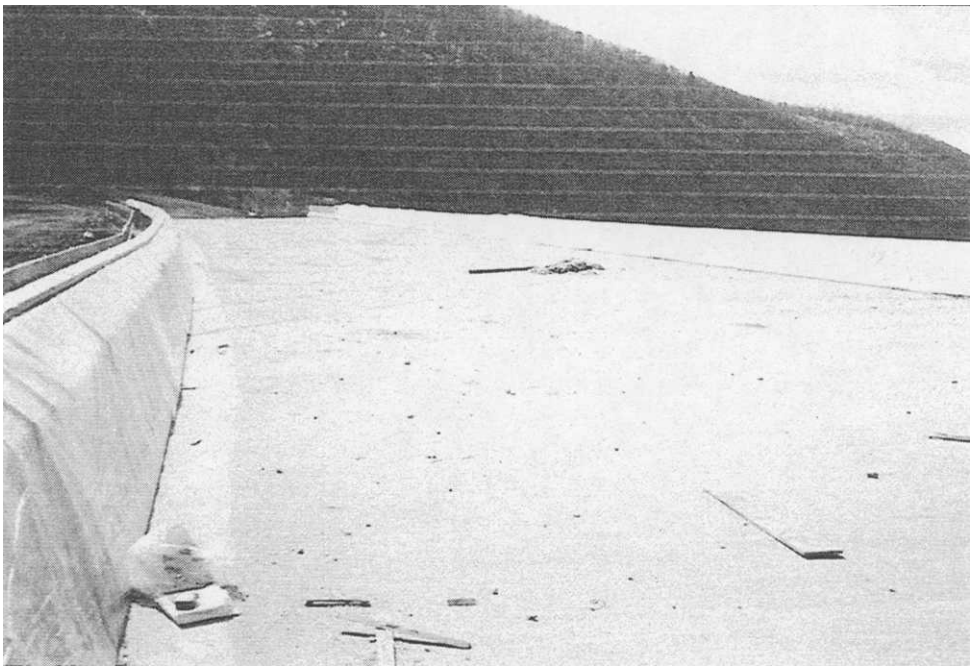


Photo 2: Bridge Deck Looking South

Bridge Deck Survey

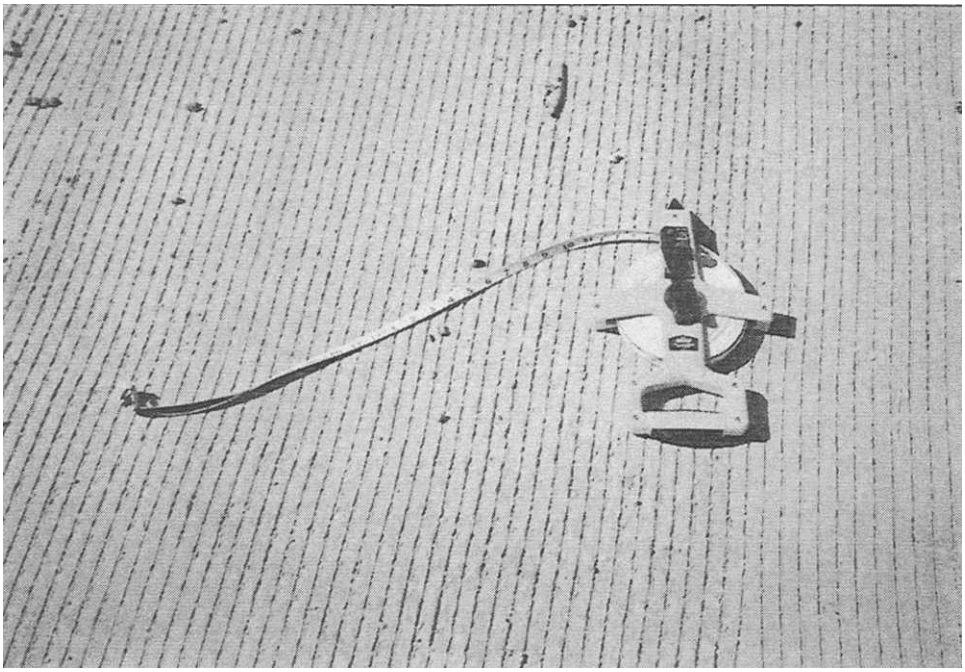
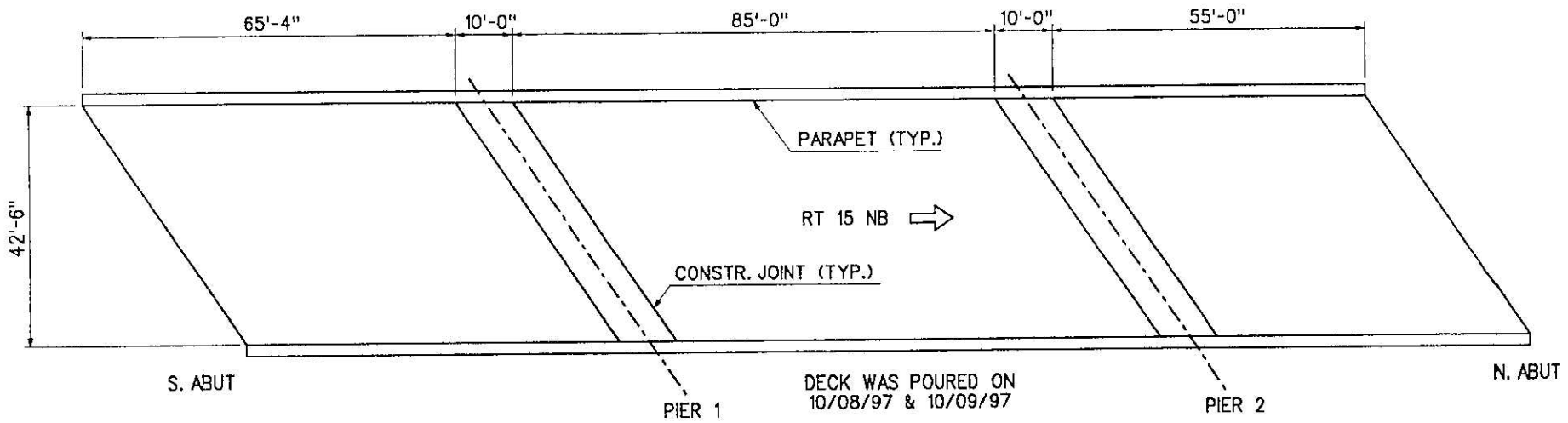


Photo 3: Bridge Deck Surface

ROUTE	CYCLE No.	DATE
15	1	03/25/98

R.T. 15 NB OVER R.T. 284



NO VISIBLE DECK SURFACE CRACK WAS FOUND

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 15 Northbound over S.R. 284

BRIDGE DECK CRACKING
2nd Cycle

June, 1998

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-22

Bridge Deck Survey

General Information

Bridge Name:	S.R. 15 Northbound over S.R. 284
Bridge Type:	Three-Span Continuous Prestressed Concrete I-Beams
Bridge Length	225’-4” (deck joint to deck joint)
No. of Spans:	3 (70’-4", 95’'-0” & 60'-0")
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 42'-6" curb to curb)
Skew:	45° ±

Survey Information

Date:	6-02-98
Inspectors:	YWL & PH
Temperature:	70° F
Weather:	Sunny, windy
Humidity:	Moderate
Sun Intensity:	Moderate

Bridge Deck Survey

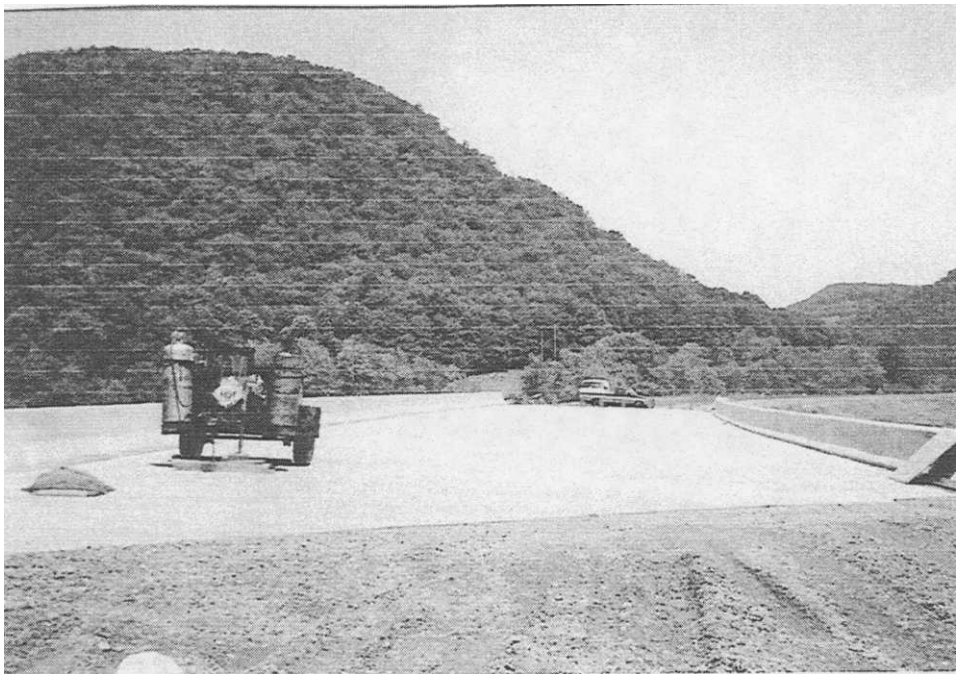


Photo 1: Bridge Deck Looking North.

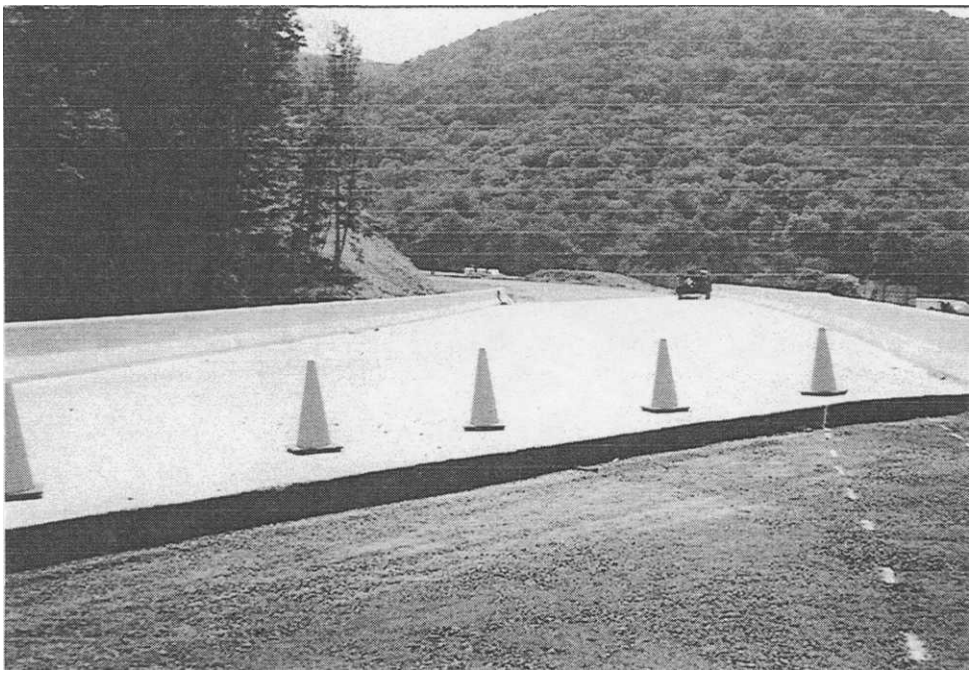


Photo 2: Bridge Deck Looking South.

Bridge Deck Survey

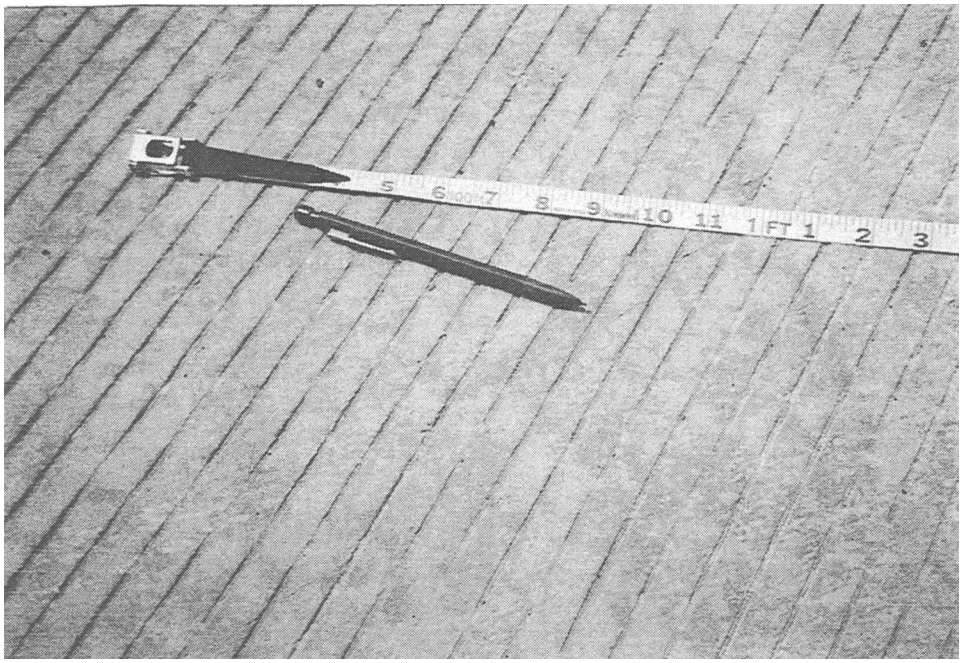
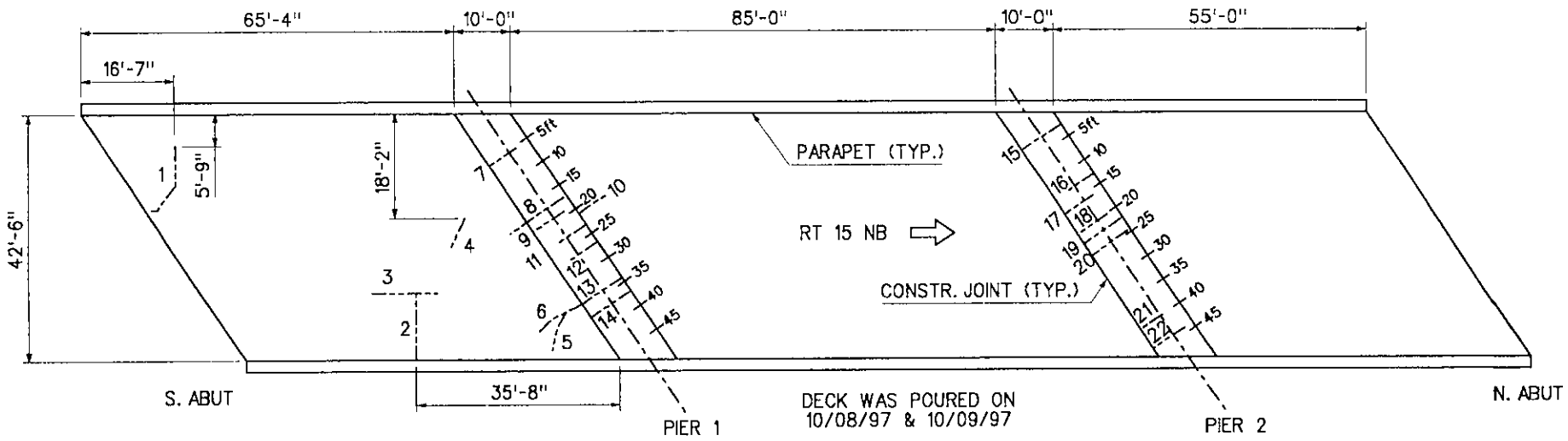


Photo 3: Bridge Deck Surface

ROUTE	CYCLE	DATE
15	2	06/02/98

R.T. 15 NB OVER R.T. 284



CRACK	LENGTH (FT)	WIDTH (IN)	CRACK	LENGTH (FT)	WIDTH (IN)	CRACK	LENGTH (FT)	WIDTH (IN)
1	9.5	0.003	9	6.9	0.005	17	5.0	0.002
2	11.5	0.005	10	3.0	0.003	18	7.0	0.005
3	6.5	0.002	11	6.5	0.005	19	7.0	0.005
4	6.5	0.005	12	3.5	0.002	20	6.9	0.003
5	12.5	0.003	13	7.0	0.002	21	5.0	0.007
6	11.0	0.003	14	7.0	0.005	22	6.0	0.005
7	5.5	0.005	15	6.9	0.007			
8	9.5	0.005	16	3.0	0.002			

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 15 Northbound over Blockhouse Creek

BRIDGE DECK CRACKING
1st Cycle

March, 1998

Prepared by
FONG & ASSOCIATES, INC.
King or Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-27

Bridge Deck Survey

General Information

Bridge Name:	S.R. 15 Northbound over Blockhouse Creek
Bridge Type:	Single Span Prestressed Concrete Spread Box Beams
Bridge Length:	81'-4" (deck joint to deck joint)
No. of Spans:	1
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 57'-6" curb to curb)
Skew:	45˚ ±

Survey Information

Date:	3-25-98
Inspectors:	YWL & GH
Temperature:	50˚ F
Weather:	Sunny, windy
Humidity:	Moderate
Sun Intensity:	Moderate

Bridge Deck Survey

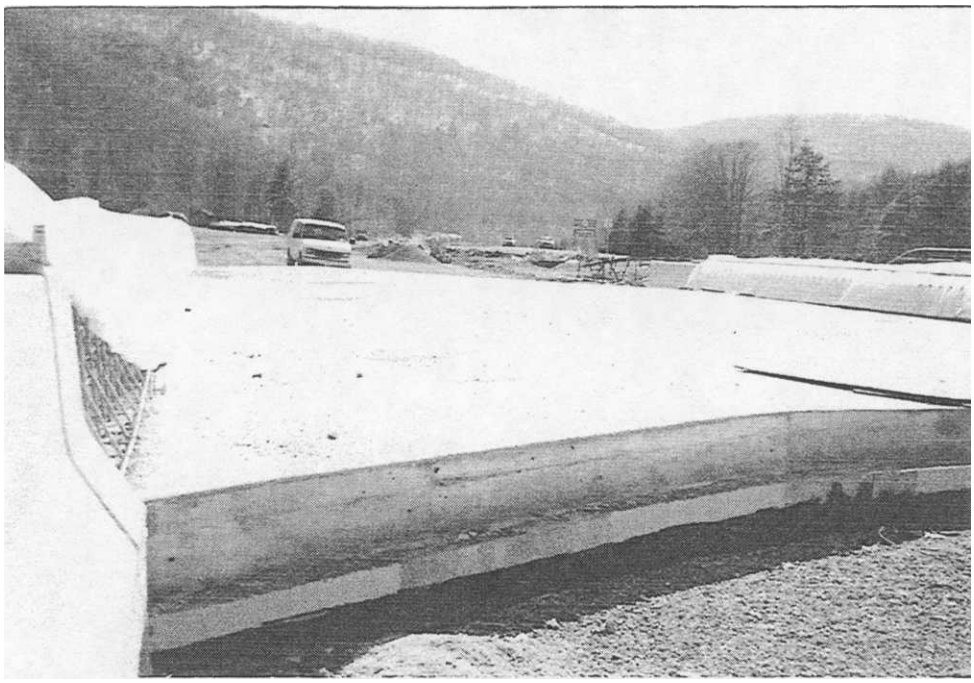


Photo1: Bridge Deck Looking North.

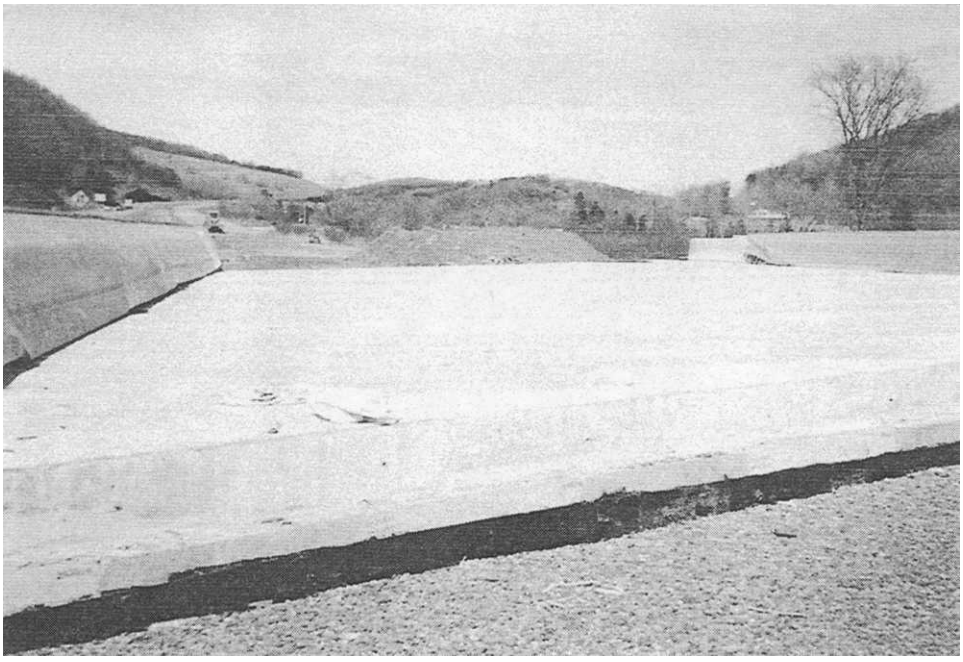
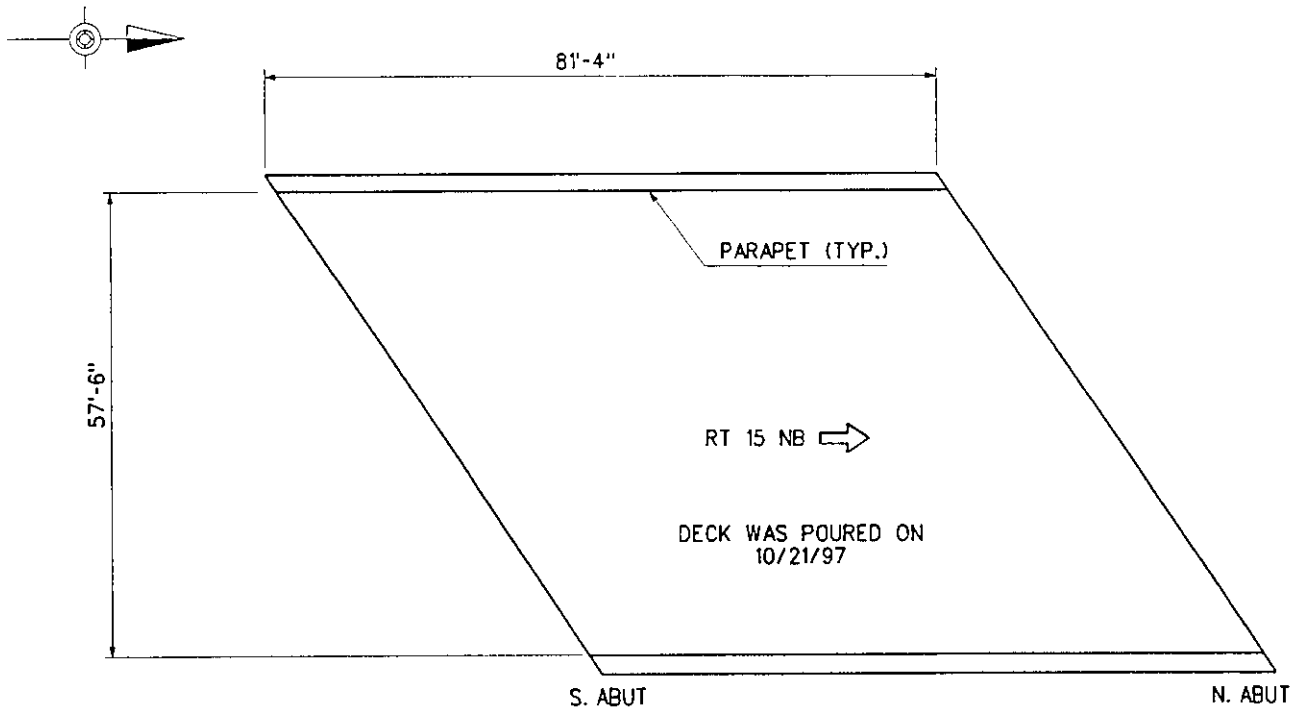


Photo 2: Bridge Deck Looking South.

ROUTE	CYCLE NO.	DATE
15	1	03/25/98

R.T. 15 NB OVER BLOCKHOUSE CREEK



NO VISIBLE DECK SURFACE CRACK WAS FOUND

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 15 Northbound over Blockhouse Creek

BRIDGE DECK CRACKING
2nd Cycle

June, 1998

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-31

Bridge Deck Survey

General Information

Bridge Name:	S.R. 15 Northbound over Blockhouse Creek
Bridge Type:	Single Span Prestressed Concrete Spread Box Beams
Bridge Length:	81’-4” (deck joint to deck joint)
No. of Spans:	1
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 57'-6" curb to curb)
Skew:	45˚±

Survey Information

Date:	6-02-98
Inspectors:	YWL & PH
Temperature:	70˚ F
Weather:	Sunny, windy
Humidity:	Moderate
Sun Intensity:	Moderate

Bridge Deck Survey

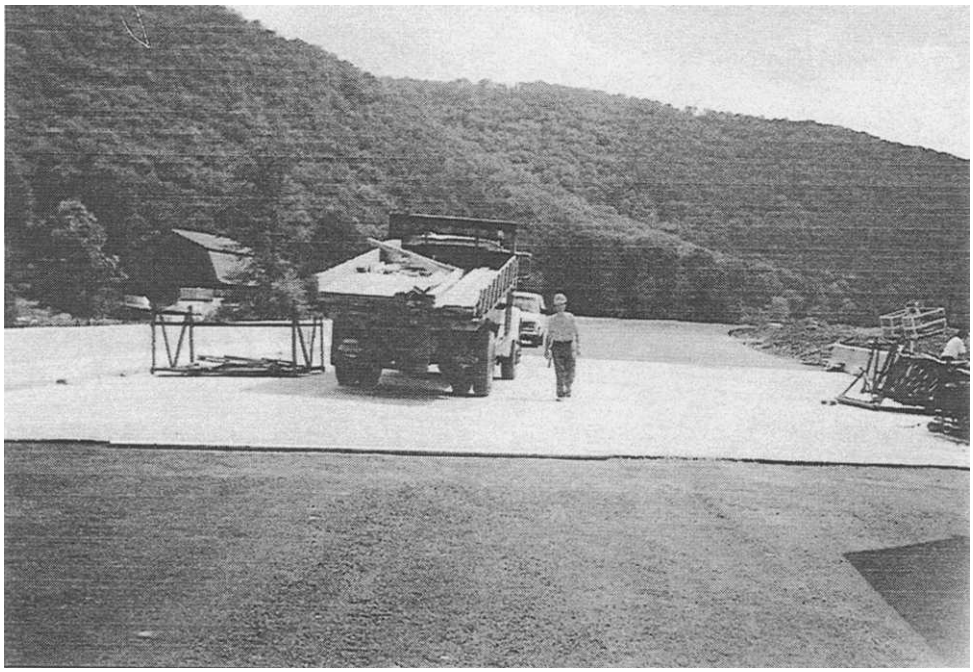
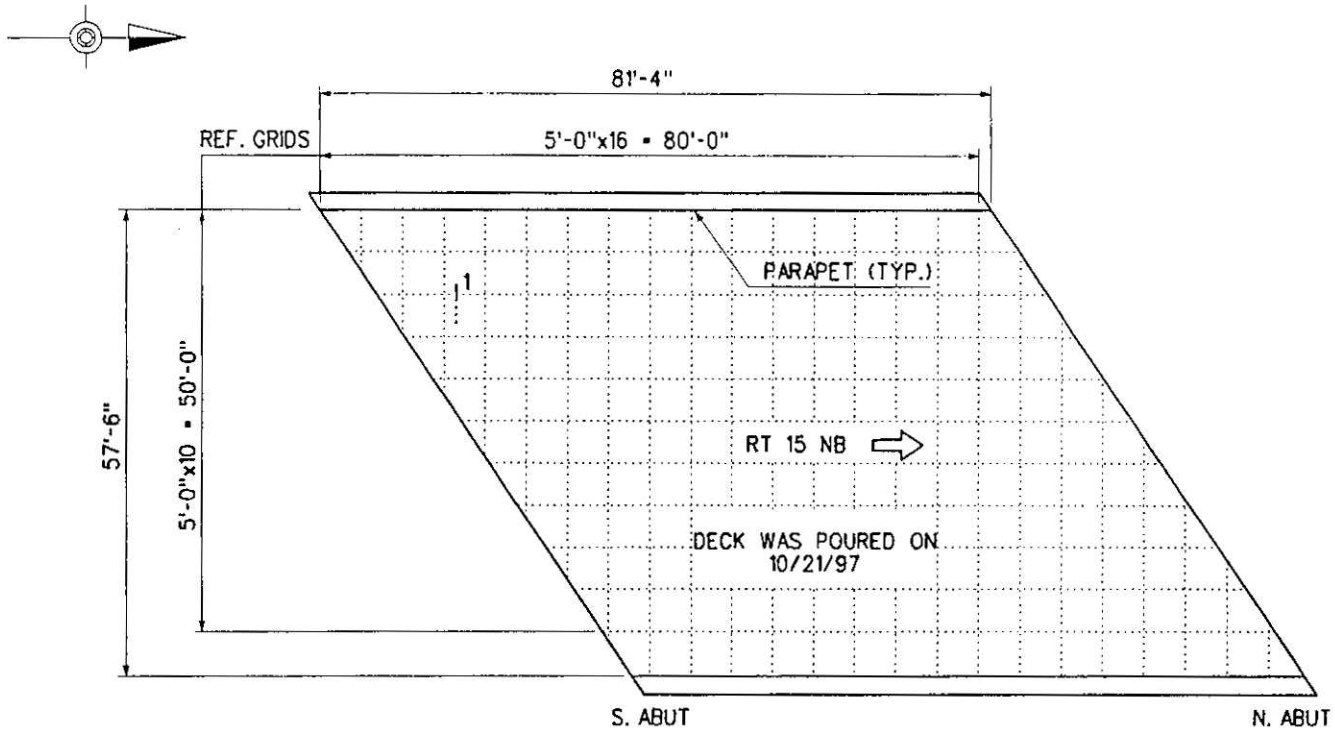


Photo 1: Bridge Deck Looking North.

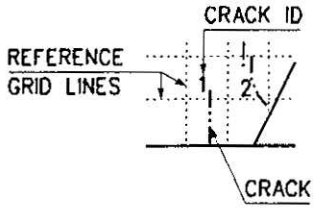
Photo 2: Bridge Deck Looking South.

ROUTE	CYCLE NO.	DATE
15	2	06/02/98

R.T. 15 NB OVER BLOCKHOUSE CREEK



LEGEND:



CRACK	LENGTH (FT)	WIDTH (IN)
1	3.0	0.003

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 220 Southbound over Pine Creek

BRIDGE DECK CRACKING
1st Cycle

June, 1998

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIEES, INC.
Devon, PA

Bridge Deck Survey

General Information

Bridge Name:	S.R. 220 Southbound over Pine Creek
Bridge Type:	Five-Span Composite Prestressed Concrete Girders
Bridge Length:	400’-0” (deck joint to deck joint)
No. of Spans:	5
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 36-0" curb to curb)
Skew:	15° ±

Survey Information

Date:	6-25-98
Inspectors:	YWL & SP
Temperature:	90° F
Weather:	Sunny, Hot
Humidity:	Humid
Sun Intensity:	Intensive

Bridge Deck Survey

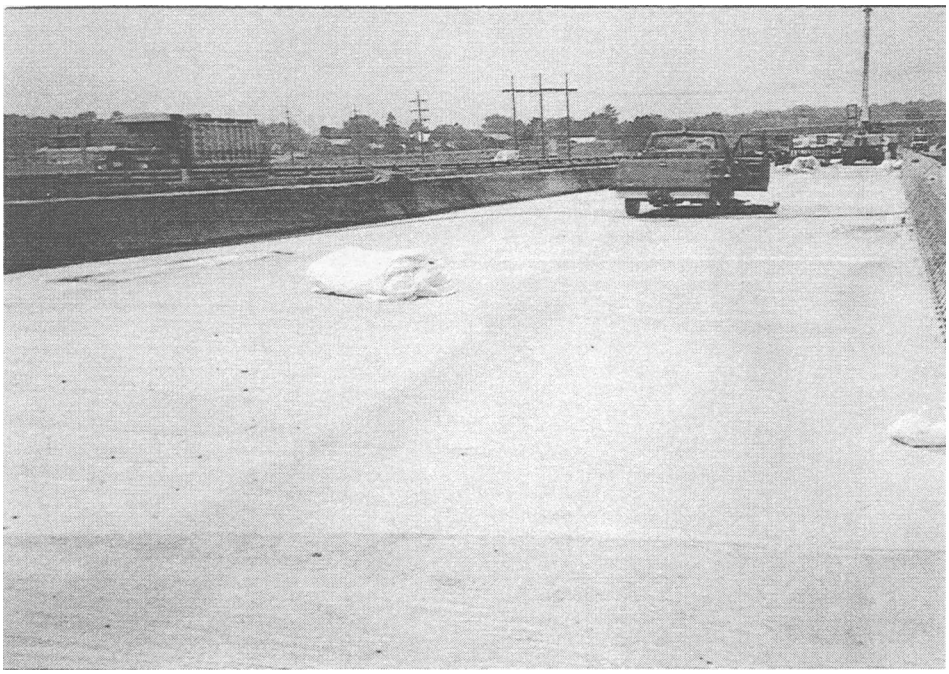


Photo 1: Bridge Deck over Pier No. 1 Looking South

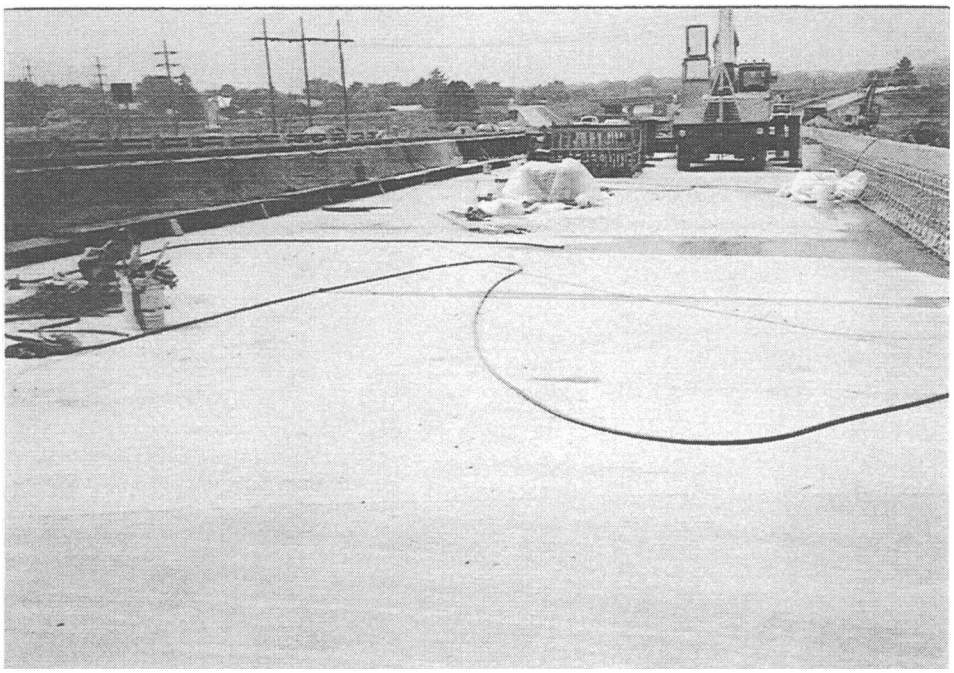
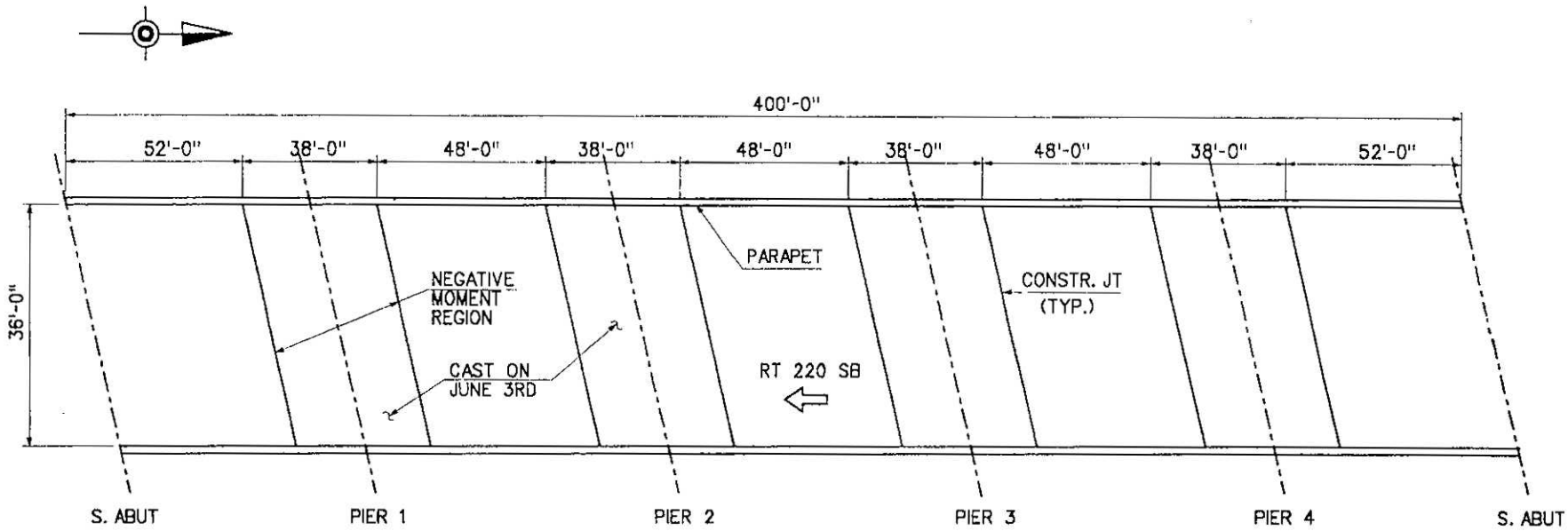


Photo 2: Bridge Deck Over Pier No. 2 Looking South

ROUTE	CYCLE NO.	DATE
220	1	06/25/98

R.T. 220 SB OVER PINE CREEK



DECK WAS POURED ON
MAY 28, 29 AND JUNE 2 & 3

NO VISIBLE DECK SURFACE CRACK WAS FOUND

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 220 Southbound over Pine Creek

BRIDGE DECK CRACKING
2nd Cycle

September 1998

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-39

Bridge Deck Survey

General Information

Bridge Name:	S.R. 220 Southbound over Pine Creek
Bridge Type:	Five-Span Composite Prestressed Concrete Girders
Bridge Length:	400’-0” (deck joint to deck joint)
No. of Spans:	5
Shoulder Width	6'-0"
Lane Width:	12'-0" (Fast Lane)
Skew:	15° ±

Survey Information

Date:	9-22-98
Inspectors:	YBL & BA
Temperature:	80° F
Weather:	Cloudy
Humidity:	Low
Sun Intensity:	Low

Bridge Deck Survey

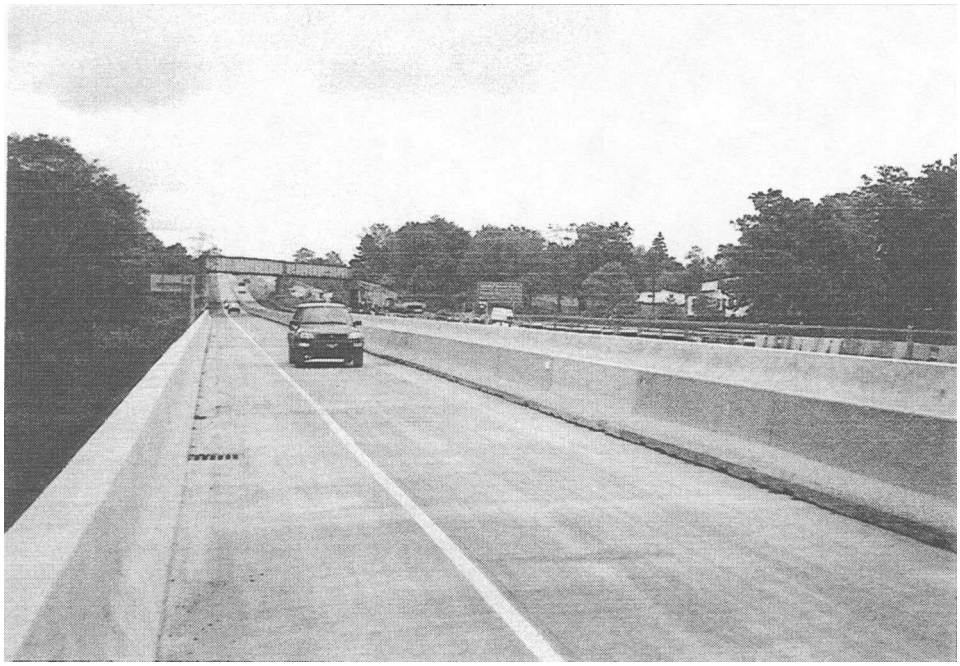


Photo 1: Bridge Deck SB Looking North.

Photo 2: Bridge Deck SB Looking South.

Bridge Deck Survey

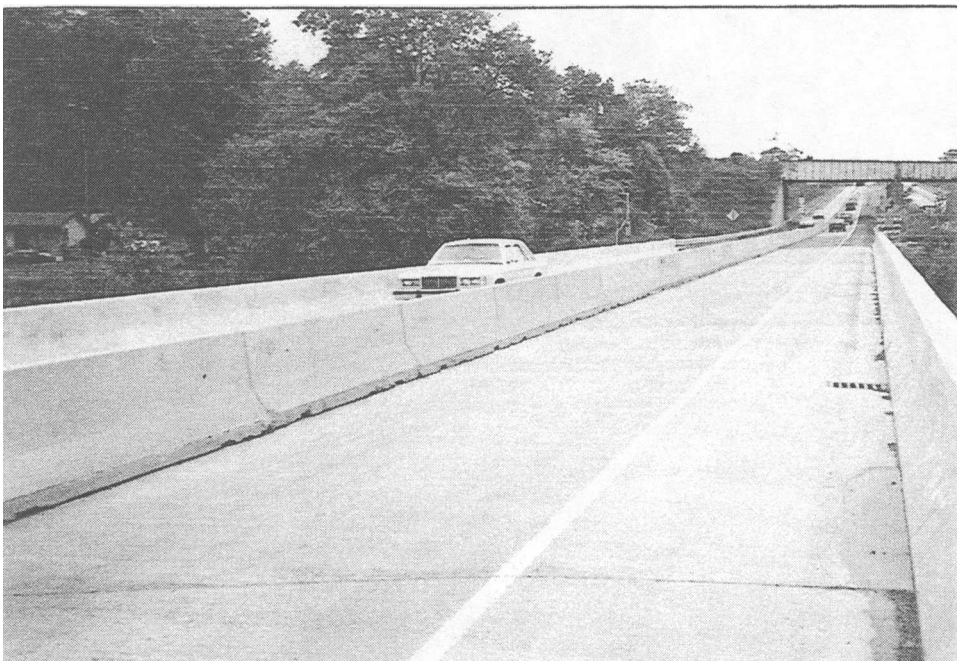


Photo 3: Bridge Deck NB (Temporary) Looking North.

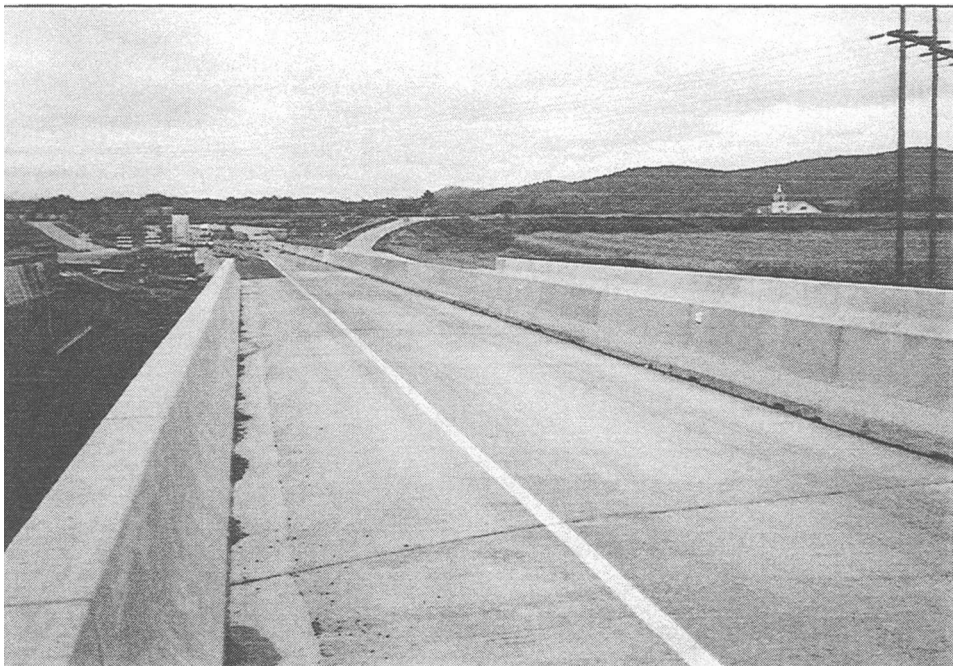
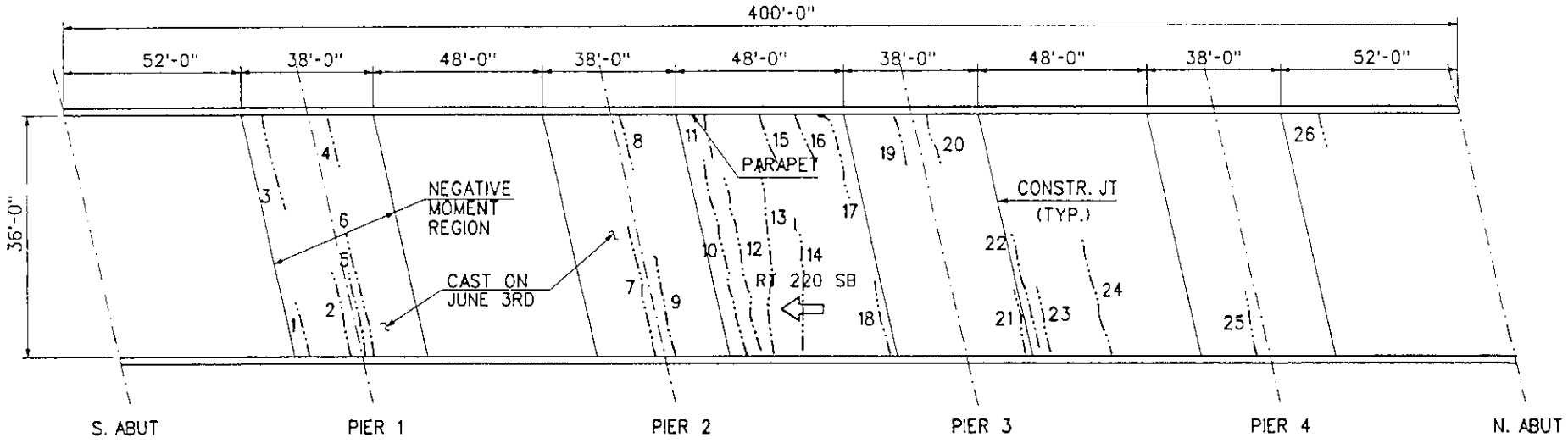


Photo 4: Bridge Deck NB (Temporary) Looking South.

ROUTE	CYCLE NO.	DATE
220	2	09/22/98

R.T. 220 SB OVER PINE CREEK



DECK WAS POURED ON
MAY 28, 29 AND JUNE 2 & 3

CRACK	LENGTH FT	WIDTH (IN)	CRACK	LENGTH FT	WIDTH (IN)	CRACK	LENGTH FT	WIDTH (IN)
1	8.0	0.002	10	30.0	0.005	19	6.0	0.002
2	10.0	0.002	11	6.0	0.002	20	6.0	0.002
3	12.0	0.002	12	24.0	0.005	21	8.0	0.002
4	6.0	0.002	13	24.0	0.005	22	12.0	0.002
5	10.0	0.002	14	18.0	0.002	23	6.0	0.002
6	15.0	0.002	15	6.0	0.002	24	18.0	0.002
7	18.0	0.002	16	6.0	0.002	25	8.0	0.002
8	6.0	0.002	17	6.0	0.002	26	5.0	0.002
9	10.0	0.002	18	8.0	0.002			

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 30 Eastbound over S.R. 272

BRIDGE DECK CRACKING
1st Cycle

September 1997

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-44

Bridge Deck Survey

General Information

Bridge Name:	S.R. 30 Eastbound over S.R. 272
Bridge Type:	Simply supported, Prestressed Concrete Spread Box Girders
Bridge Length:	146’-0” (deck joint to deck joint)
No. of Spans:	2 (67-6" & 78'-5")
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 30'-4" curb to curb)
Skew:	63°-26’

Survey Information

Date:	9-30-97
Inspectors:	YWL & GH
Temperature:	70° F
Weather:	Overcast and partly cloudy, windy
Humidity:	Moderate
Sun Intensity:	Low

Bridge Deck Survey

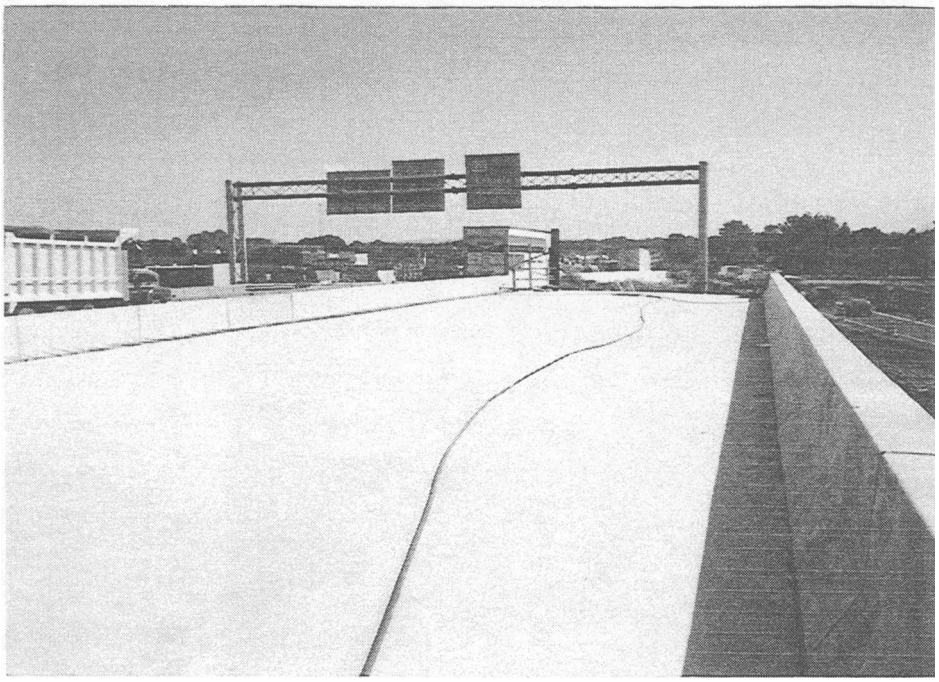
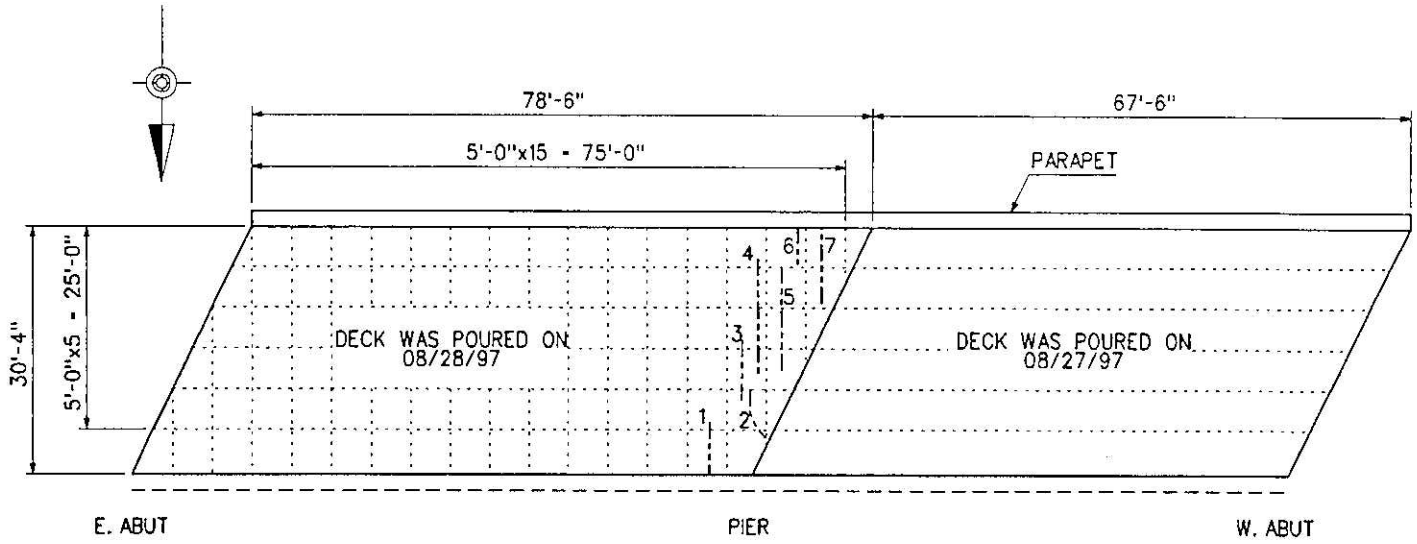


Photo 1: Bridge deck looking East.

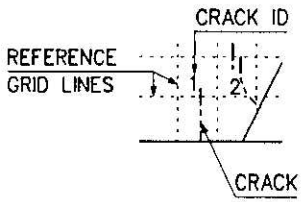
Photo 2: Bridge desk looking West.

ROUTE	STRUCTURE NO.	DATE
30	0030-009	09/30/97

S.R. 30 EASTBOUND OVER S.R. 272



LEGEND:



CRACK	LENGTH (FT)	WIDTH (IN)
1	6.5	0.002
2	7.5	0.002
3	6.0	0.002
4	14.0	0.002
5	13.0	0.002
6	5.0	0.002
7	9.5	0.002

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 30 Eastbound over S.R. 272

BRIDGE DECK CRACKING
2nd Cycle

September 1998

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-48

Bridge Deck Survey

General Information

Bridge Name:	S.R. 30 Eastbound over S.R. 272
Bridge Type:	Simply supported, Prestressed Concrete Spread Box Girders
Bridge Length:	146’-0” (deck joint to deck joint)
No. of Spans:	2 (67-6" & 78'-5")
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 30'-4" curb to curb)
Skew:	63°-26’

Survey Information

Date	9-17-98
Inspectors:	YWL & LNH
Temperature:	85° F
Weather:	Cloudy
Humidity:	Moderate
Sun Intensity:	Low

Note: Due to the ongoing construction of westbound, the eastbound is currently divided into eastbound & westbound two-way traffic with construction barriers. The traffic is very heavy and there is no shoulder, the bridge deck surface can not be accessed

Bridge Desk Survey

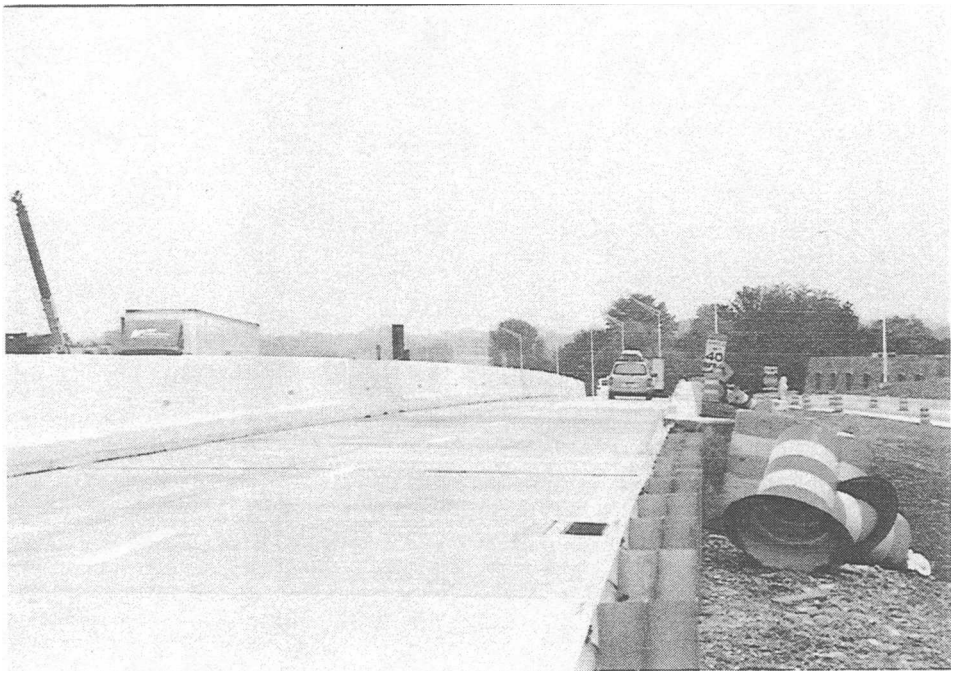


Photo 1: Bridge deck looking East.

Photo 2: Bridge deck looking West.

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 30 Westbound over S.R. 272

BRIDGE DECK CRACKING
1st Cycle

June 1999

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-51

Bridge Deck Survey

General Information

Bridge Name:	S.R. 30 Westbound over S.R. 272
Bridge Type:	Simply supported, Prestressed Concrete Spread Box Girders
Bridge Length:	146’-0” (deck joint to deck joint)
No. of Spans:	2 (67'-6" & 78'-5")
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 58'-6" curb to curb)
Skew:	63°-26’

Survey Information

Date:	6-23-99
Inspectors:	YWL & BA
Temperature:	87° F
Weather:	Sunny
Humidity:	Moderate
Sun Intensity:	Intense

Bridge Deck Survey

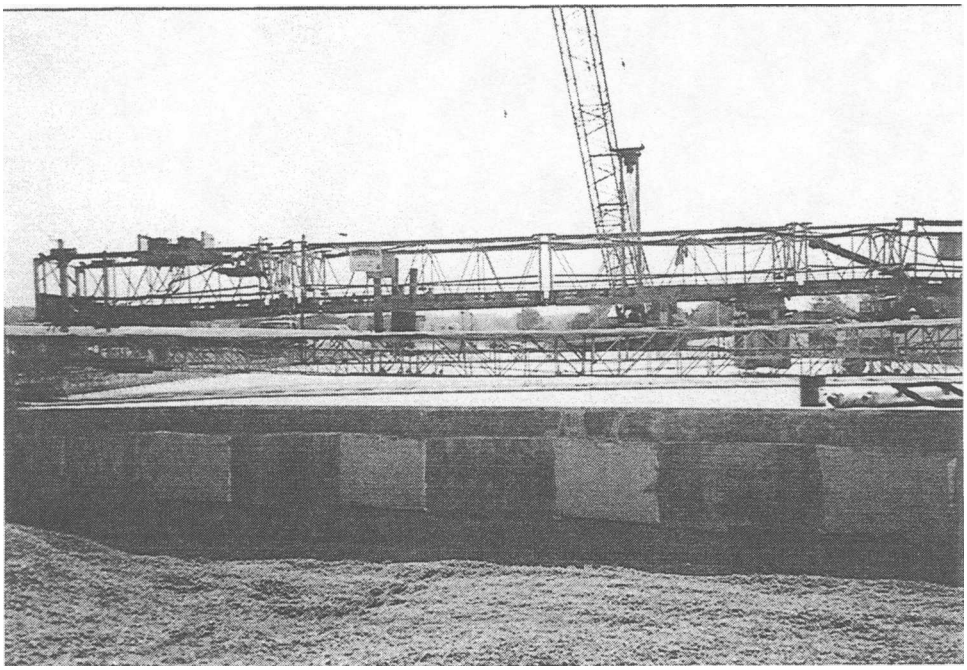


Photo 1: Bridge deck looking East.

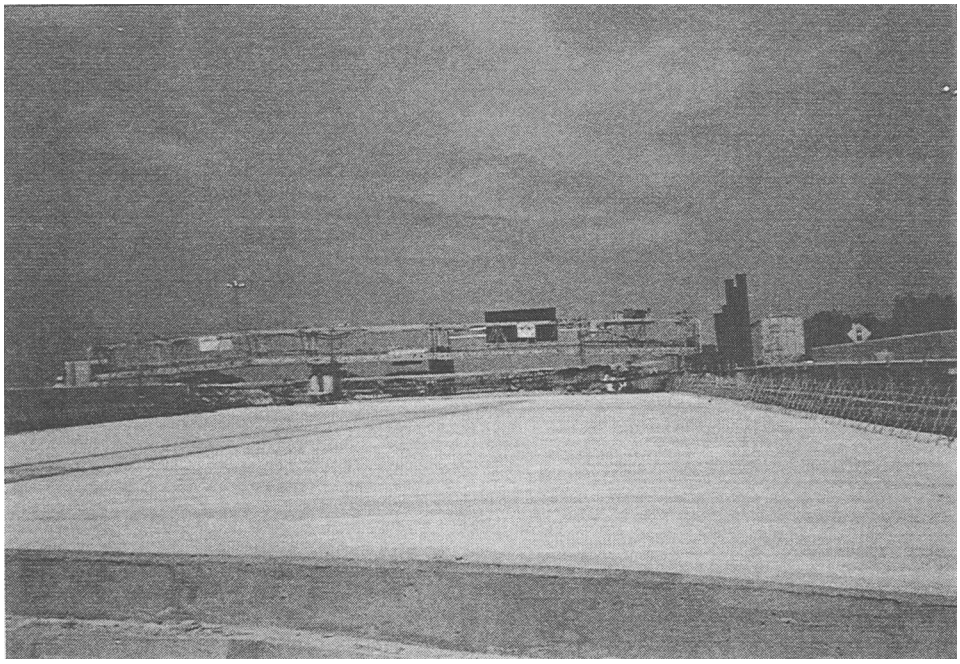
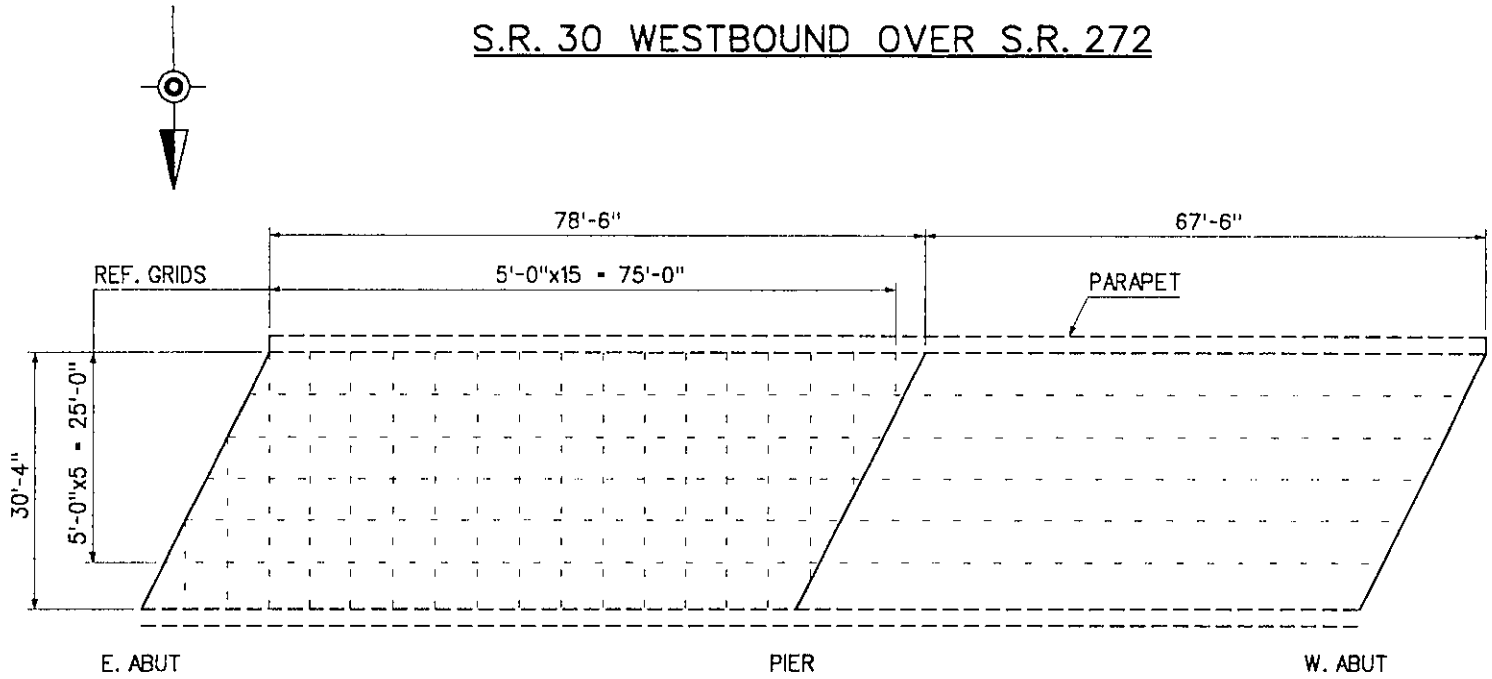


Photo 2: Bridge deck looking West.

ROUTE	STRUCTURE	DATE
30	0030-009	06/23/99

S.R. 30 WESTBOUND OVER S.R. 272



NO VISIBLE CRACKS WERE FOUND

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 30 Westbound over S.R. 272

BRIDGE DECK CRACKING
2nd Cycle

Oct 1999

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-55

Bridge Deck Survey

General Information

Bridge Name:	S.R. 30 Westbound over S.R. 272
Bridge Type:	Simply supported, Prestressed Concrete Spread Box Girders
Bridge Length:	146’-0” (deck joint to deck joint)
No. of Spans:	2 (67'-6" & 78'-5")
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 58'-6" curb to curb)
Skew:	63°-26’

Survey Information

Date:	10-05-99
Inspectors:	YWL & BA
Temperature:	65° F
Weather:	Cloudy
Humidity:	Moderate
Sun Intensity:	Low

Bridge Deck Survey

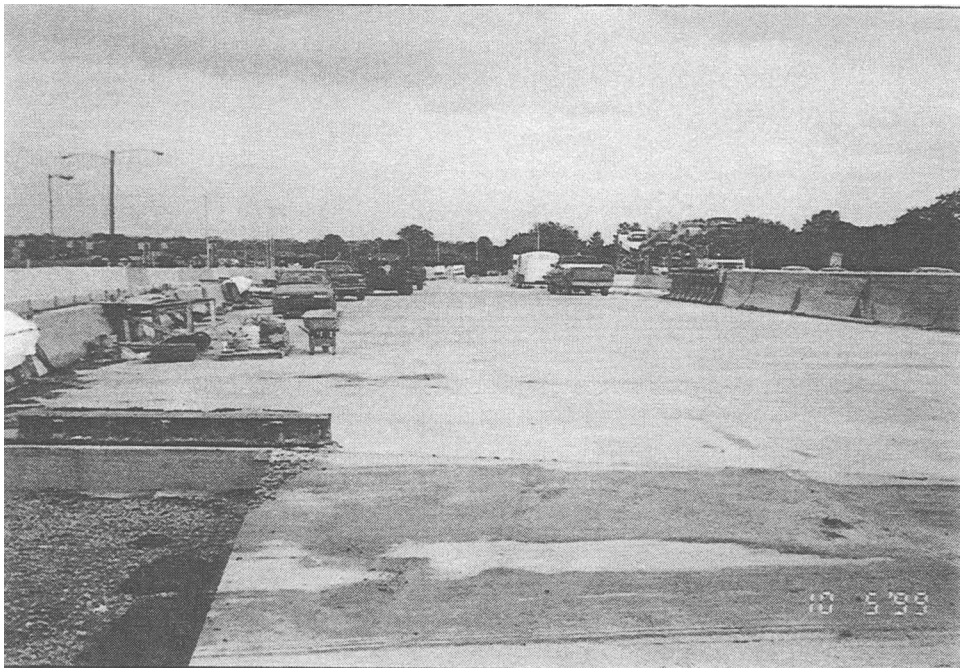


Photo 1: Bridge deck looking East.

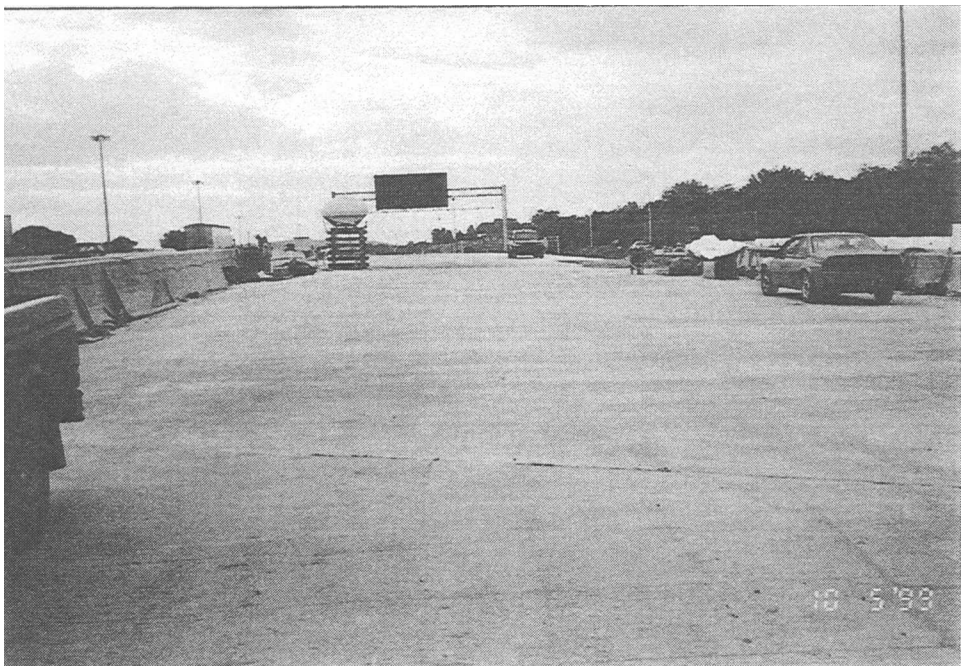
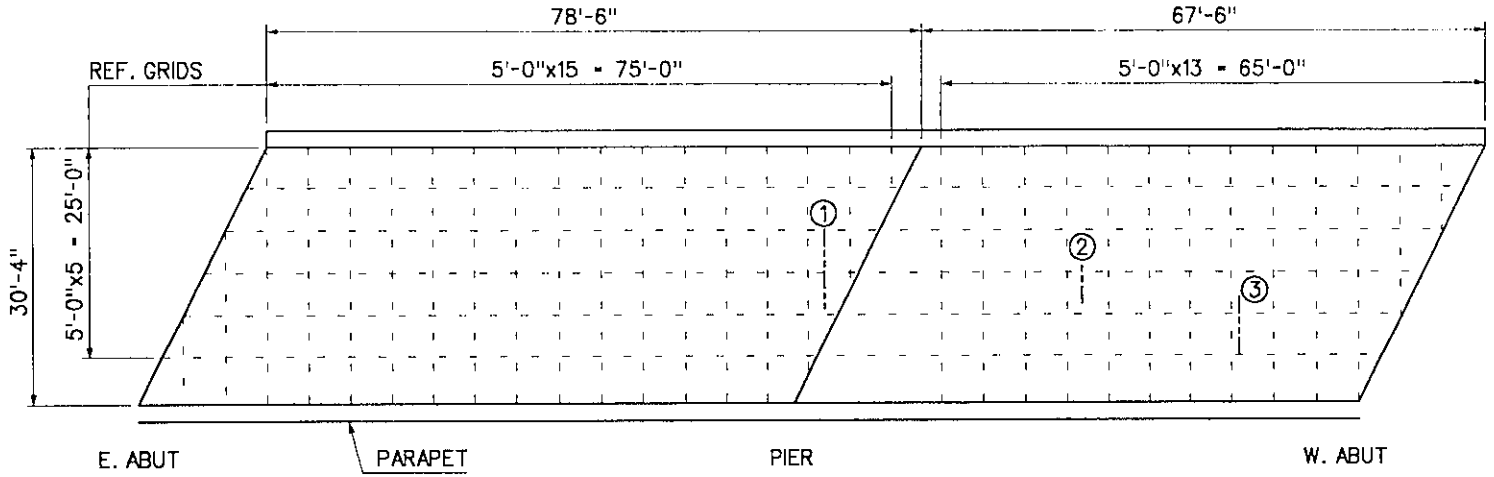


Photo 2: Bridge deck looking West.

ROUTE	STRUCTURE NO.	DATE
30	0030-009	10/05/99

S.R. 30 WESTBOUND OVER S.R. 272



DECK WAS POURED ON
06/11/99

CRACK	LENGTH (FT)	WIDTH (IN)
1	8.5	0.002
2	3.0	0.002
3	3.5	0.002

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 283 Eastbound over S.R.741

BRIDGE DECK CRACKING
1st Cycle

October 1999

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-59

Bridge Deck Survey

General Information

Bridge Name:	S.R. 283 Eastbound over S.R. 741
Bridge Type:	Simply Supported, Prestressed Concrete I-Beam, Continuous for Live Loads
Bridge Length:	250’-0” (deck joint to deck joint)
No. of Spans:	2
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 47'-6" curb to curb)
Skew:	90°

Survey Information

Date:	10-05-99
Inspectors:	YWL & BA
Temperature:	65° F
Weather:	Cloudy
Humidity:	Moderate
Sun Intensity:	Low

Bridge Deck Survey

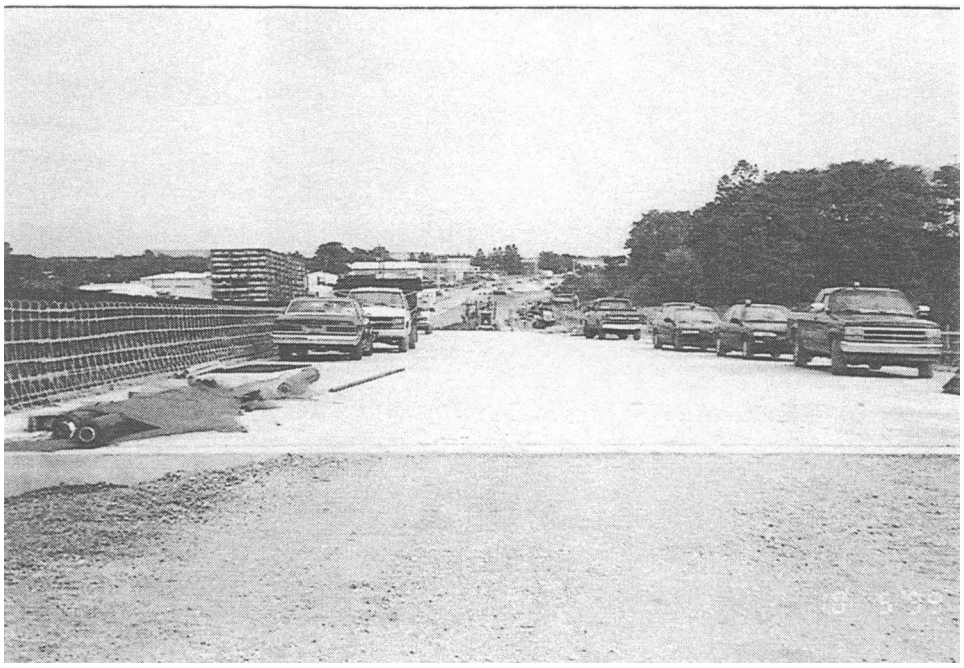


Photo 1: Bridge deck looking East.

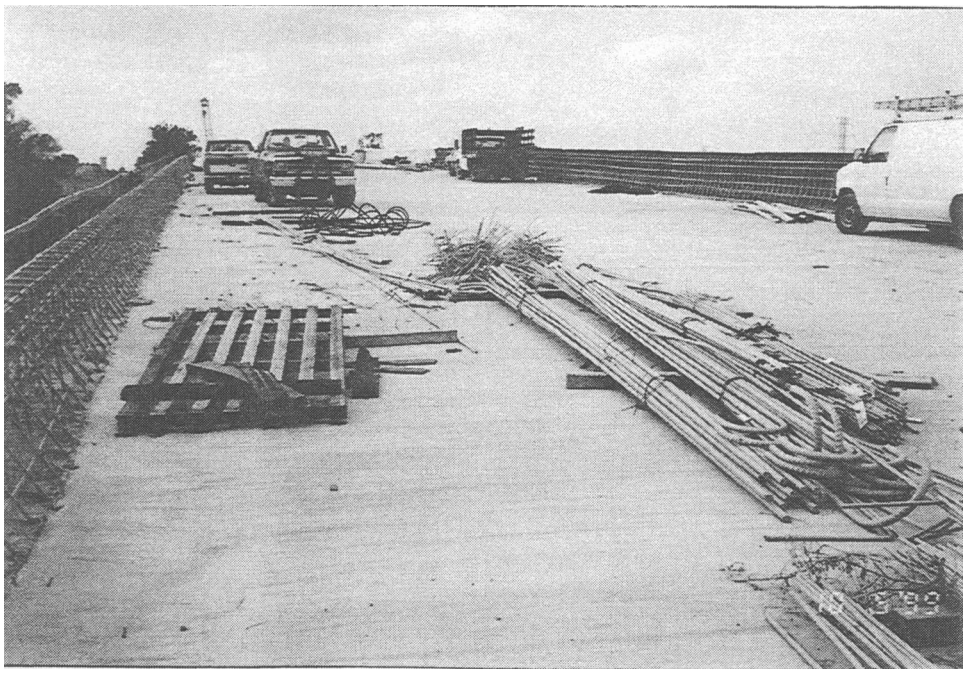
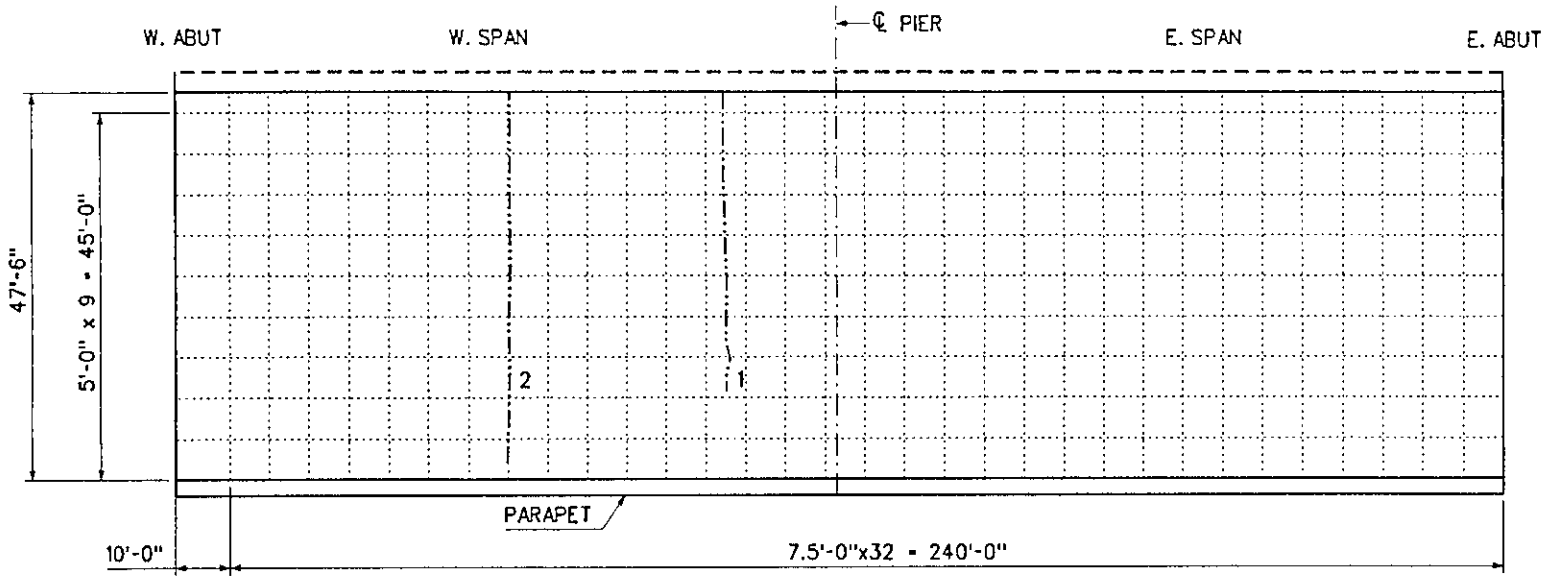


Photo 2: Bridge deck looking West.

ROUTE	CIRCLE NO.	DATE
283	2	06/07/00

S.R. 283 EASTBOUND OVER S.R. 741



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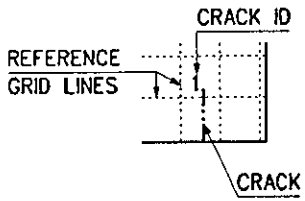


CRACK	LENGTH FT	WIDTH (IN)
1	35.0	0.013~0.016
2	42.0	0.005~0.010

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 283 Eastbound over S.R.741

BRIDGE DECK CRACKING
2nd Cycle

June 2000

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-63

Bridge Deck Survey

General Information

Bridge Name:	S.R. 283 Eastbound over S.R. 741
Bridge Type:	Simply Supported, Prestressed Concrete I-Beam, Continuous for Live Loads
Bridge Length:	250’-0” (deck joint to deck joint)
No. of Spans:	2
Shoulder Width	10'-6"
Lane Width:	12'-0" Thru-lanes & 11'-6" Ramp Lane (Roadway width 47'-6" curb to curb)
Skew:	90°

Survey Information

Date:	06-07-00
Inspectors:	PH
Temperature:	65° F
Weather:	Sunny
Humidity:	Moderate
Sun Intensity:	Low

Bridge Deck Survey

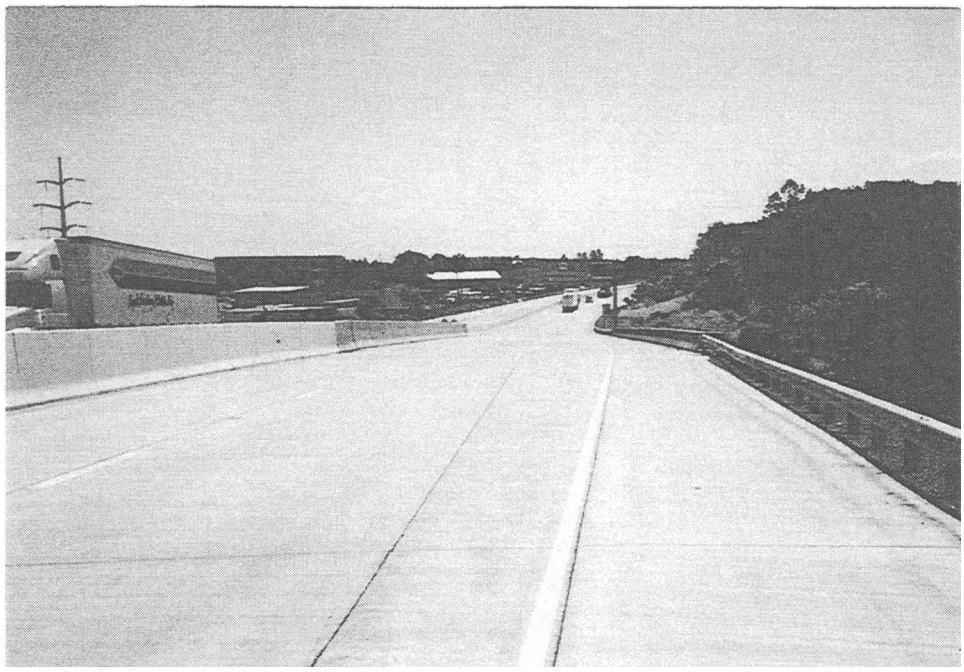


Photo 1: Bridge deck looking East.

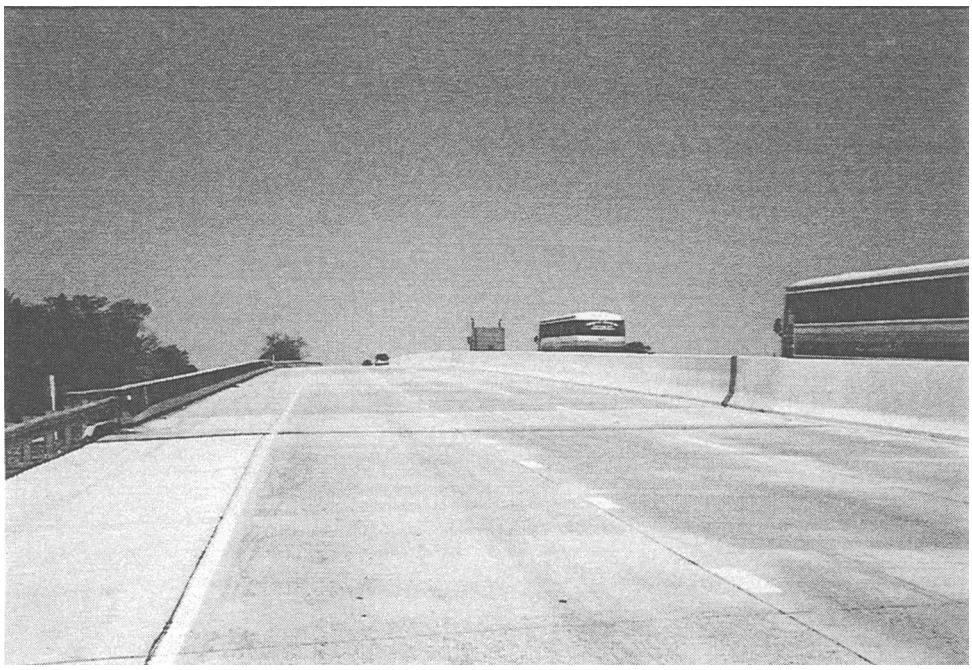


Photo 2: Bridge deck looking West.

Bridge Deck Survey

Photo 3: Bridge deck Surface looking West.

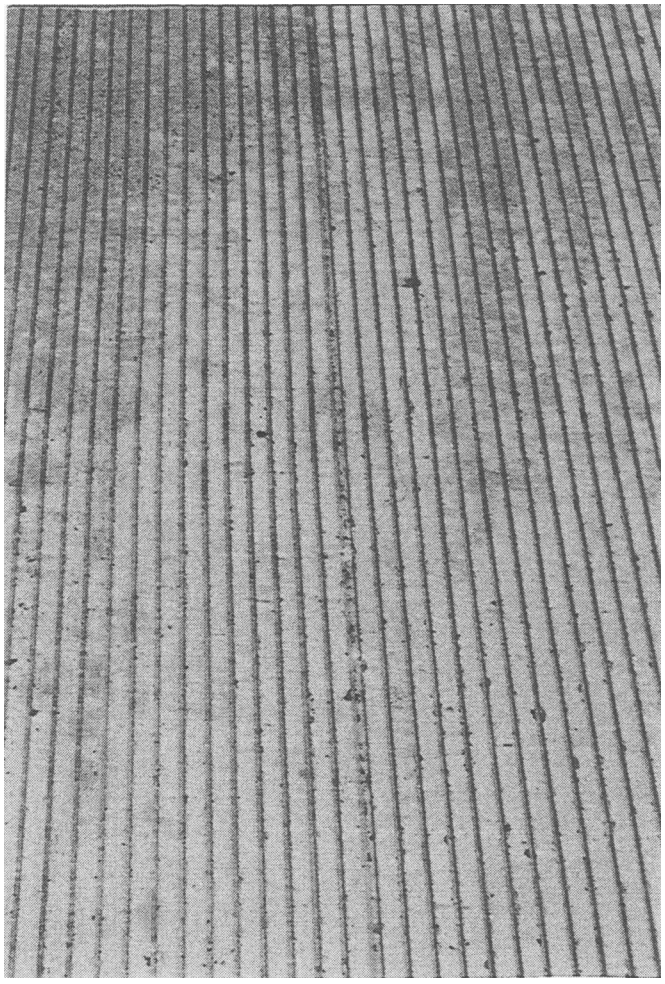
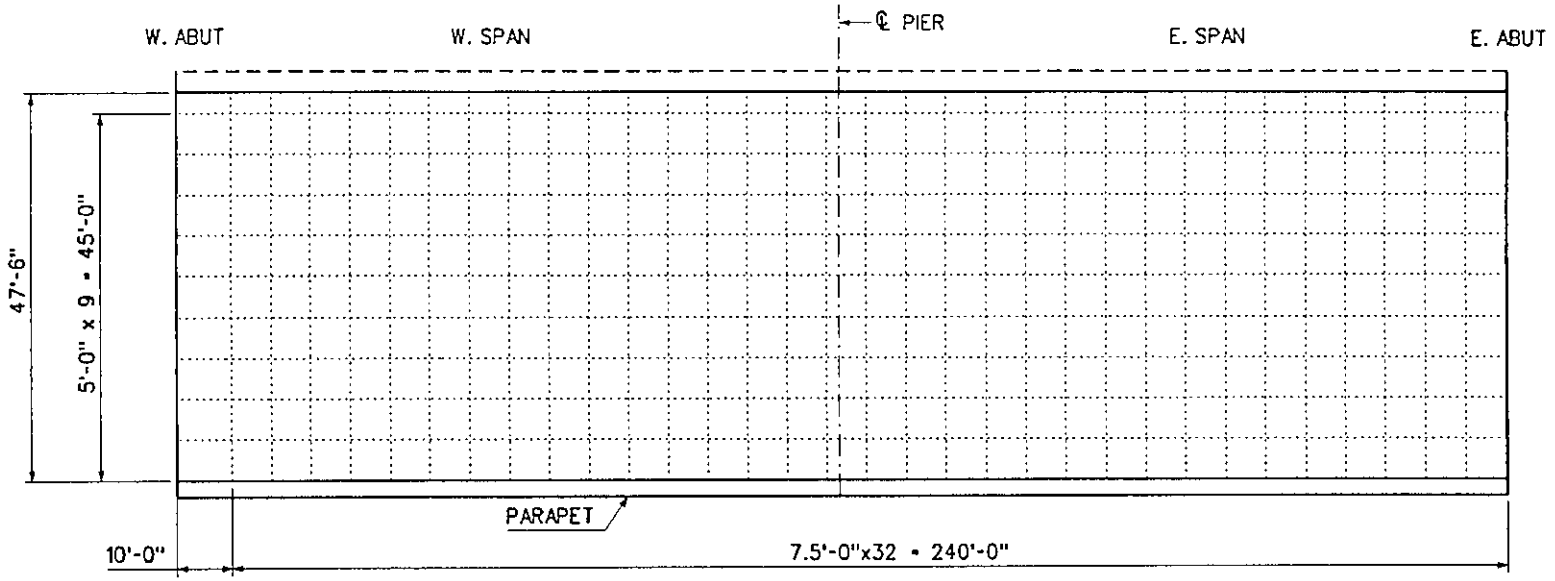


Photo 4: Fine transverse full lane width crack in the west span (arrow).

ROUTE	CIRCLE NO.	DATE
283	1	10/05/99

S.R. 283 EASTBOUND OVER S.R. 741



NO VISIBLE CRACK WAS FOUND

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 283 Westbound over S.R.741

BRIDGE DECK CRACKING
1st Cycle

September 1998

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-68

Bridge Deck Survey

General Information

Bridge Name:	S.R. 283 Westbound over S.R. 741
Bridge Type:	
Bridge Length:	250’-0” (deck joint to deck joint)
No. of Spans:	
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 35'-0" curb to curb)
Skew:	63°-26’

Survey Information

Date:	9-17-98
Inspectors:	YWL & LNH
Temperature:	85° F
Weather:	Cloudy
Humidity:	Moderate
Sun Intensity:	Low

Bridge Deck Survey

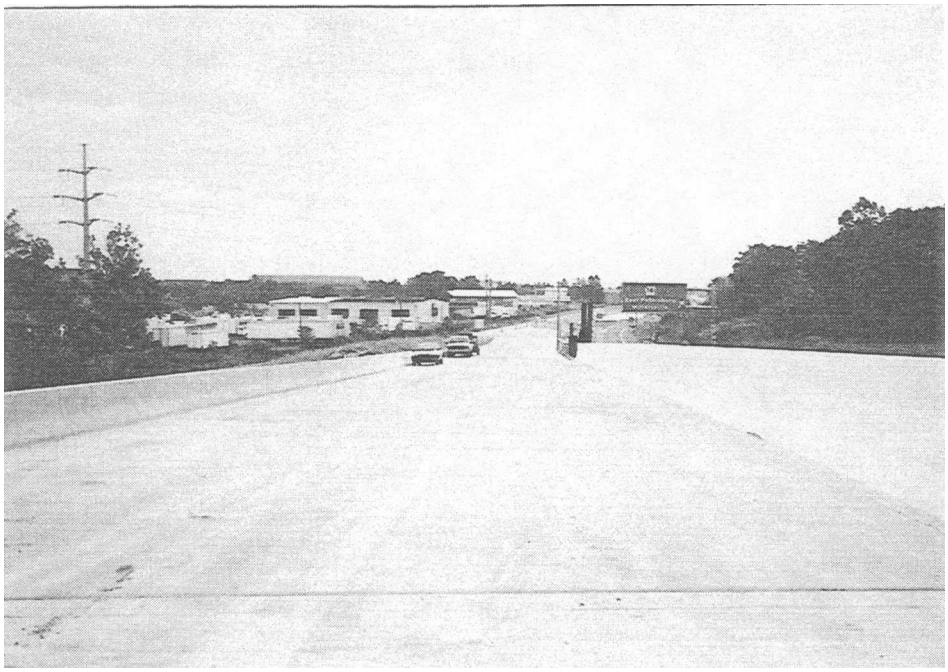


Photo 1: Bridge deck looking East.

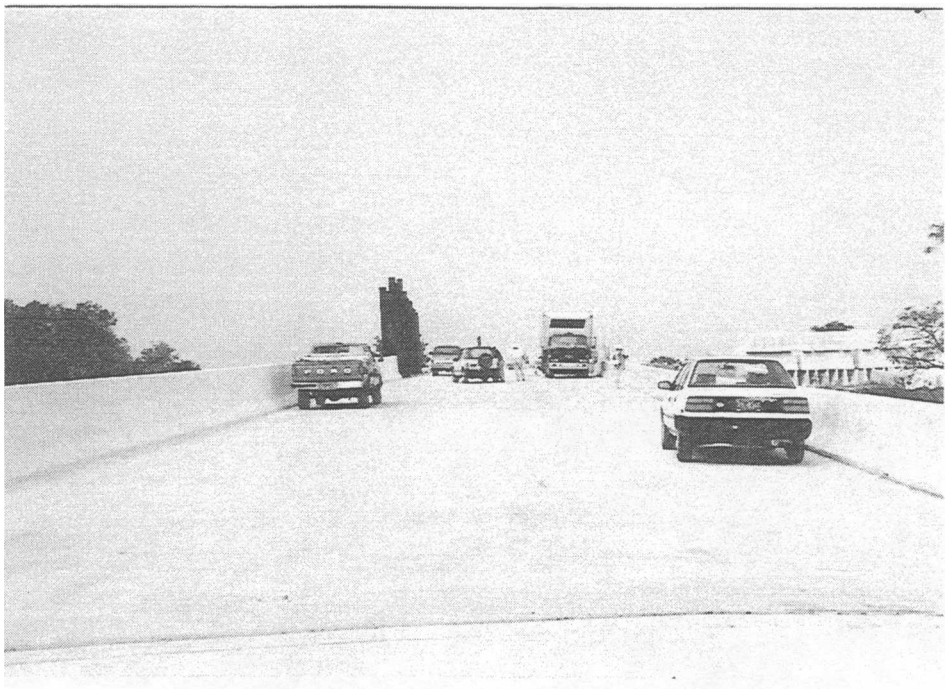


Photo 2: Bridge deck looking West.

Bridge Deck Survey

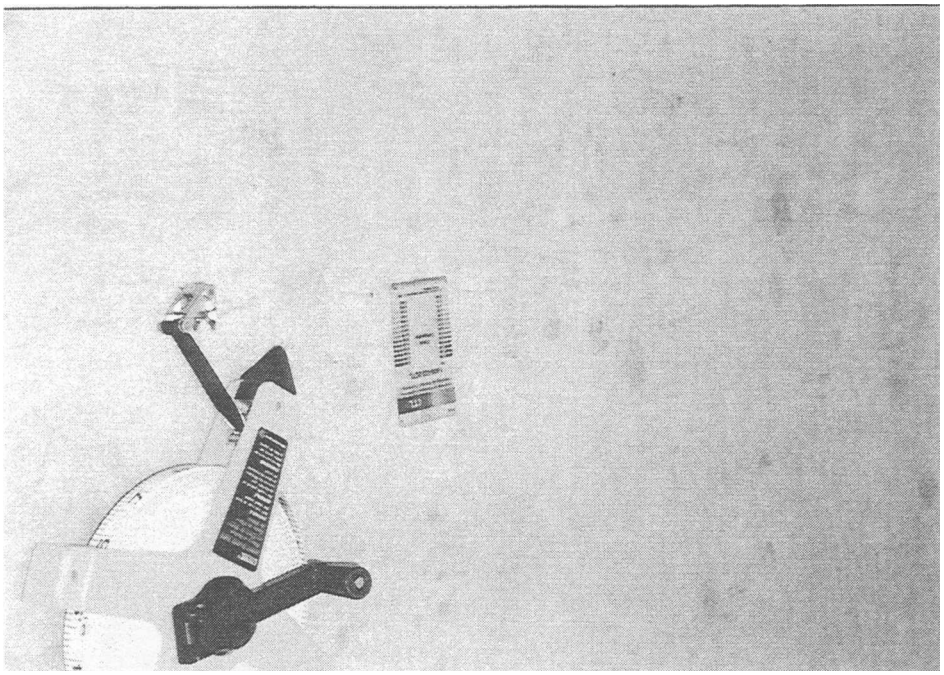
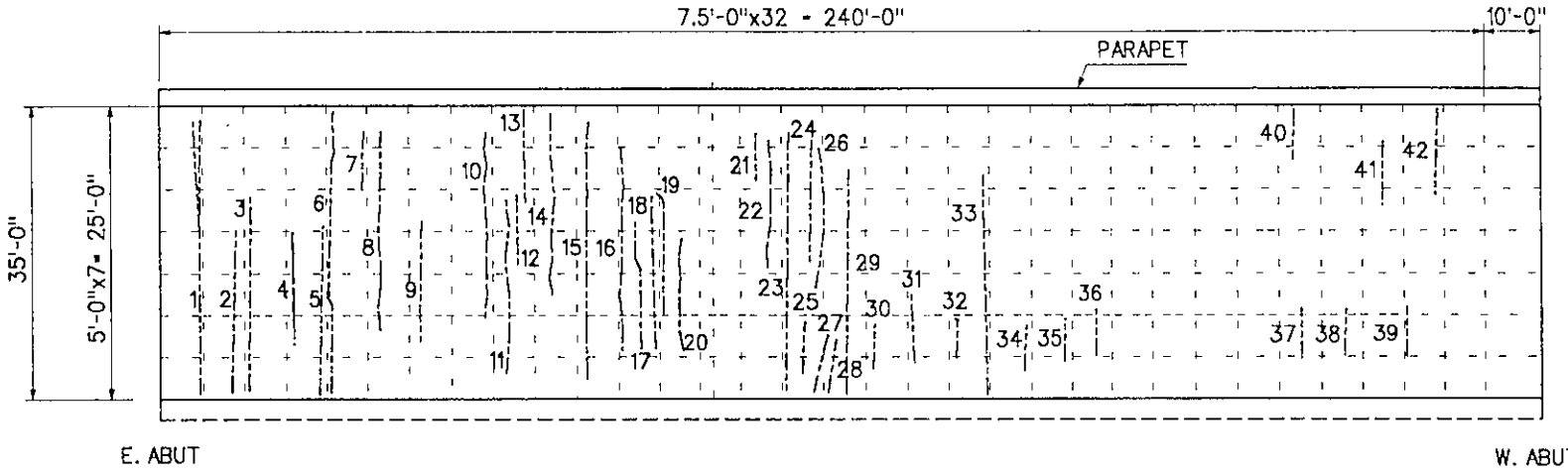


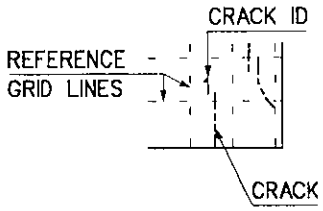
Photo 3: Bridge deck Surface

ROUTE	CIRCLE	DATE
283	1	09/17/98

S.R. 283 WESTBOUND OVER S.R. 741



LEGEND:



CRACK	LENGTH FT	WIDTH (IN)	CRACK	LENGTH FT	WIDTH (IN)	CRACK	LENGTH FT	WIDTH (IN)	CRACK	LENGTH FT	WIDTH (IN)
1	35.0	0.016	12	8.0	0.009	23	16.0	0.009	34	5.0	0.002
2	35.0	0.015	13	12.0	0.007	24	15.0	0.016	35	5.5	0.002
3	24.0	0.013	14	23.0	0.009	25	6.0	0.007	36	6.0	0.002
4	13.0	0.016	15	31.0	0.013	26	20.0	0.009	37	6.0	0.009
5	21.0	0.010	16	24.0	0.013	27	6.0	0.007	38	6.0	0.009
6	35.0	0.016	17	15.0	0.009	28	6.0	0.007	39	6.0	0.009
7	18.0	0.014	18	23.0	0.009	29	27.0	0.016	40	7.0	0.009
8	24.0	0.013	19	13.0	0.007	30	4.0	0.009	41	7.0	0.013
9	14.0	0.014	20	13.0	0.007	31	7.0	0.009	42	11.0	0.009
10	23.0	0.013	21	6.0	0.007	32	4.0	0.009			
11	21.0	0.009	22	16.0	0.007	33	27.0	0.007			

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 283 Westbound over S.R.741

BRIDGE DECK CRACKING
2nd Cycle

June 1999

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-73

Bridge Deck Survey

General Information

Bridge Name:	S.R. 283 Westbound over S.R. 741
Bridge Type:	
Bridge Length:	250’-0” (deck joint to deck joint)
No. of Spans:	
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 35'-0" curb to curb)
Skew	63º-26’

Survey Information

Date:	6-23-99
Inspectors:	YWL & BA
Temperature:	87º F
Weather:	Sunny
Humidity:	Moderate
Sun Intensity:	Intense

Note: Due to the ongoing construction of Eastbound, the westbound is currently divided into eastbound & westbound two-way traffic with construction barriers. The traffic is very heavy and there is no shoulder, the bridge deck surface can not be accessed.

Bridge Deck Survey

Photo 1: Bridge deck looking West

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 22 Section 2, Westbound Bridge over Market Street

BRIDGE DECK CRACKING
1st Cycle

June, 1999

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B–76

Bridge Deck Survey

General Information

Bridge Name:	S.R. 22 Section 2, Westbound over Market Street
Bridge Type:	Single Span Prestressed Concrete Spread Box Beams
Bridge Length:	60’-0 ” (pavement notch to pavement notch)
No. of Spans:	1
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 42'-9" curb to curb)
Skew:	90°

Survey Information

Date:	6-03-99
Inspectors:	YWL & BA
Temperature:	70° F
Weather:	Overcast
Humidity:	Moderate
Sun Intensity:	Low

Bridge Deck Survey

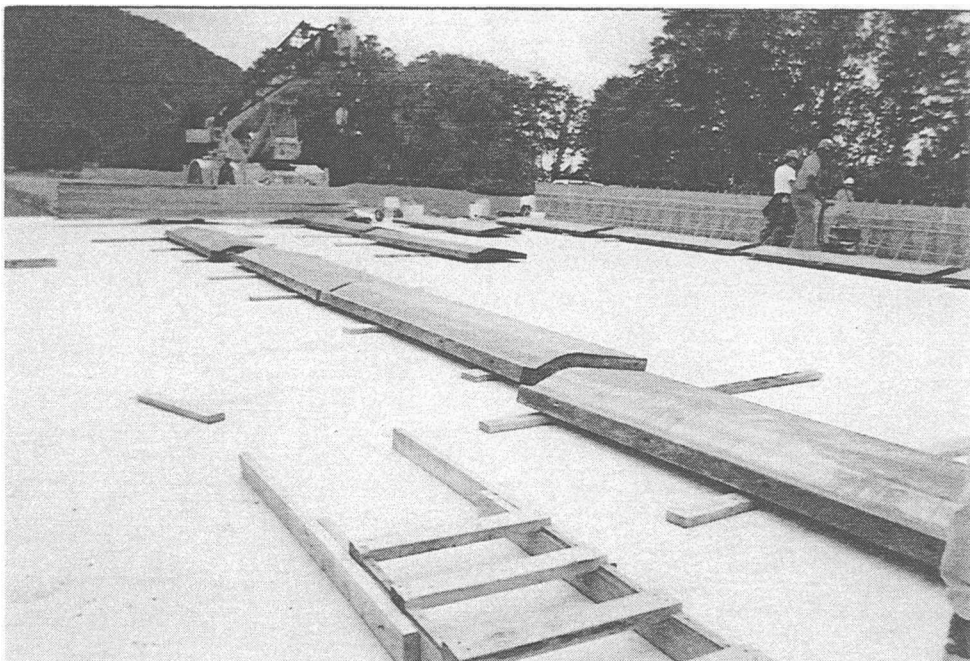


Photo 1: Bridge Deck Looking East

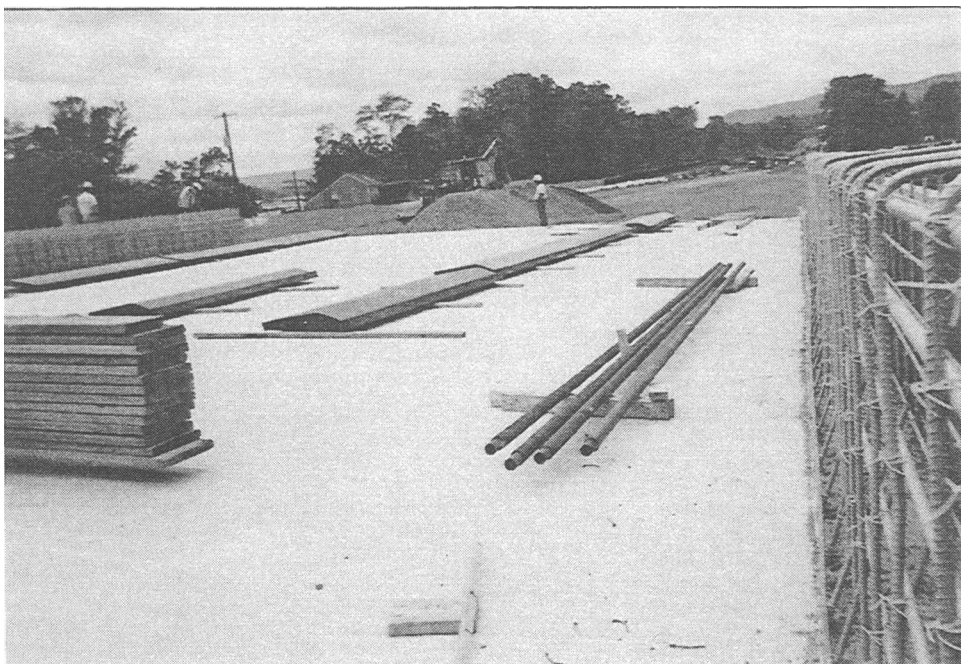
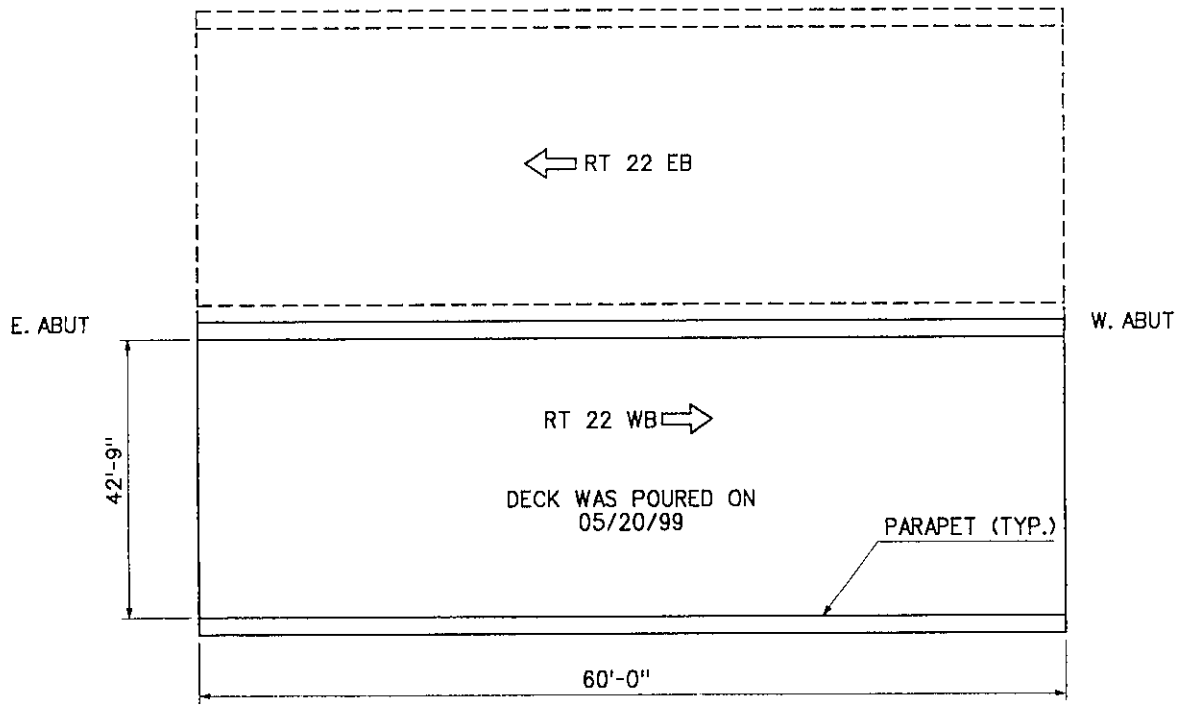


Photo 2: Bridge Deck Looking West

ROUTE	CYCLE NO.	DATE
22 WB	1	06/03/99

R.T. 22 WB OVER MARKET STREET



NO VISIBLE DECK SURFACE CRACK WAS FOUND

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 22 Section 2, Westbound Bridge over Market Street

BRIDGE DECK CRACKING
2nd Cycle

October, 1999

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B–80

Bridge Deck Survey

General Information

Bridge Name:	S.R. 22 Section 2, Westbound over Market Street
Bridge Type:	Single Span Prestressed Concrete Spread Box Beams
Bridge Length:	60’-0” (pavement notch to pavement notch)
No. of Spans:	1
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 42'-9" curb to curb)
Skew:	90°

Survey Information

Date:	10-05-99
Inspectors:	YWL & BA
Temperature:	65° F
Weather:	Overcast
Humidity:	Moderate
Sun Intensity:	Low

Bridge Deck Survey

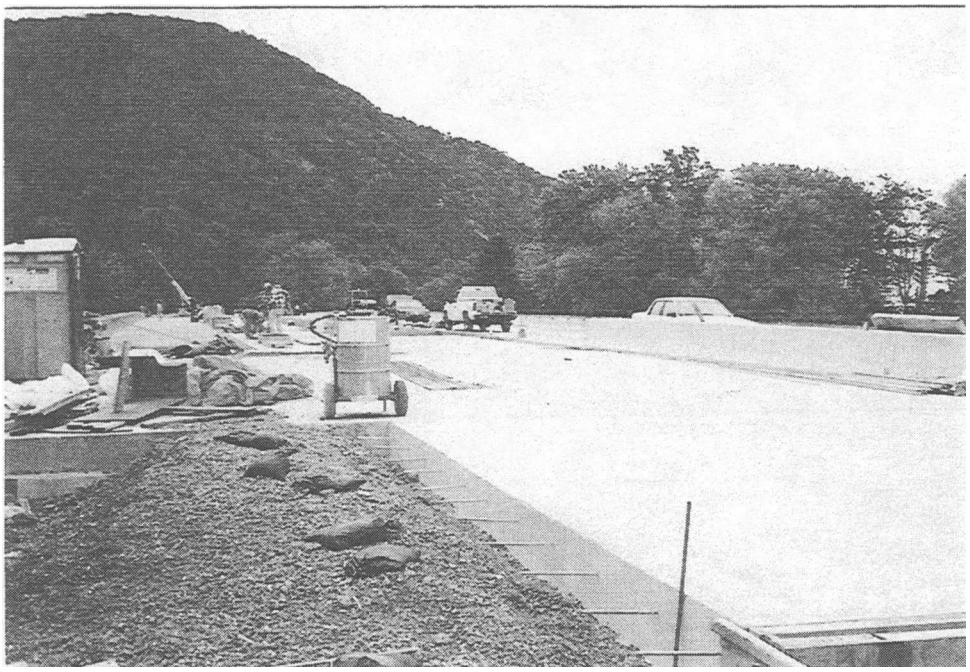


Photo 1: Bridge Deck Looking East

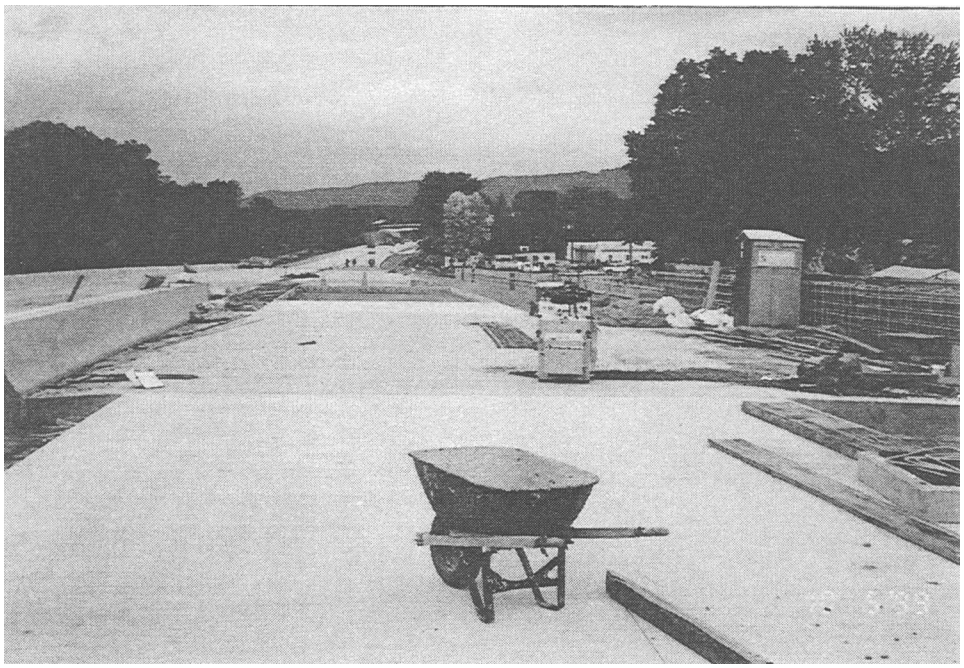
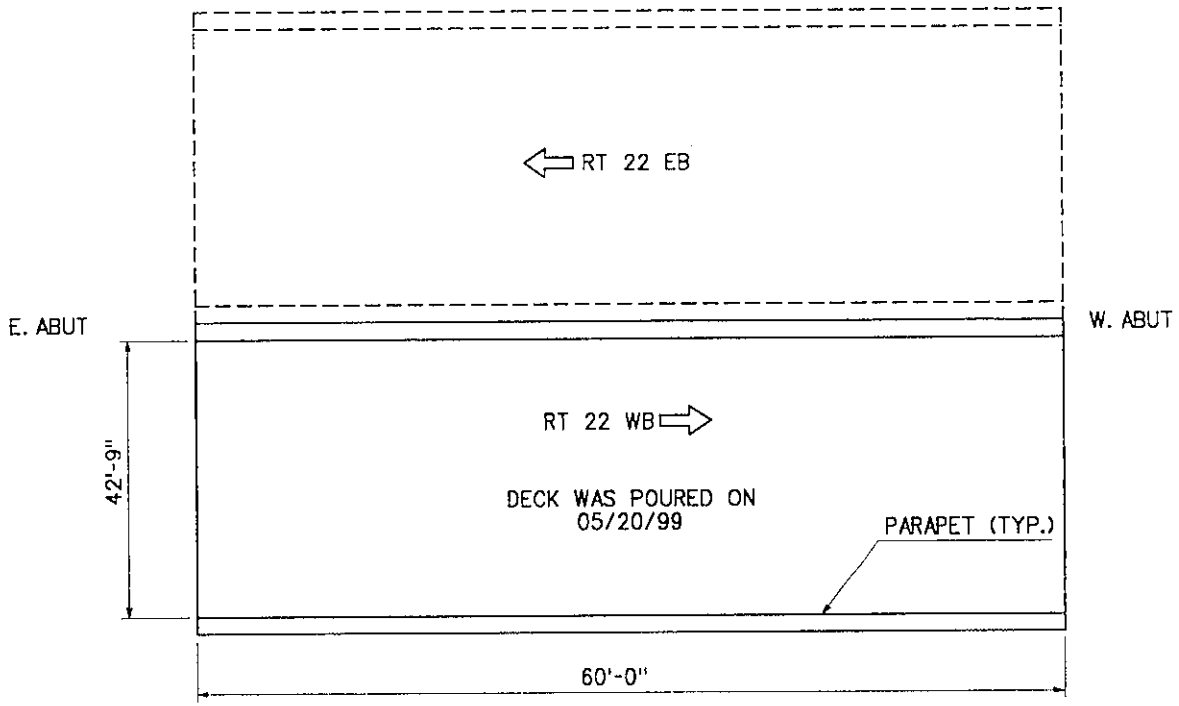


Photo 2: Bridge Deck Looking West

ROUTE	CYCLE N.	DATE
22 WB	2	10/05/99

R.T. 22 WB OVER MARKET STREET



NO VISIBLE DECK SURFACE CRACK WAS FOUND

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 22 Section 2, Eastbound Bridge over Market Street

BRIDGE DECK CRACKING
1st Cycle

May, 1999

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-84

Bridge Deck Survey

General Information

Bridge Name:	S.R. 22 Section 2, Eastbound over Market Street
Bridge Type:	Single Span Prestressed Concrete Spread Box Beams
Bridge Length:	60’-0” (pavement notch to pavement notch)
No. of Spans:	1
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 42'-0" curb to curb)
Skew:	90°

Survey Information

Date:	5-19-99
Inspectors:	YWL & BA
Temperature:	65° F
Weather:	Overcast
Humidity:	Moderate
Sun Intensity:	Low

Bridge Deck Survey

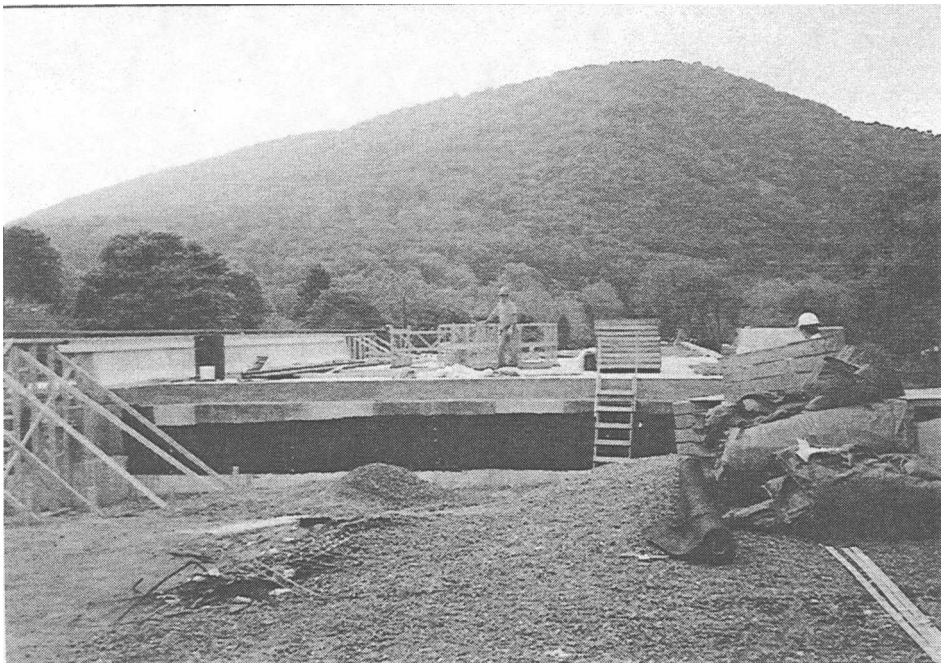


Photo 1: Bridge Deck Looking East

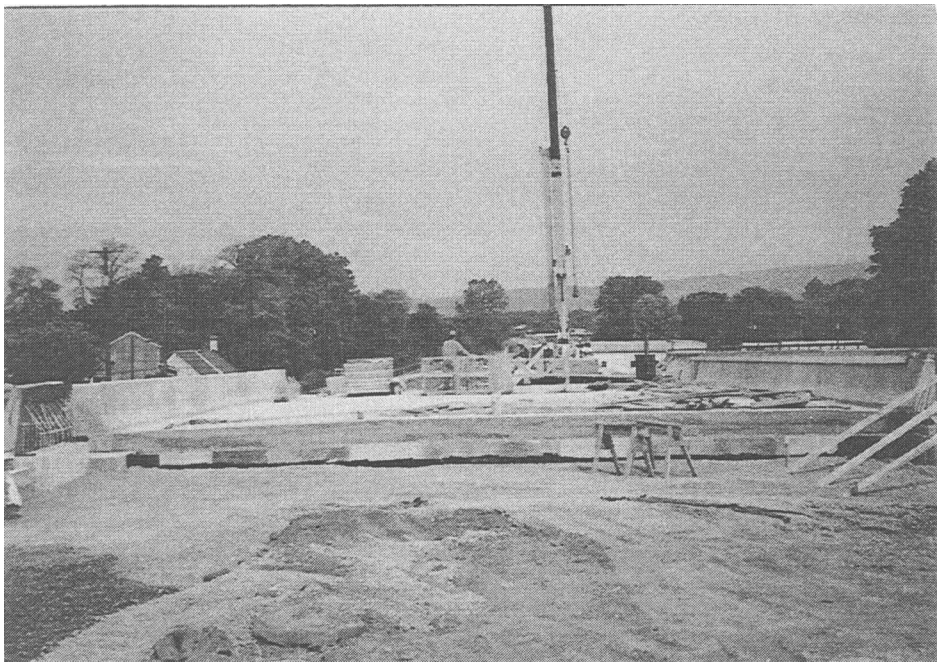
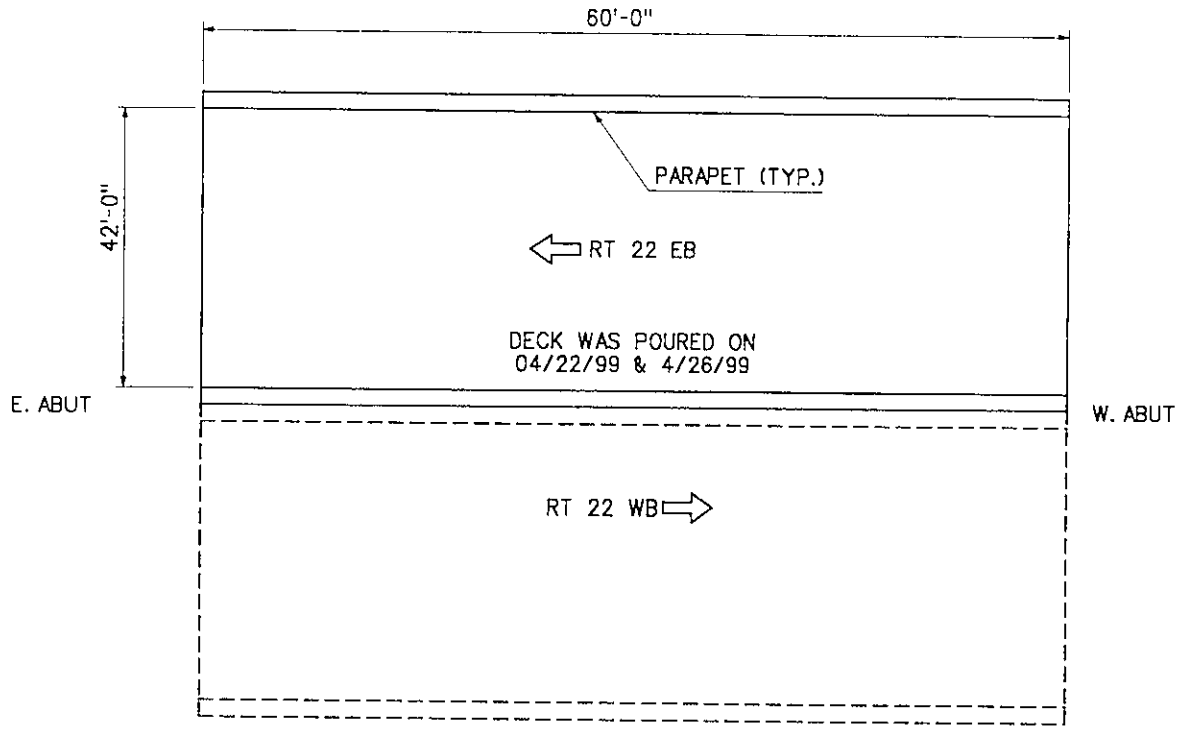


Photo 2: Bridge Deck looking West

ROUTE	CYCLE	DATE
22 EB	1	05/19/99

R.T. 22 EB OVER MARKET STREET



NO VISIBLE DECK SURFACE CRACK WAS FOUND

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 22 Section 2, Eastbound Bridge over Market Street

BRIDGE DECK CRACKING
2nd Cycle

October 1999

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-88

Bridge Deck Survey

General Information

Bridge Name:	S.R. 22 Section 2, Eastbound over Market Street
Bridge Type:	Single Span Prestressed Concrete Spread Box Beams
Bridge Length:	60’-0”(pavement notch to pavement notch)
No. of Spans:	1
Shoulder Width:	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 42'-0" curb to curb)
Skew:	90°

Survey Information

Date:	10-05-99
Inspectors:	YWL & BA
Temperature:	65° F
Weather:	Overcast
Humidity:	Moderate
Sun Intensity:	Low

Bridge Deck Survey

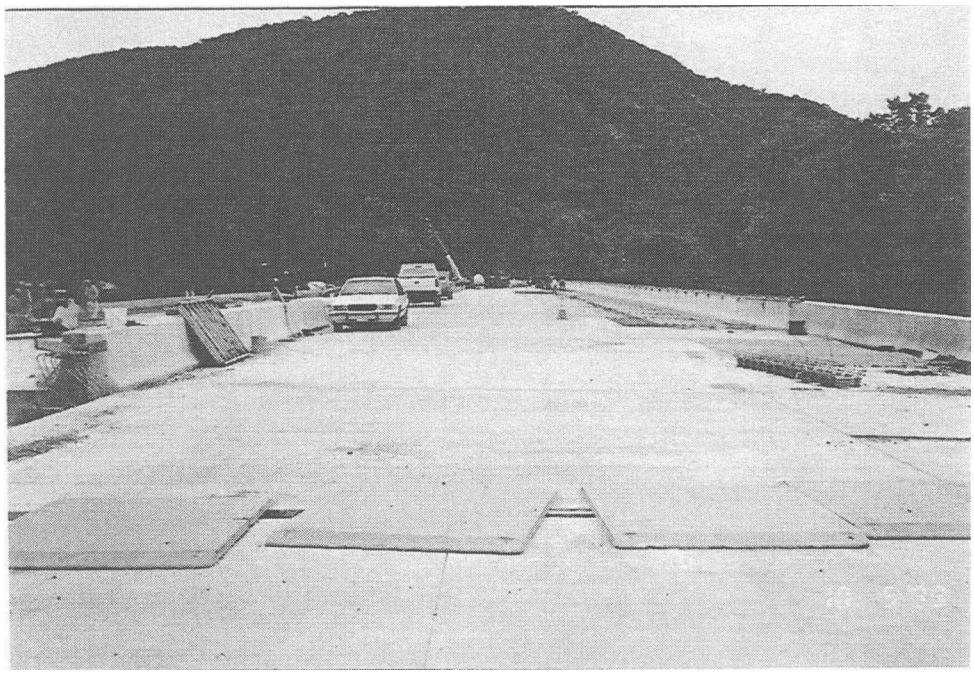
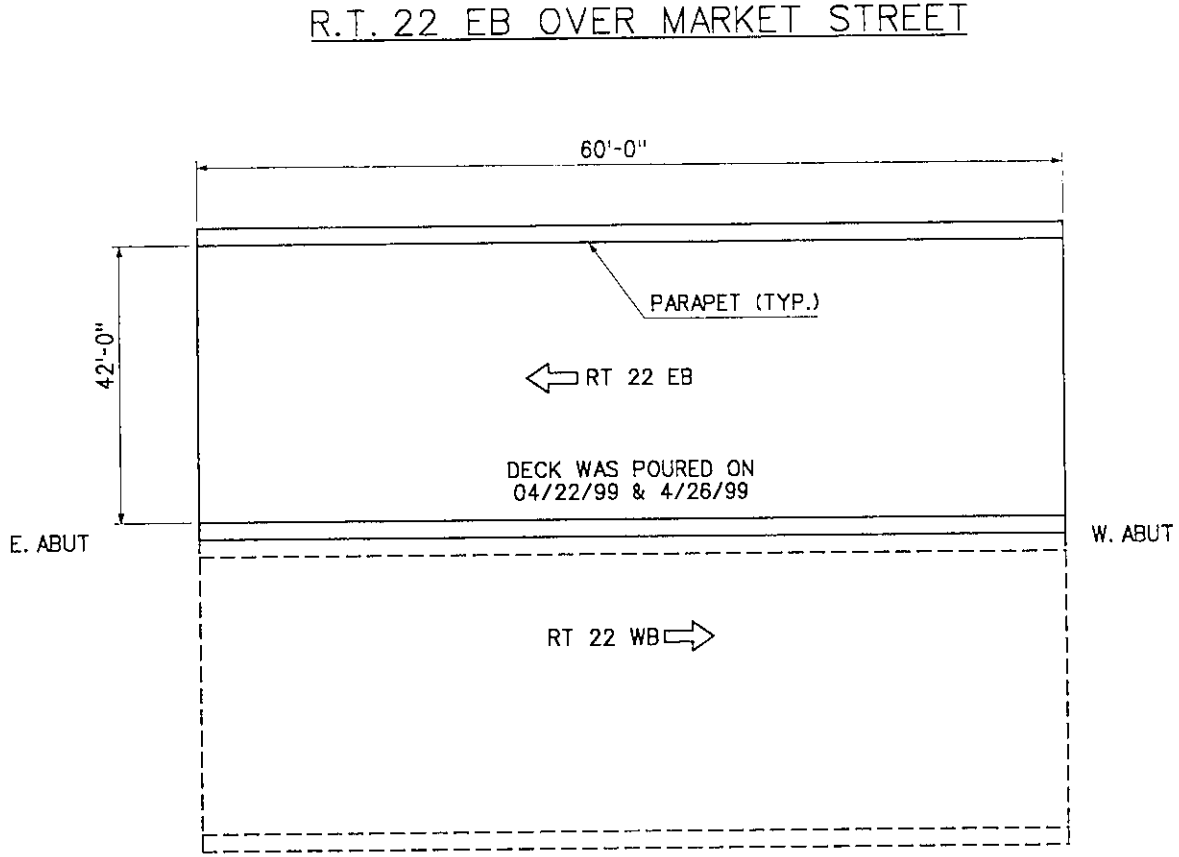


Photo 1: Bridge Deck Looking East

ROUTE	CYCLE No.	DATE
22 EB	2	10/05/99

R.T. 22 EB OVER MARKET STREET



NO VISIBLE DECK SURFACE CRACK WAS FOUND

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 322 Westbound at Sta. 88+87

BRIDGE DECK CRACKING
1st Cycle

February 1999

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-92

Bridge Deck Survey

General Information

Bridge Name:	S.R. 322 Westbound at Sta. 88+87
Bridge Type:	Four Span Composite Prestressed Concrete Girders
Bridge Length:	434'-6" (deck joint to deck joint)
No. of Spans:	4
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 42'-6" curb to curb)
Skew:	70° ±

Survey Information

Date:	2-18-99
Inspectors:	PH & GH
Temperature:	45° F
Weather:	Sunny
Humidity:	Humid
Sun Intensity:	Moderate

Note: The first cycle survey was performed on 6-25-98, but we located a wrong bridge.

Bridge Deck Survey

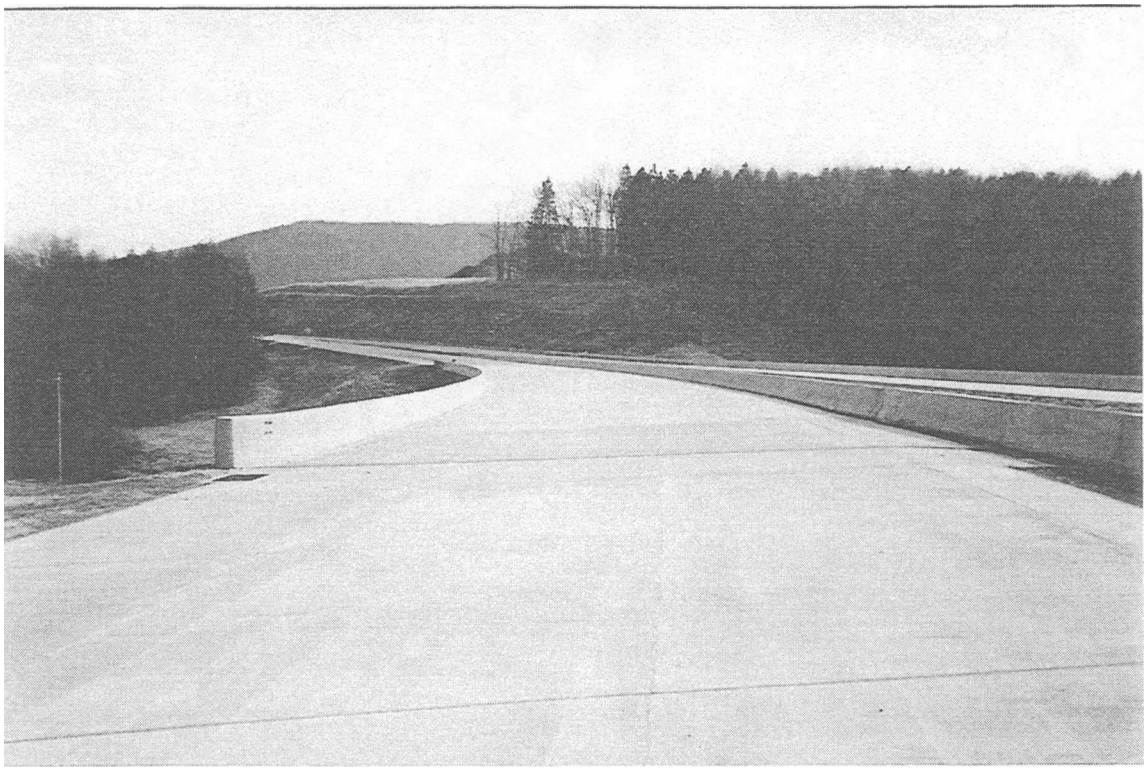


Photo l: Bridge Deck Looking East

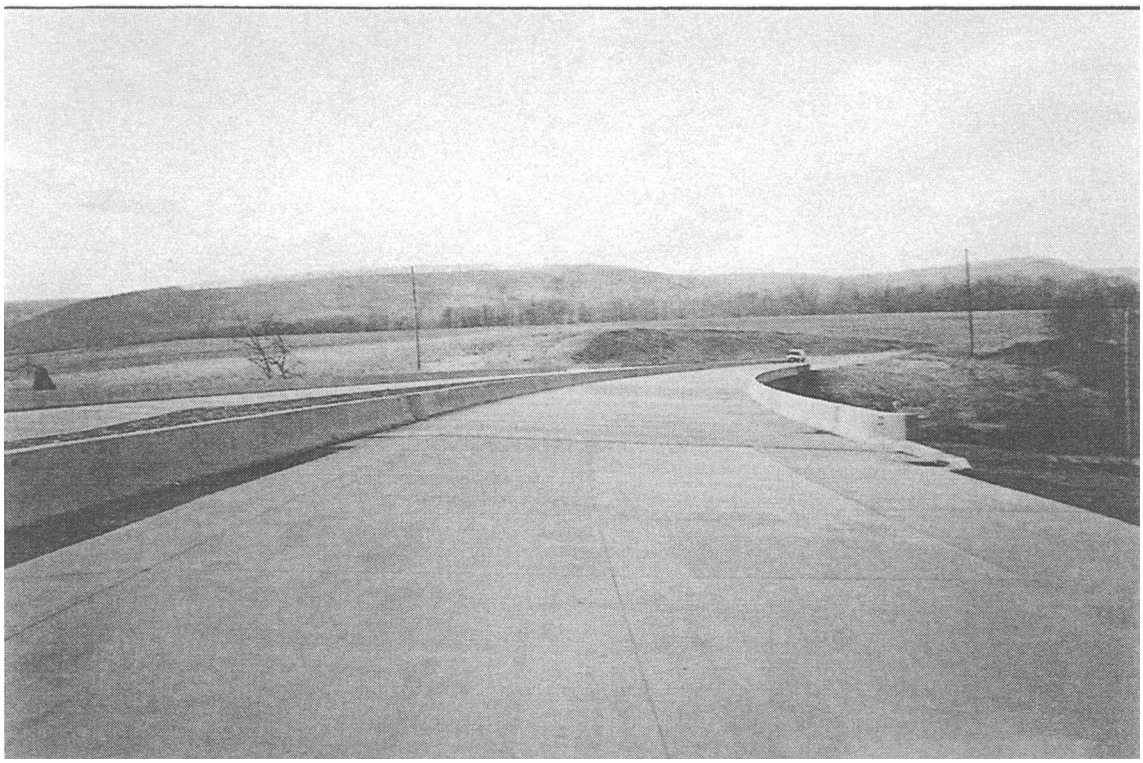
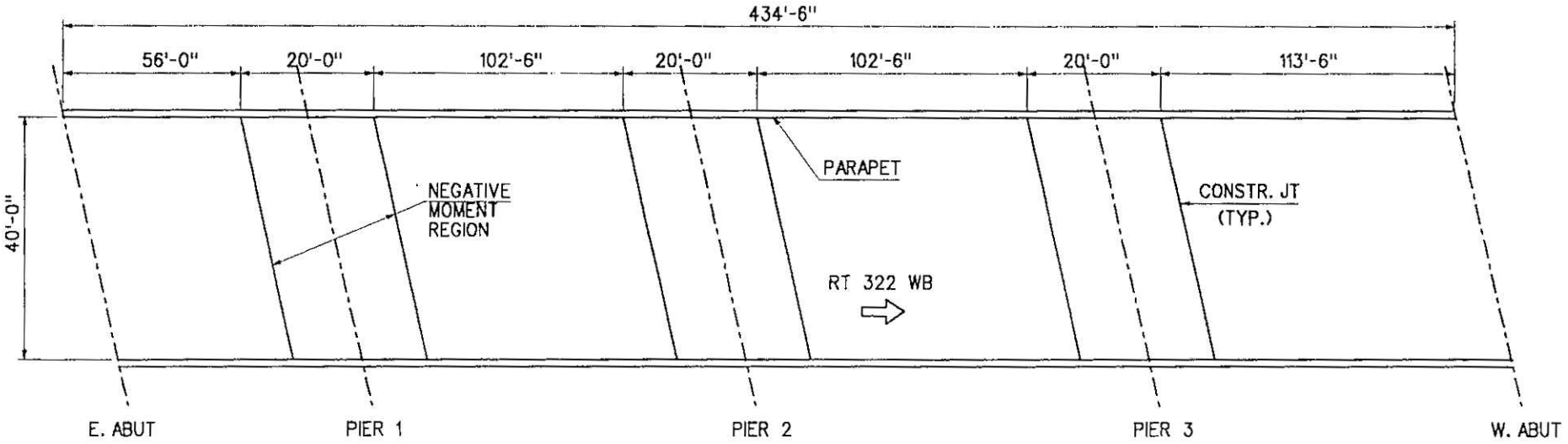


Photo 2: Bridge Deck Over Looking West

ROUTE	CYCLE #	DATE
322	1	2/18/99

R.T. 322 WB AT STA. 88+87



DECK WAS POURED ON
6/3/98

NO VISIBLE DECK SURFACE CRACK WAS FOUND

PA DEPARTMENT OF TRANSPORTATION

Materials-Related Forensic Analysis and Product Evaluation
PennDOT Research Project No. 96-09

S.R. 322 Westbound at Sta. 88+87

BRIDGE DECK CRACKING
2nd Cycle

May 1999

Prepared by
FONG & ASSOCIATES, INC.
King of Prussia, PA

for

VALLEY FORGE LABORATORIES, INC.
Devon, PA

B-96

Bridge Deck Survey

General Information

Bridge Name:	S.R. 322 Westbound at Sta. 88+87
Bridge Type:	Four Span Composite Prestressed Concrete Girders
Bridge Length:	434’-6” (deck joint to deck joint)
No. of Spans:	4
Shoulder Width	N/A (Unmark)
Lane Width:	N/A (Unmark, roadway width 42'-6" curb to curb)
Skew:	70° ±

Survey Information

Date:	5-19-99
Inspectors:	YWL & BA
Temperature:	65° F
Weather:	Overcast
Humidity:	Humid
Sun Intensity:	Moderate

Bridge Deck Survey

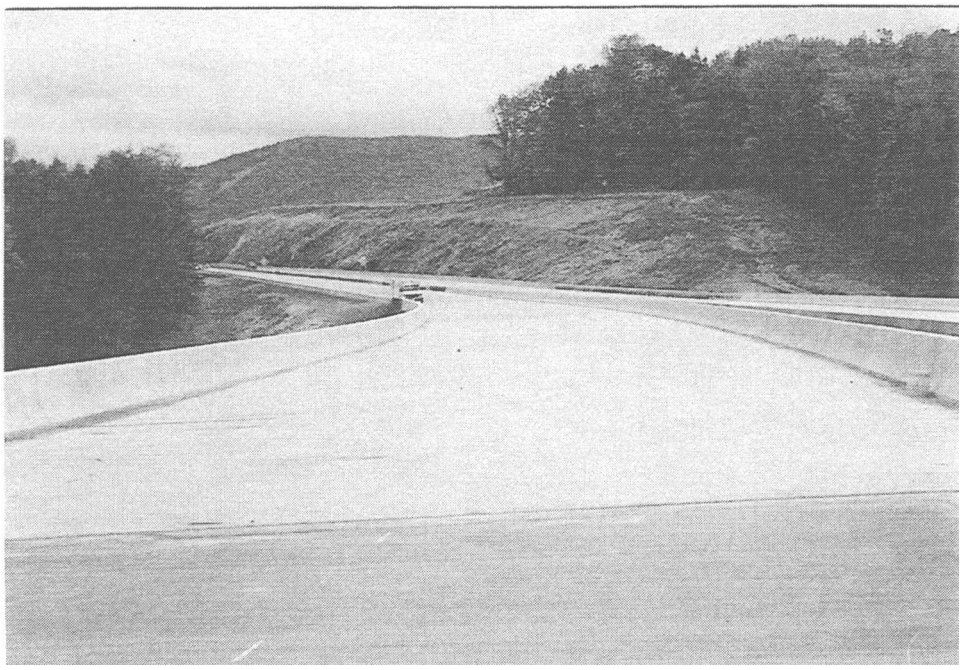


Photo l: Bridge Deck Looking East

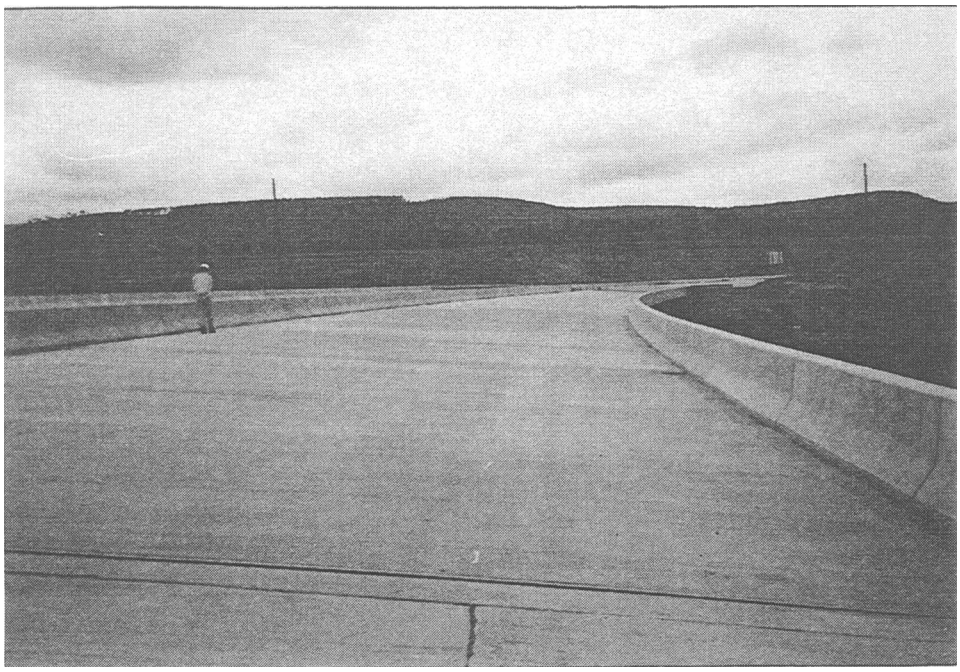
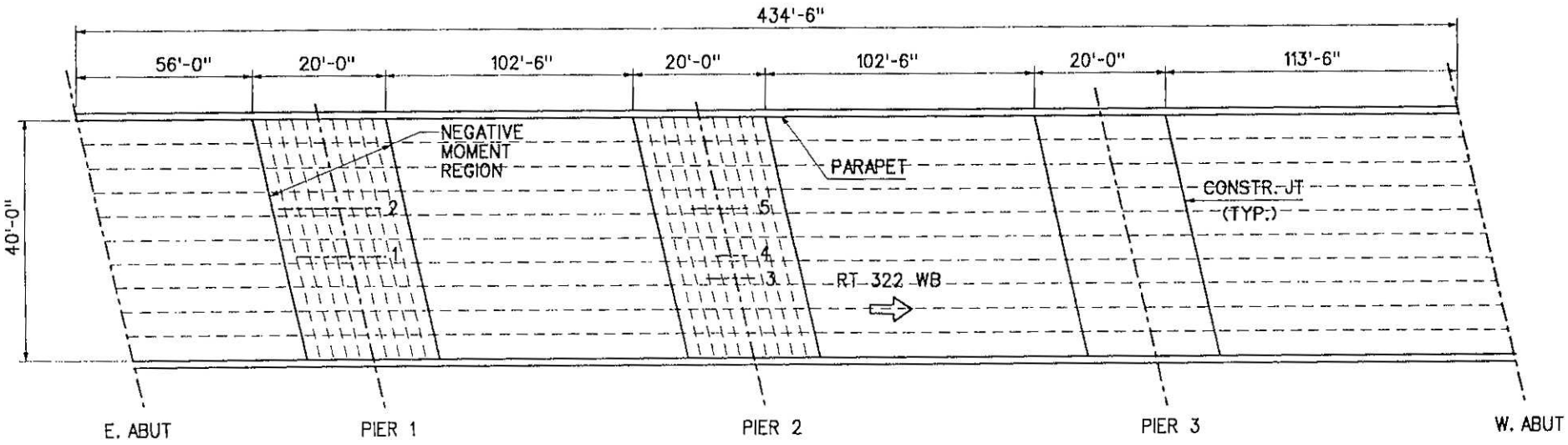


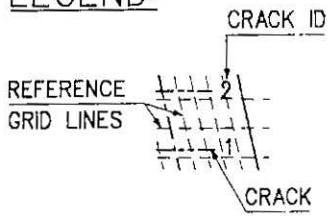
Photo 2: Bridge Deck Over Looking West

ROUTE	CYCLE	DATE
322	2	5/19/99

R.T. 322 WB AT STA. 88+87



LEGEND:



CRACK	LENGTH (FT)	WIDTH (IN)
1	14.0	0.003
2	16.0	0.003
3	7.0	0.003
4	5.0	0.003
5	6.0	0.003