Field Evaluation of Class A Subbase Using Fly Ash

Final Report for MLR-87-3

October 1988

Highway Division

Iowa Department of Transportation

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Final Report
for
MLR-87-3

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October 1988

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DISCLAIMER

ACKNOWLEDGEMENT

The author wishes to thank the contractor, Fred Carlson Co., Inc., of Decorah, Iowa for their efforts and cooperation during the course of this project.

The author also wishes to extend a note of special appreciation to the construction and materials personnel who put forth an extra effort to complete the extra record keeping, sampling and testing required by this project.

ABSTRACT

This project consisted of slipforming a 4-inch thick econocrete subbase on a 6-mile section of US 63. The project location extends south from one mile south of Denver, Iowa to Black Hawk County Road C-66 and consisted of the reconstruction and new construction of a divided four-lane facility. The econocrete was placed 27.3 feet wide in a single pass.

Fly ash was used in this field study to replace 0, 30, 45 and 60 percent of the portland cement in three portland cement econocrete base paving mixes. The three mixes contained 300, 350 and 400 pounds of cementitious material per cubic yard. Two Class "C" ashes from Iowa approved sources were used. The ash was substituted on the basis of one pound of ash for each pound of cement removed.

The work was done October 6 through October 29, 1987 and May 25 through June 9, 1988. The twelve subbase mixes were placed in sections 2500 to 3000 feet in length on both the north and southbound roadways.

Compressive strengths of all mixes were determined at 3 and 28 days of age. Flexural strengths of all mixes were determined at 7 and 14 days. In all cases strengths were adequate.

The freeze/thaw durability of the econocrete mixes used was reduced by increased fly ash levels but remained above acceptable limits.

The test results demonstrate the feasibility of producing econocrete with satisfactory properties even using fly ash at substitution rates up to 45 percent.

INTRODUCTION

Econocrete is a low portland cement content concrete designed for specific strength levels, applications and environments. Econocrete in this study is being utilized as a Class "A" subbase. Presently, the Iowa specifications relating to this subbase call for 400 pounds of cement per cubic yard with no fly ash substitution allowed. Econocrete has been allowed as an alternate subbase section since 1975 in Iowa. Prior to 1984, 300 pounds of cement per cubic yard were required. Both the econocrete specification and the cement treated granular subbase specification were changed to 400 pounds of cement per cubic yard in 1984. The reason for the change was the inconsistency in consolidation of the cement treated granular subbase. At 400 pounds, the mixture could be consolidated by roller to the needed density for durability. No problems with the 300 pound cement factor in econocrete were experienced. However, the cement factor was changed to match that of the cement treated aggregate subbase.

The purpose of using an econocrete subbase is to provide a uniform, stable and permanent support for the subsequent pavement. Econocrete can also reduce or eliminate joint faulting, increase the subgrade support (K) and prevent the pumping of fine grained soils.

OBJECTIVES

The objective of this study is to determine if it is possible to decrease the cost of Class "A" subbase while maintaining the required physical properties.

Reducing the cementitious material content, increasing the fly ash substitution rates or a combination of both, were investigated as a means of achieving the cost reductions.

PROJECT DESCRIPTION

In the study, mixes containing 300, 350 and 400 pounds of cementitious material per cubic yard were examined with fly ash substitution rates of 0, 30, 45 and 60 percent by weight.

The project is located in Black Hawk County, just north of Waterloo, Iowa on US 63. The reconstruction and new construction ran from one mile south of Denver, Iowa to Black Hawk County Road C-66, a length of approximately 6 miles. The placement of the subbase was performed during two separate periods. The first ran from October 6 to October 29, 1987 and the second ran from May 25 to June 6, 1988. One 2500 to 3000 foot section of each mix was placed during each period.

The subbase was placed by a conventional pcc paver on a natural subgrade. The specified slump and air content were 1/2 inches to 2 inches and 5% to 9% respectively.

The following materials were used on the project (the test reports are in Appendix A):

1. The fly ashes, one from Council Bluffs and one from Ottumwa, were both Class "C" and were substituted on the basis of one pound of ash for each pound of cement removed.

2. The cement was Type I. The cement was supplied by Northwestern States in 1987 and by Lehigh Cement Company in 1988.

3. The air entraining agent was CSC Air-Double Strength (neutralized vinsol resin)

4. The water reducer was Sika Chemical Co.'s Plastocrete 161.

5. The coarse aggregate was from Basic Materials Corp.'s Raymond-Pints Quarry, A07002.

6. The fine aggregate was from Basic Materials Corp.'s Waterloo Sand Pit, A07504.

The aggregates were combined in a 60% coarse/40% fine ratio. The following combined gradation limits were used:

Sieve No.	% Passing
1"	100
3/4"	90-100
1/2"	76-92
3/8"	60-85
No.4	42-67
No.8	30-53
No.30	14-32
No.200	4-7

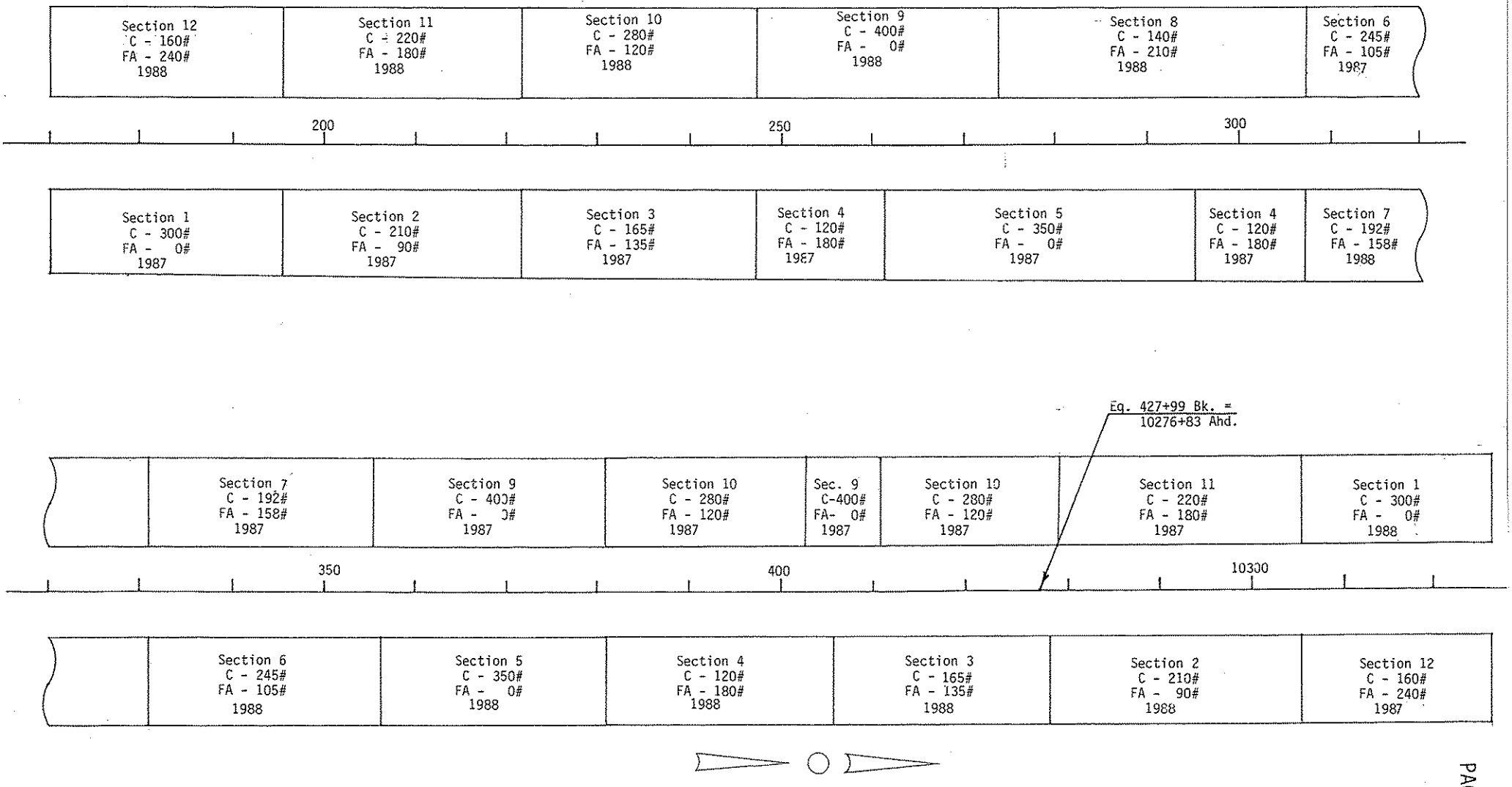
The layout of the twelve mixes used is shown in Figure 1.

All measurement of slump and air content and all sample preparation was done in the field.

Six 4 1/2" x 9" compressive strength test cylinders and four 6" x 6"x 20" flexural strength test beams were taken from each mix placement each year. The cylinders were tested at 3 and 28-days of age and the beams were tested at 7 and 14-days of age using center point loading.

Four durability beams were taken from mixes 1, 4, 5, 8, 9 and 12 in 1987 and from mixes 2, 3, 6, 7, 10 and 11 in 1988.

Figure 1 Test Section Layout



CONSTRUCTION

The contractor on this project was Fred Carlson Co., Inc. of Decorah, Iowa. The bid for the entire paving project was $6,024,999 with a bid price for the subbase component of $881,964 ($4.30/sq yd).

A Rex batch plant was set up approximately two miles north of the south end of the project. A conventional Rex paver was used to place base 4 inches thick and 27.3 feet wide in a single pass.

The first half of the subbase was placed during October 1987. The daily temperatures during this period were seasonal with lows in the 20's and 30's and highs in the 50's to low 70's. Cold weather protection was utilized as needed and consisted of covering the subbase with a single layer of burlap. The second half was placed from late May to early June 1988. The temperatures during this period were somewhat above normal with lows in the 50's and 60's and highs from the low 70's to the mid 90's. Conditions during this later period were very dry due to an extreme shortage of late spring and early summer rain.

The method of curing the in-place subbase was the standard white pigmented curing compound. The compound was placed using a full width spraying cart immediately following the completion of the hand finishing. The pavement over the subbase was 9 1/2 inch thick doweled, jointed pcc. The specifications allowed the contractor to place pavement the day following the subbase placement. Due to the

contractor's schedule, no pavement was placed over subbase that had cured less than 7 days.

Two of the primary concerns of this project in relation to the construction practices were:

1. How would the high percentage fly ash mixes move through the paver?

2. Would there be problems with finishing the work behind the paver?

The contractor experienced no problems in relation to either of these concerns. Photographs of the construction are in Appendix B.

RESULTS

The results are shown in Tables 1 and 2. Table 1 includes data from samples taken in 1987 and Table 2, the data from 1988.

TABLE 1
1987 Test Results

MIX NO.	CEMENT LBS.	FLY ASH LBS.	AVG W/C RATIO	SLUMP IN.	AIR CONTENT (%)	COMPRESSIVE STR. 4.5"X9"CYL. 3-DAY	28-DAY	(PSI) CORES 28-DAY	FLEX. STR. (PSI) 6"X6"X20" BEAM 7-DAY	14-DAY	DUR. FACTOR (%)	REMARKS
1	300	0	0.90	1.50	8.0	1380	2710	1970	410	510	93	C.B. #3 Fly Ash Used
2	210	90	0.90	2.00	8.5	1170	2390	2590	400	450		" "
3	165	135	0.90	2.00	8.0	880	2320	2240	360	445		" "
4A	120	180	0.84	2.50	7.2	650	1760	2000	270	360	61	" "
4B	120	180	0.85	2.00	7.0	540	1070	1440				Ottumwa Fly Ash Used
5	350	0	0.82	2.00	7.2	1720	3350	3190	505	530	93	" "
6	245	105	0.79	1.00	5.0	1370	2830	2970	425	505		" "
7	192	158	0.81	2.00	6.0	1230	2280	2860	350	425		" "
8	140	210	0.74	2.50	6.0	500	1490	1990	200	260	75	" "
9	400	0	0.74	1.50	5.5	2550	3990	3100	560	620	90	" "
10	280	120	0.66	2.00	7.5	1340	3700	3540	500	555		" "
11	220	180	0.66	2.00	5.2	1210	3710	3140	475	600		" "
12	160	240	0.62	1.50	5.0	690	2240	2000	290	420	60	" "

TABLE 2
1988 Test Results

MIX NO.	CEMENT LBS.	FLY ASH LBS.	AVG W/C RATIO	SLUMP IN.	AIR CONTENT (%)	COMPRESSIVE STR. 4.5"X9"CYL. 3-DAY	28-DAY	(PSI) CORES 28-DAY	FLEX. STR. (PSI) 6"X6"X20" BEAM 7-DAY	14-DAY	DUR. FACTOR (%)	REMARKS
1	300	0	0.96	1.50	6.6	1720	2200	1540	365	400		Ottumwa Fly Ash Used
2	210	90	0.88	1.50	6.8	1470	2220	2350	310	420	72	" "
3	165	135	0.89	1.00	6.8	1190	2390	2490	315	320	68	" "
4	120	180	0.84	2.00	7.0	960	2160	1660	300	395		" "
5	350	0	0.85	1.00	6.2	2410	3210	2580	345	465		" "
6	245	105	0.79	1.00	6.2	1890	2890	2680	360	420	69	" "
7	192	158	0.80	1.50	6.0	1240	2140	2840	305	365	70	" "
8	140	210	0.72	1.75	6.0	1050	2580	2400	320	345		" "
9	400	0	0.75	1.25	7.0	2120	3000	2880	445	450		" "
10	280	120	0.70	1.75	7.2	1840	2750	3070	395	400	62	" "
11	220	180	0.70	1.75	6.2	1760	3580	3200	405	420	66	" "
12	160	240	0.65	2.25	5.4	1470	3190	3310	385	465		" "

Figures 2 and 2A are plots of the data from the 28-day cylinders. Figure 2 shows the compressive strength versus the percent of fly ash substituted and Figure 2A shows compressive strength versus individual mix type. The trends indicated are within reason of what would have been expected, with two exceptions. One, a spike at the 45% substitution rate with 400 pounds of cementitious material. Two, the mixes containing 300 pounds of cementitious material appear to be somewhat less sensitive to the fly ash substitution than the other mixes.

Figure 3 and 3A are plots of the data from the 3-day cylinders. The trend is more consistent at the 3-day period. As the percent of fly ash is increased, the compressive strength is lowered. With this type of base, early strength is important. Placement of the pavement is permitted the day after placement of the subbase.

Figures 4 and 4A show the data from the flexural beams. Figure 4 is a plot of flexural strength versus percent fly ash substituted. Figure 4A plots flexural strength versus mix type. The trends are again reasonable and again there is an indication that the 300 pound mix may be somewhat less sensitive to the substitution of the fly ash.

Figures 5, 5A and 5B are plots of the data from ASTM C666, Method B durability testing. The samples were cast and cured in the field. As soon as the samples could be transported to the laboratory, they

FIGURE 2

28-DAY COMPRESSIVE STRENGTH FROM CYLINDERS

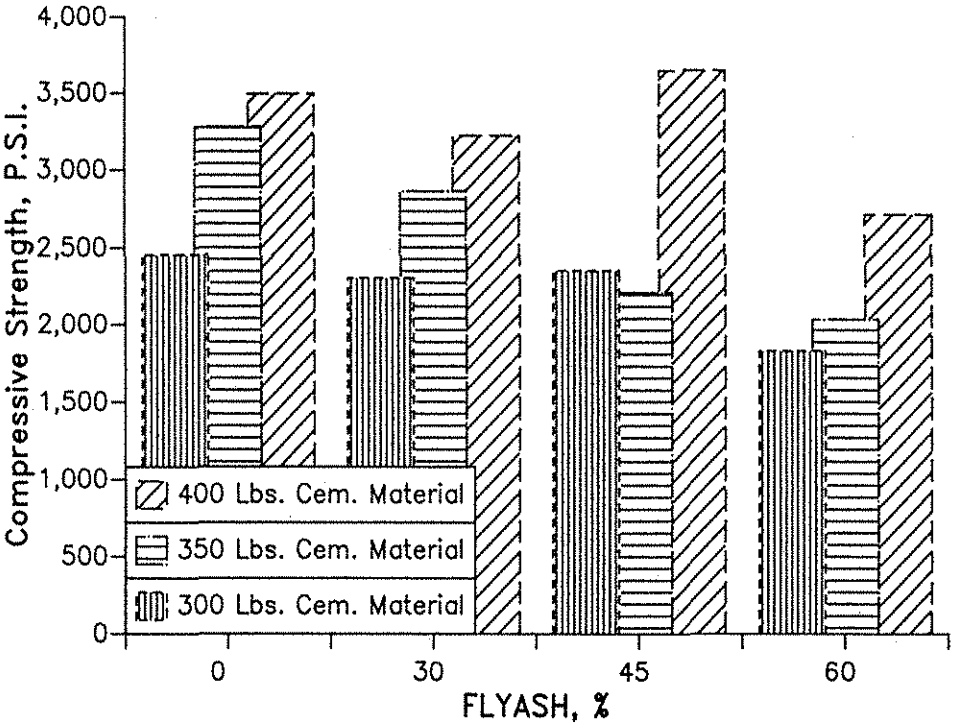


FIGURE 2A
28-DAY COMPRESSIVE STRENGTHS
FOR CYLINDERS BY MIX TYPE

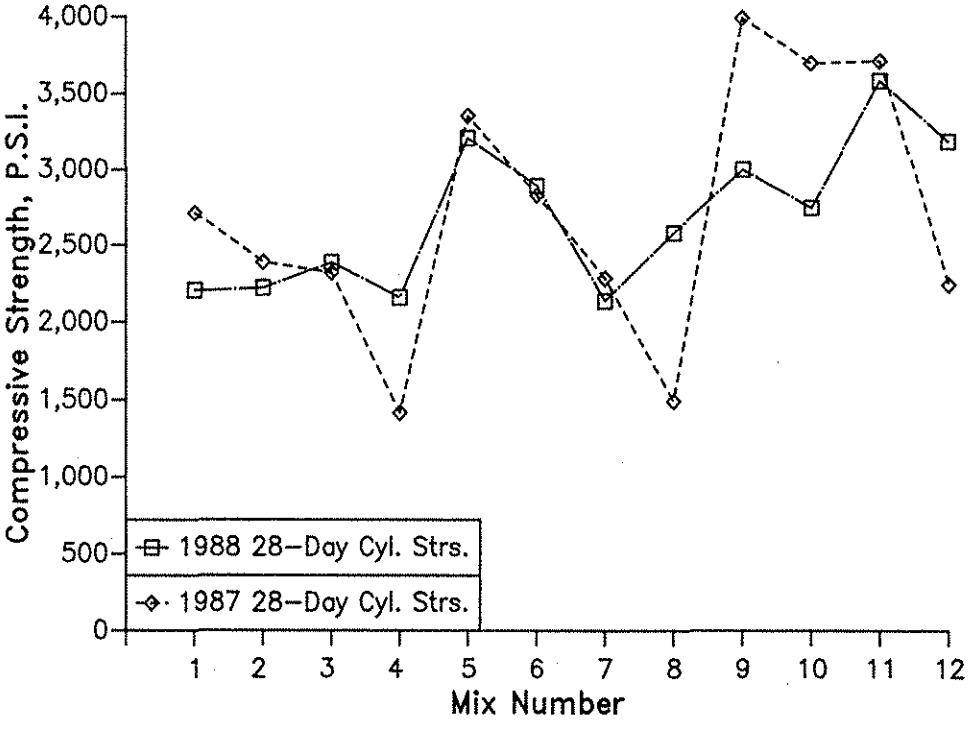


FIGURE 3

3-DAY COMPRESSIVE STRENGTH FROM CYLINDERS

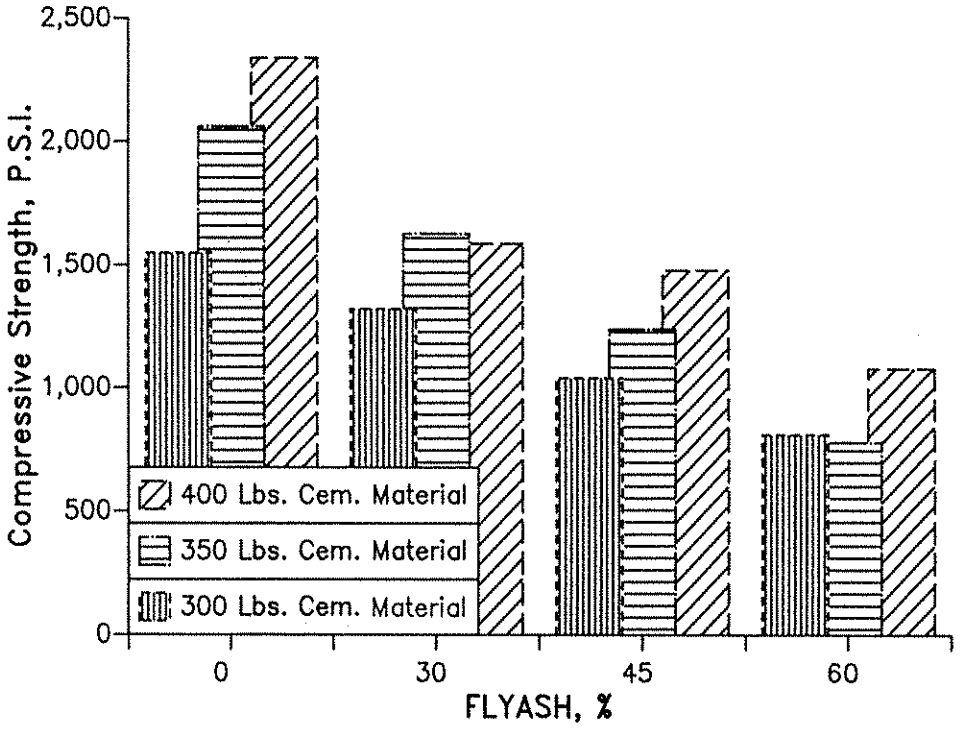


FIGURE 3A

3-DAY COMPRESSIVE SRENGTH FOR CYLINDERS BY MIX TYPE

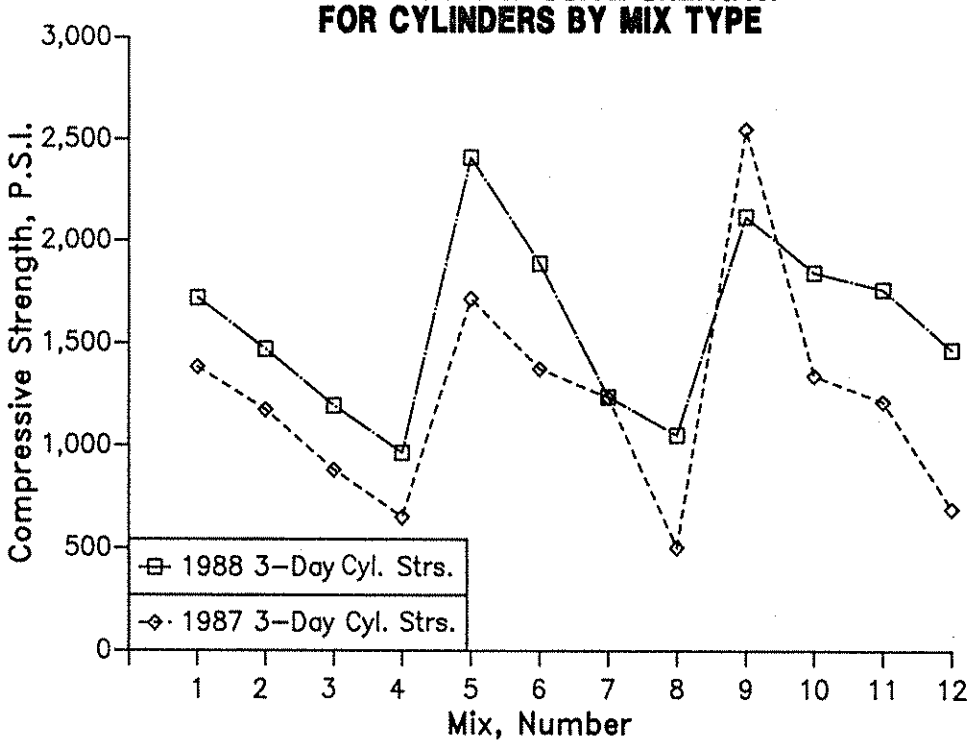


FIGURE 4

14-DAY FLEXURAL STRENGTH

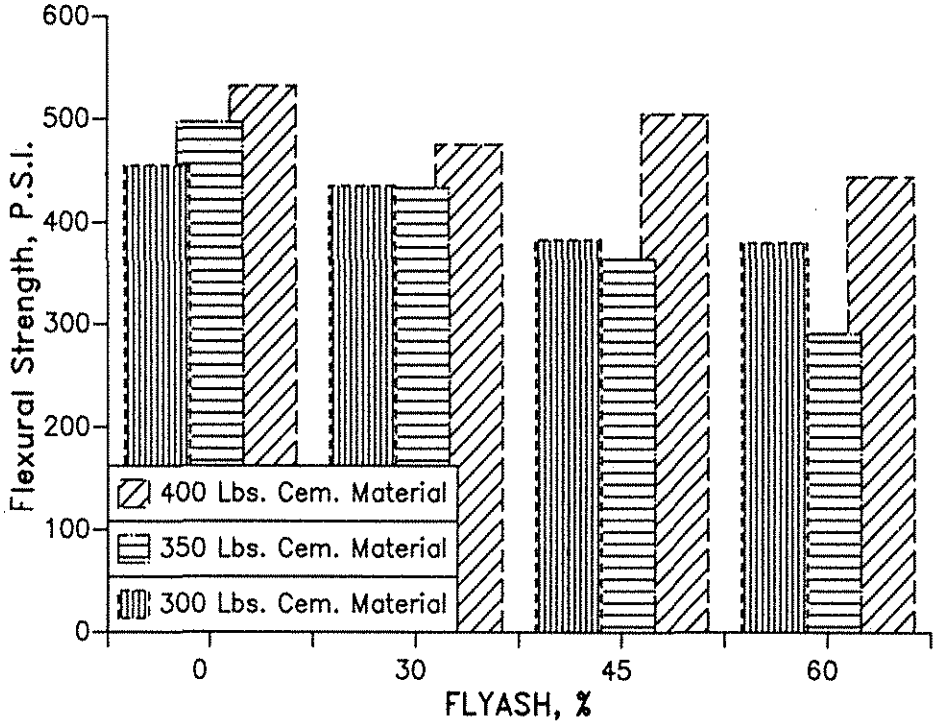


FIGURE 4A

14-DAY FLEXURAL STRENGTH BY MIX TYPE

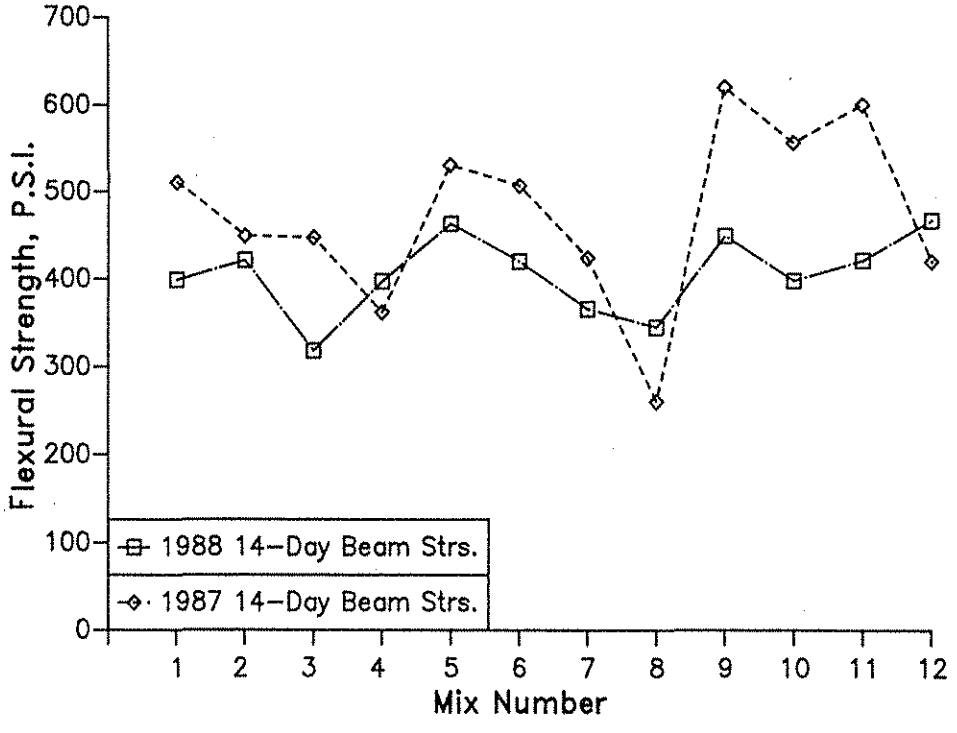


FIGURE 5 FREEZE/ THAW DURABILITY SUMMARY
300 POUNDS OF CEMENTITIOUS MATERIAL

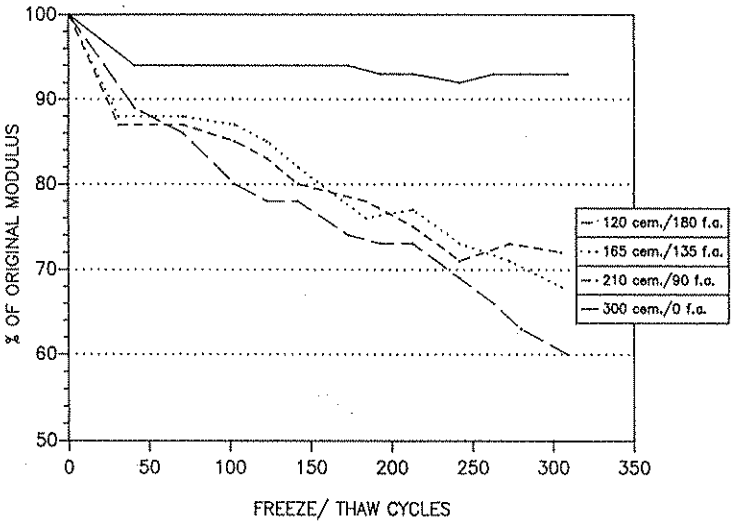


FIGURE 5A FREEZE/ THAW DURABILITY SUMMARY
350 POUNDS OF CEMENTITIOUS MATERIAL

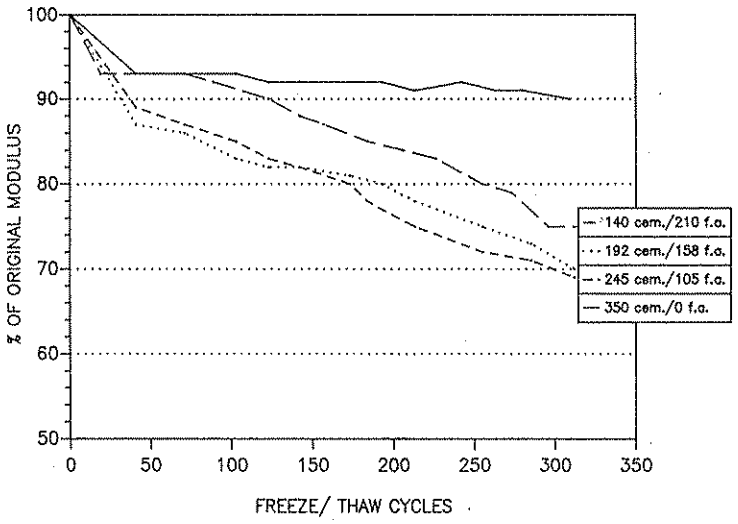
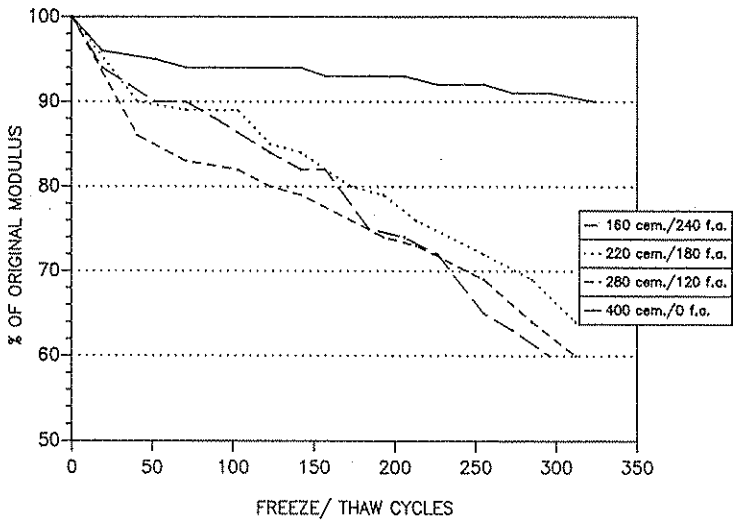


FIGURE 5B FREEZE/ THAW DURABILITY SUMMARY
400 POUNDS OF CEMENTITIOUS MATERIAL



were placed in 97% plus relative humidity at 73°F to complete the curing. All specimens were cured for a total of 90 days.

The coarse aggregate used for the project is not suitable for regular portland cement concrete paving. The material is a combination of the Rapid and Solon ledges of the Cedar Valley limestone formation. The Rapid material has an extensive system of large pores. Concrete containing this aggregate and sufficient entrained air will perform well on the C666 test, but perform poorly in service. Durability factors of 90% or greater would be reasonable for the 0% substitution mixes. However, lower durability factors for mixes with fly ash are unusual. One theory for the lower durability factor is that the fly ash reduced the permeability of the cement paste. The large amount of water in the Rapid stone may not have been able to escape sufficiently to the paste during the freeze. Further investigation is currently underway.

CONCLUSIONS

The results of this study indicate that a reduction in cementitious material and an increase in the percentage of fly ash are viable options. More fly ash and lower cementitious content did not reduce the workability or placeability.

During the nine years prior to 1984, compressive strength of the subbase was adequate with a 300 pound cement factor mix. A 28-day strength of 300 psi flexural or 2500 psi compressive strength is about the target strength for econocrete. Test mixes with 245

pounds cement/105 pounds fly ash and 220 pounds cement/180 pounds fly ash provided 3-day compressive strengths equivalent with the 300 pound cement mix. With proper precautions, the higher ultimate strength should not create problems.

RECOMMENDATIONS

Based on the test results the following recommendations are made:

1. Revise specification article 2114.026, "Slip-Formed Portland Cement Concrete Base" item 2 as follows:

   The cementitious material content of the base shall be one of the following:

	Portland Cement (pounds per cubic yard)	Class C Fly Ash (pounds per cubic yard)
Mix a	350	0
Mix b	245	105
Mix c	220	180

2. The restriction on fly ash usage between October 16 and March 15 should apply to Class A subbase.

APPENDIX A
Material Test Reports

ASSURANCE SAMPLE

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
REPORT OF CEMENT TESTS
LAB LOCATION AMES

MATERIAL CEMENT LAB NO. ACV7-374

INTENDED USE

COUNTY BLACK HAWK PROJ NO. F-63-6(42)--20-07

DESIGN CONTRACT NO. 27097

PRODUCER NORTHWESTERN CEMENT CO. CONTRACTOR FRED CARLSON CO.

PLANT MASON CITY, IA

UNIT OF MATERIAL 15 LB. BAG LINE SAMPLE; CARLSON PORTABLE PLANT, HWY 63, S. OF DENVER; BIN #63G; PROJECT QTY.

SAMPLED BY SWENSON SENDER'S NO. 2MS7-017

DATE SAMPLED 10-8-87 REC'D 10-13-87 REPORTED 10-21-87

LAB NO.	ACV7-374
SENDER'S NO.	2MS7-017
BIN NO.	63G
CAR OR INV NO.	
NO. OF TONS	
TYPE	I
N. C.	25.4
TIME OF SET	OK
BLAINE SPEC. SURFACE	375
% OF AIR C-185	9.6
AUTO-CLAVE EXP. %	.01
STRENGTH	
3 DAY AVER.	
7 DAY AVER.	4990
DISPOSITION	COMPLIES

COPIES:
CEMENT
P. HASSENSTAB
~~F-63-6(42)--20-07~~, BLACK HAWK

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

ASSURANCE SAMPLE

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
REPORT OF CEMENT TESTS
LAB LOCATION AMES

MATERIAL CEMENT — LAB NO. ACV8-129

INTENDED USE ECONO-CRETE SUB BASE

COUNTY BLACK HAWK — PROJ NO. F-63-6(42)20-07

DESIGN — CONTRACT NO. 27097

PRODUCER LEHIGH CEMENT CO. — CONTRACTOR CARLSON

PLANT MASON CITY, IA

UNIT OF MATERIAL BIN #46-52D; SAMPLED AT CARLSON'S PAVING PLANT ON 63 NORTH IN WATERLOO; PROJECT QTY.

SAMPLED BY SCHULDT/GARCIA — SENDER'S NO. 2CS8-052

DATE SAMPLED 5-27-88 — REC'D 6-6-88 — REPORTED 6-17-88

LAB NO.	ACV8-129
SENDER'S NO.	2CS8-052
BIN NO.	46-52D
CAR OR INV NO.	
NO. OF TONS	
TYPE	I
N. C.	27.8
TIME OF SET	OK
BLAINE SPEC. SURFACE	389
% OF AIR C-185	9.2
AUTO-CLAVE EXP. %	.13
STRENGTH	
3 DAY AVER.	
7 DAY AVER.	5210
DISPOSITION	COMPLIES

COPIES:
CEMENT
P. HASSENSTAB
G. LUND
C. SCHULDT
F-63-6(42)20-07, BLACK HAWK

SIGNED: ORRIS J. LANE, JR.
TESTING ENGINEER

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - MISCELLANEOUS MATERIALS
LAB LOCATION AMES

*CORRECTED REPORT
ASSURANCE SAMPLE

MATERIAL FLY ASH CLASS C — LAB NO. ACF7-134

INTENDED USE PC BASE (FOR PAVING)

COUNTY BLACK HAWK — PROJ NO. F-63-6(42)--20-07

DESIGN — CONTRACT NO. 27097

PRODUCER *COUNCIL BLUFFS UNIT #3 — CONTRACTOR FRED CARLSON CO. INC.
MARKETER: MIDWEST FLY ASH
SOURCE *COUNCIL BLUFFS, IA

UNIT OF MATERIAL LINE SAMPLE, CARLSON PORTABLE PLANT. HWY 63 S. OF DENVER
PROJECT QTY.
SAMPLED BY SWENSON — SENDER'S NO. 2MS7-018

DATE SAMPLED 10-8-87 — REC'D 10-13-87 — REPORTED 2-12-88

CHEMICAL ANALYSIS - %	
SIO2	32.41
AL2O3	18.83
FE2O3	7.01
SUBTOTAL	58.25
NA2O	2.05
K2O	0.29
ALKALI EQUIVALENT	2.24
AVAILABLE ALKALI	1.60
SO3	3.19
MOISTURE	0.00
LOSS ON 800 DEG. C. IGNITION	0.29
MGO	6.42
CAO	28.29

PHYSICAL TESTS ASTM C-311-87	
SPECIFIC GRAVITY	2.76
POZZ. ACTIVITY	
7 DAY	97.5
28 DAY	98.7%
WATER REQUIREMENT	90.5%
AUTOCLAVE	.04%
325 MESH	85.4% PSG
SPEC. SURF.	11522 CM2/CM3
COMPRESSIVE STRENGTH	
FLY ASH & SAND:	
1 DAY	444 PSI
7 DAY	788 PSI

COPIES:
FLY ASH
P. HASSENSTAB
K. JONES
J. NASH
MIDWEST FLY ASH
F-63-6(42)--20-07, BLACK HAWK

DISPOSITION: COMPLIES WITH ASTM 618 CLASS C

SIGNED: ORRIS J. LANE, JR.

IOWA DEPARTMENT OF TRANSPORTATION
ASSURANCE SAMPLE OFFICE OF MATERIALS
TEST REPORT - MISCELLANEOUS MATERIALS
LAB LOCATION AMES

MATERIAL FLY ASH CLASS C LAB NO. ACF7-141

INTENDED USE PCC PAVING

COUNTY BLACK HAWK PROJ NO. F-63-6(42)20-07

DESIGN CONTRACT NO. 27097

PRODUCER OTTUMWA GENERATING STATION CONTRACTOR CARLSON
MARKETER: MIDWEST FLY ASH
SOURCE CHILLICOTHE, IA

UNIT OF MATERIAL B/L 712158; SAMPLED FROM CARLSON'S PLANT IN WATERLOO
PROJECT QTY.
SAMPLED BY SCHULDT SENDER'S NO. 2CS7-161

DATE SAMPLED 10-22-87 REC'D 10-26-87 REPORTED 2-5-88

CHEMICAL ANALYSIS - %	
SIO2	37.48
AL2O3	22.19
FE2O3	5.35
SUBTOTAL	65.02
NA2O	2.28
K2O	0.49
ALKALI EQUIVALENT	2.60
AVAILABLE ALKALI	1.89
SO3	1.51
MOISTURE	0.06
LOSS ON 800 DEG. C. IGNITION	0.10
MGO	4.41
CAO	23.83

PHYSICAL TESTS ASTM C-311-87	
SPECIFIC GRAVITY	2.73
POZZ. ACTIVITY	
7 DAY	109.5%
28 DAY	120.0%
WATER REQUIREMENT	90.5%
AUTOCLAVE	.04%
325 MESH	89.0% PSG
SPEC. SURF.	14009 CM2/CM3
COMPRESSIVE STRENGTH	
FLY ASH & SAND:	
1 DAY	189 PSI
7 DAY	338 PSI

COPIES:
FLY ASH
P. HASSENSTAB
G. LUND C. SCHULDT
K. JONES J. NASH
MIDWEST FLY ASH
F-63-6(42)20-07, BLACK HAWK

DISPOSITION: COMPLIES WITH ASTM 618 CLASS C

SIGNED: ORRIS J. LANE, JR.

IOWA DEPARTMENT OF TRANSPORTATION
* SUPPLEMENTAL REPORT OFFICE OF MATERIALS
ASSURANCE SAMPLE TEST REPORT - MISCELLANEOUS MATERIALS
LAB LOCATION AMES

MATERIAL FLY ASH CLASS C LAB NO. ACF8-59

INTENDED USE ECONO-CRETE SUB BASE

COUNTY BLACK HAWK PROJ NO. F-63-6(42)20-07

DESIGN CONTRACT NO. 27097

PRODUCER OTTUMWA GENERATING STATION CONTRACTOR CARLSON
MARKETER: MIDWEST FLY ASH
SOURCE CHILLICOTHE, IA

UNIT OF MATERIAL LOI = 0.4% FINENES = 10.7% - SAMPLED AT CARLSON'S PAVING PLANT HWY 63 NORTH IN WATERLOO; PROJECT QTY.
SAMPLED BY SCHULDT/GARCIA SENDER'S NO. 2CS8-53

DATE SAMPLED 5/27/88 REC'D 6/7/88 REPORTED 8/29/88

CHEMICAL ANALYSIS - %

SIO2	35.18
AL2O3	21.45
FE2O3	5.66
SUBTOTAL	62.29
NA2O	2.42
K2O	0.41
ALKALI EQUIVALENT	2.69
AVAILABLE ALKALI	1.85
SO3	1.93
MOISTURE	0.04
LOSS ON 800 DEG. C. IGNITION	0.31
MGO	4.63
CAO	25.19

PHYSICAL TESTS ASTM C-311-87

SPECIFIC GRAVITY	2.67
POZZ. ACTIVITY	
7 DAY	93.4%
28 DAY	102.0%
WATER REQUIREMENT	90.5%
AUTOCLAVE	.04%
325 MESH	81.4% PSG.
SPEC. SURF.	10713 CM2/CM3
COMPRESSIVE STRENGTH	
FLY ASH & SAND:	
1 DAY	342 P.S.I.
7 DAY	885 P.S.I.

COPIES:
FLY ASH
P. HASSENSTAB
G. LUND, C. SCHULDT
S. MOUSSALLI
K. JONES, T. PARHAM, MIDWEST FLY ASH

DISPOSITION: COMPLIES

SIGNED: ORRIS J. LANE, JR.

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - ROAD STONE
LAB LOCATION - AMES

MATERIAL: - CR. STONE LAB NO.: AAR7-0214

SIZE: 3/4

INTENDED USE: BASE

COUNTY: BLACK HAWK PROJ NO.: F-63-6(42)--2G-07

DESIGN: CONTRACT NO.:

PRODUCER: MARTIN MARIETTA CONTRACTOR: CARLSON'S

SOURCE: PINTS-RAYMOND SW-36-089N-12W, BLACK HAWK QTY: 24000. TONS

SAMPLE LOCATION : STOCKPILE

SAMPLE DESC.: BEDS 178-2B

SAMPLED BY: AUSTIN SENDER'S NO.: 2LW70161

DATE SAMPLED: 06/11/87 REC'D: 06/16/87 REPORTED: 06/30/87

.... PROJ. NOT ON FILE, STD. SPECS. CHECKED

AFTER 16 CYCLES, F&T METHOD A	11 % LOSS
AFTER 25 CYCLES, F&T METHOD C	2 % LOSS
LA ABRASION, GRADING B	29 % LOSS
SPECIFIC GRAVITY	2.667
ABSORPTION	2.33 %
PLASTICITY INDEX	0 .... NON-PLASTIC

COPIES:
PROJECT
GEOLOGY
ROAD STONE
DIST - 2,
WOLFF, BASIC MATERIALS,

DISPOSITION: COMPLIES WITH CURRENT SPECS. SIGNED: ORRIS J. LANE, JR.

F = NON-COMPLIANCE
* = SPEC NOT CHECKED
@ = CORRECTED ITEM

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - CRUSHED STONE
LAB LOCATION - AMES

CORRECTED REPORT

MATERIAL: CEMENT TREATED BASE   LAB NO.: AAC8-0291

CLASS: 1   SIZE: 3/4

INTENDED USE: BASE

COUNTY: BLACK HAWK   PROJ NO.: F-63-6(42)--20-07

DESIGN: CONTRACT NO.: 27097

PRODUCER: BASIC MATERIALS CORP   CONTRACTOR: FRED CARLSON CO.

SOURCE: RAYMOND-PINTS   SW-36-089N-12W, BLACK HAWK   QTY: 0 TONS

SAMPLE LOCATION : SAMPLED/STCKP @ CARLSON PLANT

SAMPLE DESC.: BEDS 18-27

SAMPLED BY: SCHULDT & GARCIA   SENDER'S NO.: 2CS80051

DATE SAMPLED: 05/27/88   REC'D: 06/07/88   REPORTED: 06/30/88

@ WATERLOO, USED IN ECONO-CRETE SUB BASE

- -

AFTER 16 CYCLES, F&T METHOD A   11 % LOSS *

LA ABRASION, GRADING B   32 % LOSS *

COPIES:
PROJECT
GEOLOGY
CRUSHED STONE
DIST - 2,

DISPOSITION: COMPLIES WITH CURRENT SPECS.   SIGNED: ORRIS J. LANE, JR.

F = NON-COMPLIANCE
* = SPEC NOT CHECKED
@ = CORRECTED ITEM

MONITOR SAMPLE

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT- - MISCELLANEOUS MATERIALS
LAB LOCATION AMES

MATERIAL AIR ENTRAINING AGENT
BRAND: CSC, LOT #7HF-37
LAB NO. ACA7-373

INTENDED USE P.C. BASE

COUNTY BLACK HAWK
PROJ NO. DEPT. INFO.

DESIGN
CONTRACT NO. 27097

PRODUCER CSC
CONTRACTOR FRED CARLSON CO.

SOURCE

UNIT OF MATERIAL 1 QT. LINE SAMPLE, CARLSON PORTABLE PLANT; PROJECT QTY.
FOR USE ON PROJECT ~~F-63-6~~(42)--20-07
SAMPLED BY SWENSON
SENDERS' NO. 2MS7-019

DATE SAMPLED 10-8-87 REC'D 10-13-87 REPORTED 10-13-87

SOLIDS 22.6%

COPIES:
AIR ENTRAINING AGENT
P. HASSENSTAB
CSC

DISPOSITION: COMPLIES FOR CSC, LOT #7HF-37

SIGNED: ORRIS J. LANE, JR.

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT- -. MISCELLANEOUS MATERIALS
LAB LOCATION AMES

ASSURANCE SAMPLE

MATERIAL WATER REDUCER — LAB NO. ACI8-54
BRAND: PLASTOCRETE 161; LOT NO. 80007P
INTENDED USE ECONO-CRETE SUB BASE

COUNTY BLACK HAWK — PROJ NO. F-63-6(42)--20-07

DESIGN — CONTRACT NO. 27097

PRODUCER SIKA — CONTRACTOR CARLSON

SOURCE

UNIT OF MATERIAL SAMPLED AT CARLSON'S PAVING PLANT, HWY 63 NORTH IN WATERLOO

SAMPLED BY SCHULDT & GARCIA — SENDERS' NO. 2CS8-55

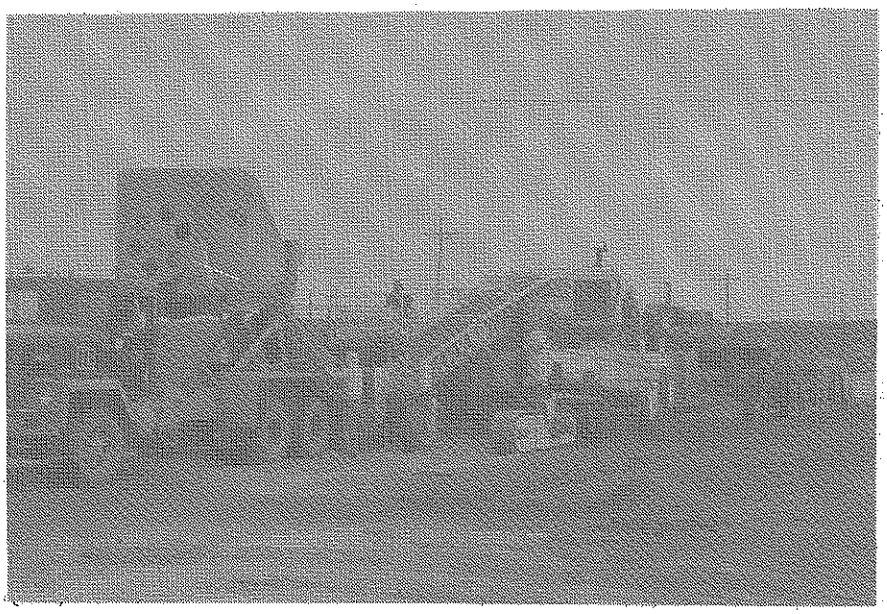
DATE SAMPLED 5/27/88 REC'D 6/8/88 REPORTED 6/10/88

TOTAL SOLIDS	34.5%
SPECIFIC GRAVITY	1.164
CHLORIDE AS CL	.04%

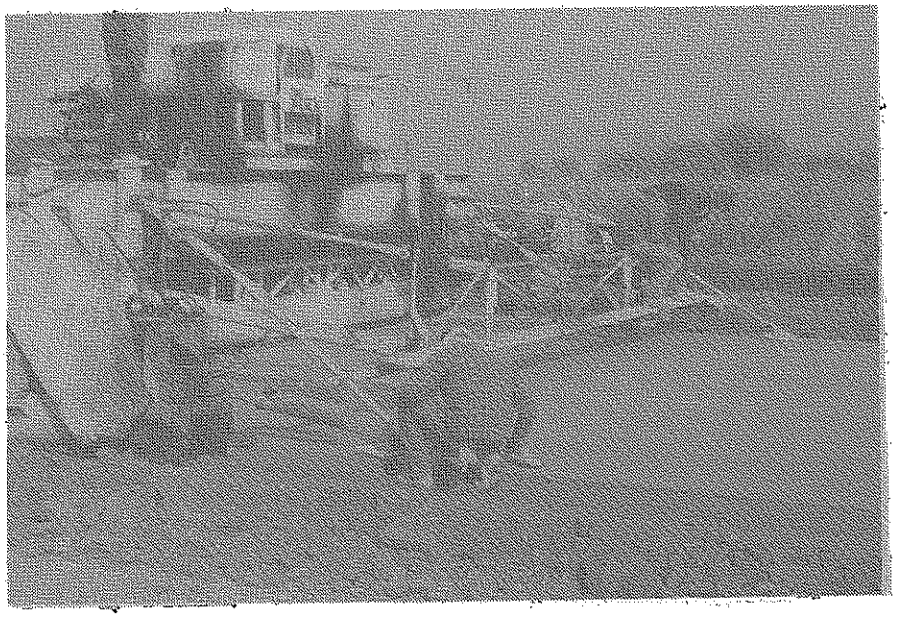
COPIES:
CONCRETE ADMIXTURE
P. HASSENSTAB
G. LUND
C. SCHULDT
F-63-6(42)--20-07, BLACK HAWK

DISPOSITION: COMPLIES FOR PLASTOCRETE 161; LOT NO. 80007P
SIGNED: ORRIS J. LANE, JR.

Econocrete mix was produced in a Rex batch plant

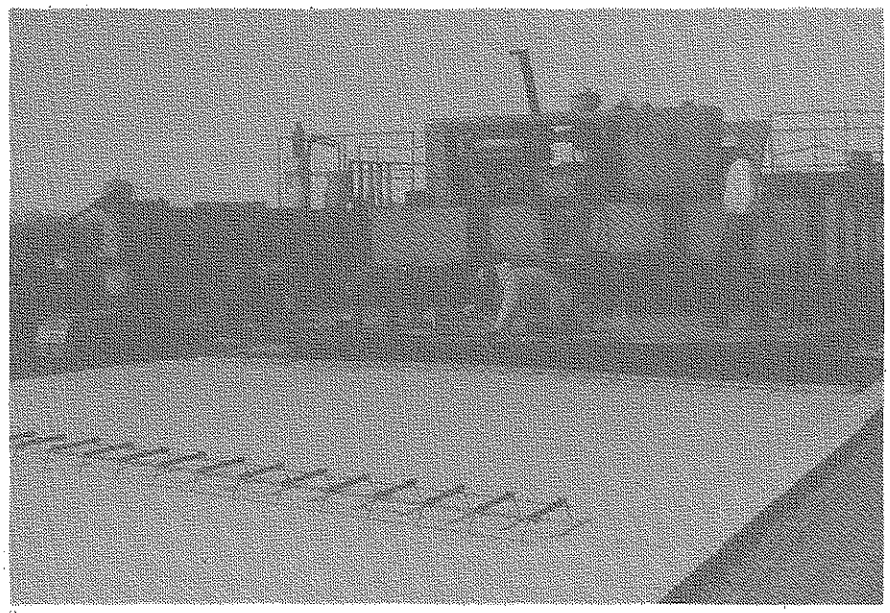


Mix was dumped onto the belt of the subgrader and placed ahead of the paver

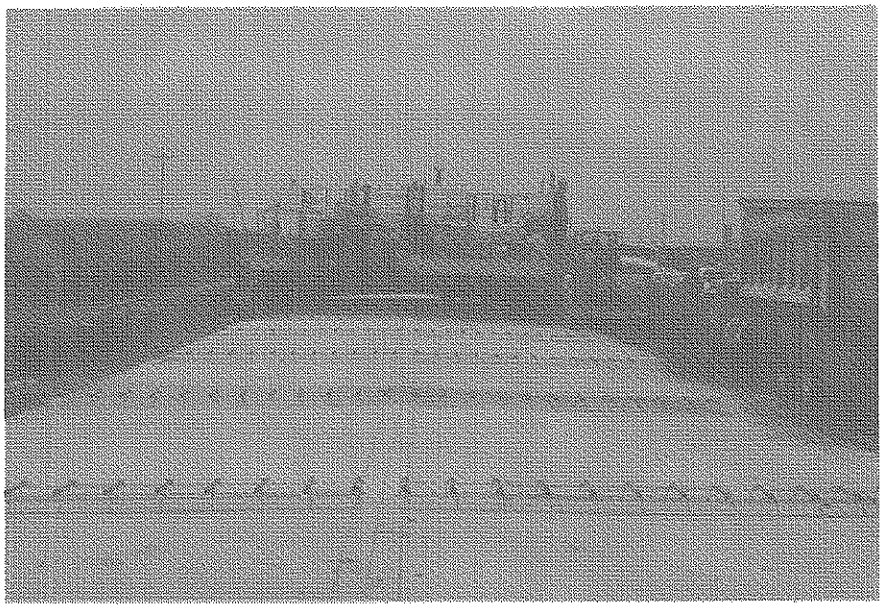


The paver was a conventional paver

A weakened plane was created at the location of the pavement transverse joints



The dowel bar assemblies were placed in the fresh subbase



The tracks of the paver ran on the subbase
when the pavement was placed

Appendix B
Construction Photos