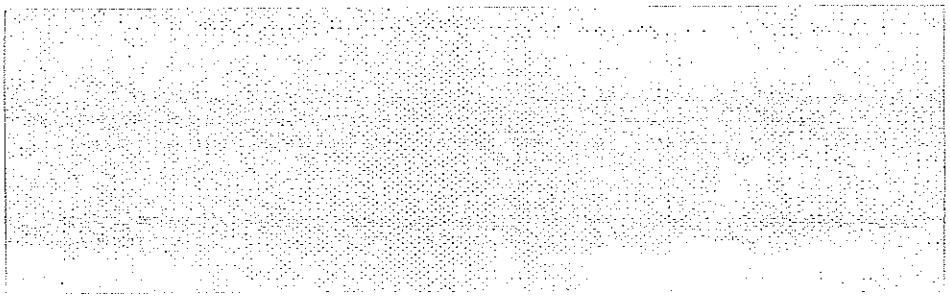
EVALUATION OF LIME, FLY ASH BASE COURSE MIXTURES
Construction Report

MATERIALS and TECHNOLOGY DIVISION



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Evaluation of lime, fly
ash base course mixtures :
construction report

EVALUATION OF LIME, FLY ASH BASE COURSE MIXTURES
Construction Report

V. T. Barnhart

An Experimental Project by the Michigan Department of Transportation in Cooperation with the U. S. Department of Transportation Federal Highway Administration

Research Laboratory Section
Materials and Technology Division
Research Project 84 D-47
Research Report No. R-1281

Lansing, January 1987

This project was initiated in 1983 to evaluate the use of bituminous and aggregate mixtures containing fly ash when used in the construction of highway shoulder bases. This research is being conducted in cooperation with the U. S. Department of Transportation, Federal Highway Administration and in conjunction with the University of Michigan, Civil Engineering Department and the Michigan Ash Sales Co.

The concept of using an aggregate mixture containing fly ash for highway shoulder base was evaluated about 23 years ago by the Department and the results of the evaluation were not favorable (1). The mixture had been placed late in the year, and the report recommended that should the material be evaluated again at least one month of in-place cure at summer temperatures should be allowed before the onset of cold weather.

Test sections of two different types of fly ash material were placed as shoulder base as part of the shoulder reconstruction and resurfacing project (Control Section 77051, Job Number 24173A) on M 29 in St. Clair County (Fig. 1). The first material placed was a fly ash-extented (FAE) bituminous base course and the second material placed was a lime/fly ash/aggregate (LFA) base course. These base courses were placed in June and July of 1986, respectively. In addition, two sections of a conventional bituminous base course (Bituminous Base Mix No. 500, 20C) for shoulders were also placed as control sections.

The test section for the fly ash-extended bituminous base course was further subdivided into three subsections, each consisting of a different ratio of fly ash-to-asphalt (Table 1). The test section layout, including the two control sections, is shown in Figure 2.

TABLE 1
RATIOS OF FLY ASH-TO-ASPHALT FOR
FLY ASH EXTENDED BITUMINOUS BASE

Ratio No.	Asphalt in Mix by Weight, percent	Fly Ash Added by Weight, percent
1	3.6	2.1
2	3.4	2.6
3	3.1	3.1

The construction of the FAE bituminous base course was done in accordance with MDOT 1984 Standard Specifications for Construction of Bituminous Base Course and Pavement (4.00) for a Bituminous Base Course Mix Number 500 (20C Modified). Materials and experimental features were covered in a 'Special Provision for Bituminous Base Course - Special.' The construction procedures for the LFA base, materials and experimental features were covered in a 'Special Provision for Construction of Experimental Lime-Fly Ash-Aggregate Shoulder Base.' The special provisions

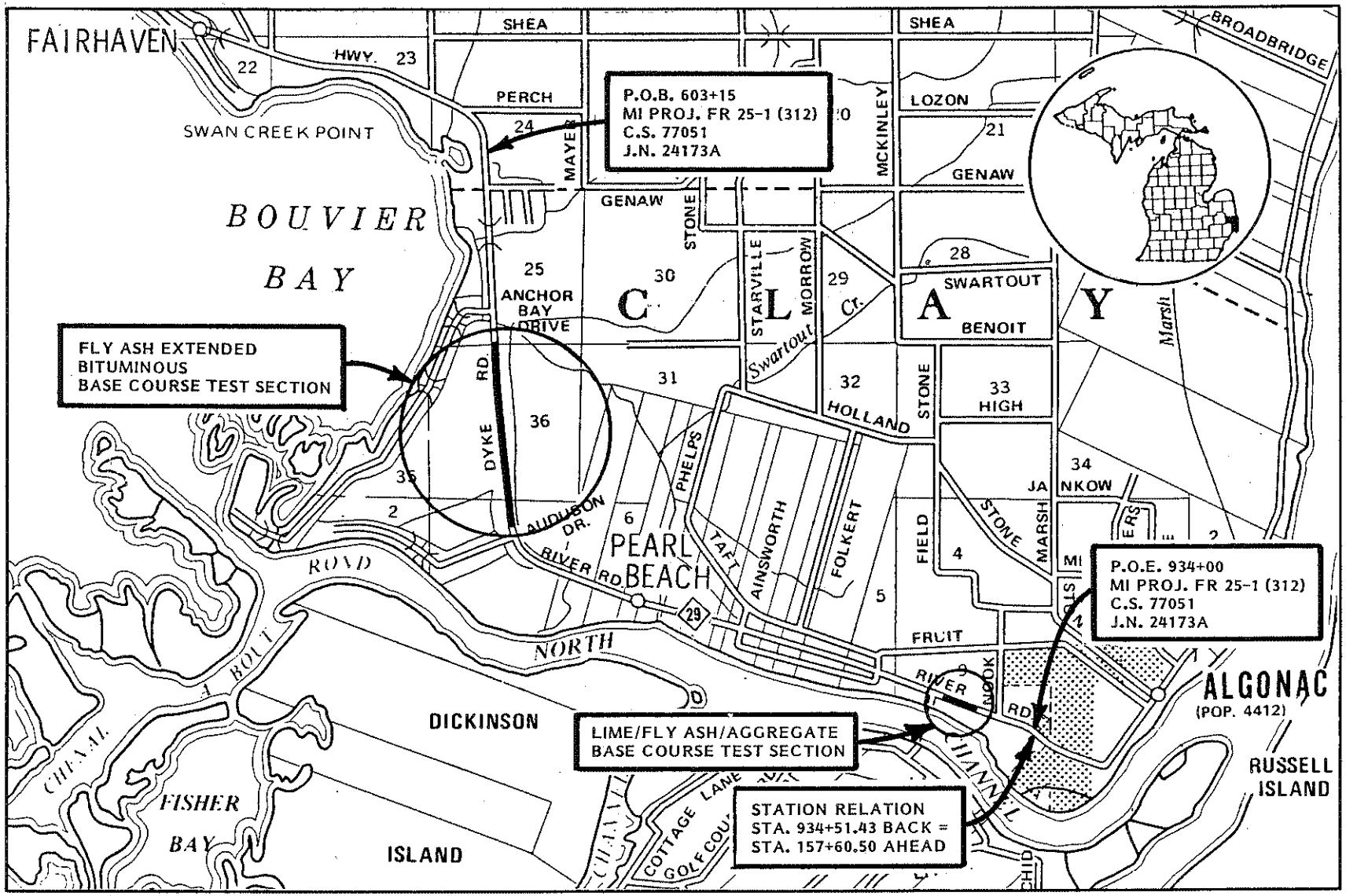

Figure 1. Location of test sections for the fly ash extended bituminous base course and the lime/ fly ash/aggregate base course.

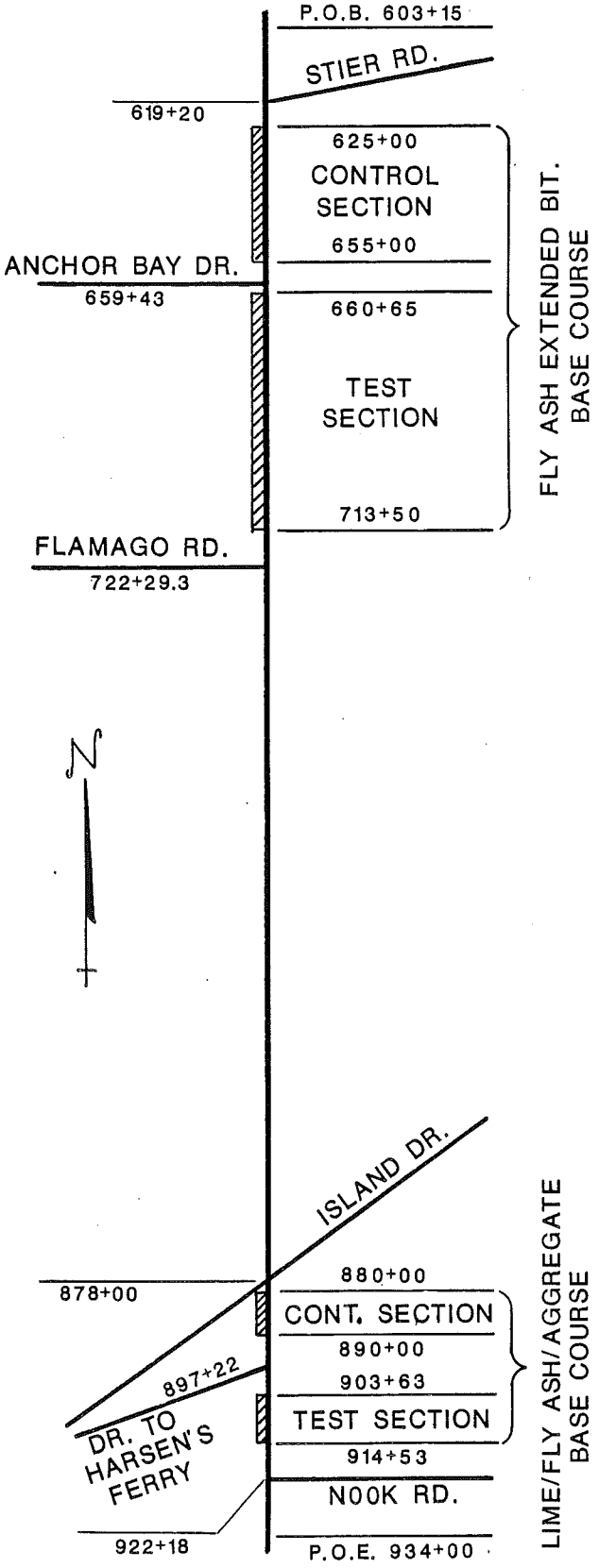

Figure 2. Experimental fly ash material test and control sections.

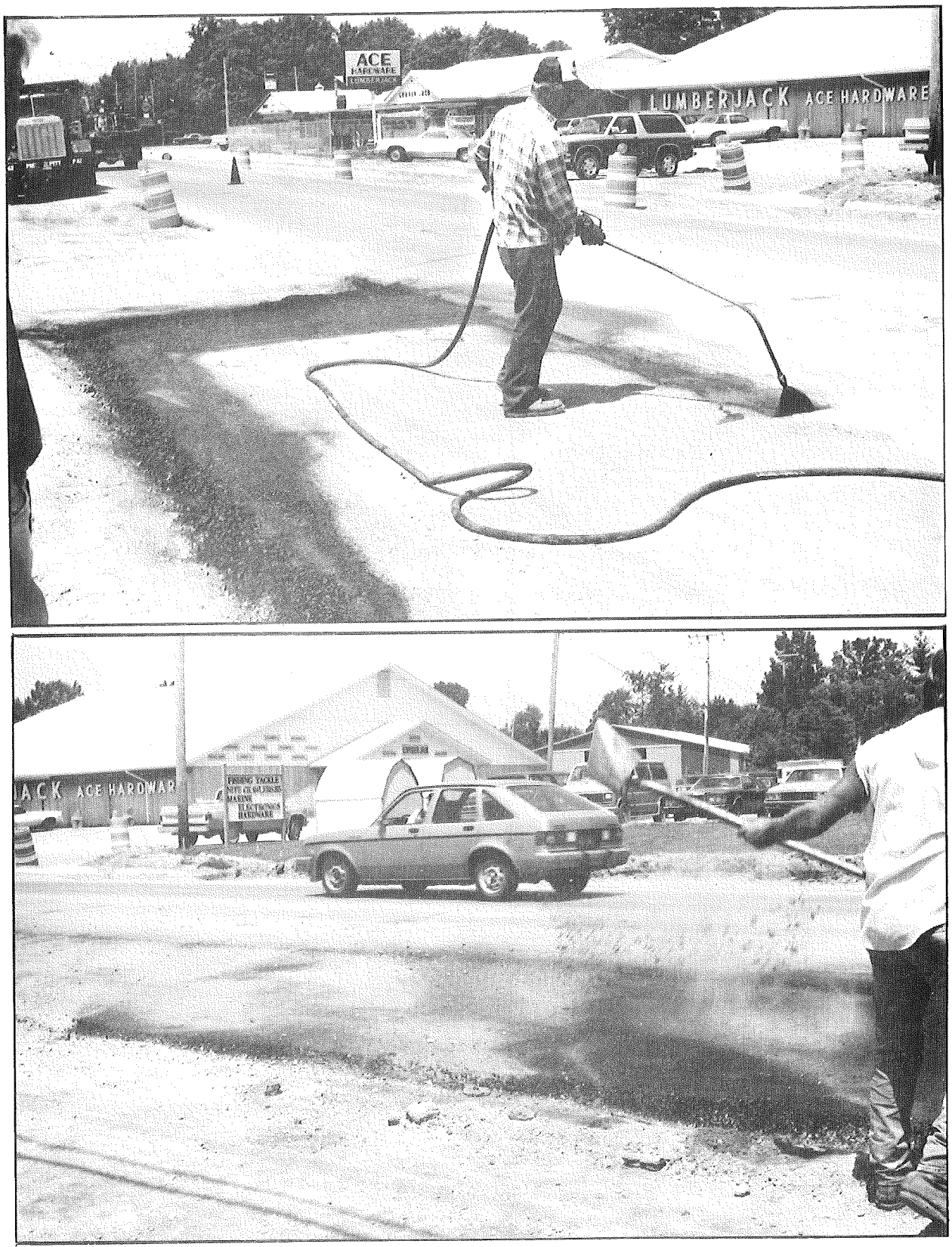

Figure 3. Bituminous curing coat being placed on LFA base course (above). Placement of a layer of soil on top of bituminous curing coat (below).

for the test sections were included in the project proposal and are contained in Appendix A.

The FAE bituminous base course material was produced in a conventional stationary drum mix plant owned by the paving contractor and located north of Utica. The LFA base material was produced in a portable pug mill owned by Michigan Ash Sales Co. and located in Bay City.

The preliminary mix designs (Table C, Special Provision for Bituminous Base - Special, Appendix A) for the fly ash-extended bituminous base course was done by the University of Michigan, Civil Engineering Department. Several weeks prior to the start of construction, the paving contractor sent samples of materials for the production of the FAE bituminous base course to the Materials and Technology Laboratory for job mix design testing. The test results for each of the three ratios of fly ash-to-asphalt are contained in Appendix B.

The FAE bituminous base course was constructed in two layers varying in thickness from 8 in. at the edge of the existing pavement to 3 in. at the outside edge of the shoulder. During construction, samples were taken at the plant and tested for asphalt and fly ash content. Samples were also taken at the job site and molded into specimens for later laboratory testing. The material was transported approximately 25 miles from the plant to the job site in 40-ton truckloads.

The LFA base material was placed in one layer varying in thickness from 8 in. at the edge of the existing pavement to 3 in. at the outside edge of the shoulder. The material was placed and compacted using the same equipment that was used for the FAE bituminous base course. After the material was compacted to the required density it was covered with a bituminous curing coat sprayed on at the rate of 0.1 gal/sq yd, in accordance with MDOT 1984 Standard Specifications for Construction of Bituminous Prime Coat (4.00.08). A layer of soil was then hand placed over the bituminous curing coat to protect the LFA base from traffic while it was curing (Fig. 3). During construction, samples of the LFA base material were taken at the job site and molded into specimens for later laboratory testing. The LFA material was designed by Michigan Ash Sales Co. (Table 2), mixed at their plant in Bay City, and transported approximately 125 miles to the job site in 50-ton truckloads.

TABLE 2
MIX DESIGN FOR LIME/FLY ASH/AGGREGATE BASE

Material	Dry Weight, percent
23A Modified Aggregate	83
Fly Ash	13
Hydrated Lime	4
Water	10-13

The FAE bituminous base and the LFA base material were covered with a bituminous leveling course and a bituminous top course in accordance with MDOT 1984 Standard Specifications for Construction of Bituminous Base Course and Pavement (4.00) for Bituminous Mixes No. 1100L, 20AA and No. 1100T, 20AA.

The placement of the FAE bituminous base course was completed in two days and required 1,445 tons of material. The LFA base was placed in one day and required 262 tons of material. The unit prices for the FAE base and LFA base were $32.25/ton and $28.95/ton, respectively. The unit price of the conventional bituminous base course used on the remainder of the project was $27.85/ton.

Evaluation

The construction of the FAE bituminous base test section was completed without any significant problems. There was some difficulty in matching the three different ratios of fly ash-to-asphalt placed in the second layer of the FAE base with the corresponding fly ash-to-asphalt ratio area in the first layer of the FAE base. The difficulty in matching the two layers of the FAE base should not affect the results of the study nor should it affect the integrity of the shoulder cross-section. There also was a delay at the plant caused by a malfunction of the controls of the equipment that controlled the amount of fly ash added to the bituminous mixture, causing the operations to be shut down and three truckloads of material to be rejected. The problem was corrected and the placement of the FAE base proceeded smoothly thereafter.

The following problems were encountered during the construction of the test section for the LFA base course:

1) Due to the length of time involved in the transportation of the LFA base course material from the plant in Bay City to the job site, the material settled in the trucks and unloading became quite difficult.

2) After the LFA base course had been compacted the outside edge of the shoulder, where there was no lateral support, displaced laterally when pressure was applied and continued to do so after the base had been in place for 16 days. The LFA base course was inspected at the time the leveling course was placed and it was found that traffic had deteriorated the outside 4 to 6 in. of the shoulder. In an area where dirt had not been pulled up next to the outside edge, it had the appearance of a rolled curb.

There was traffic on the LFA base course test section prior to the placement of the bituminous leveling course because of vehicles entering and leaving several residential driveways along the test section. Further, traffic traversed the shoulder as a result of traffic channelizing cones used to close off the westbound lane of M 29 while the existing joints in that lane were being repaired.

3) Prior to the placement of the leveling course the layer of soil placed during the construction of the LFA base course was removed using compressed air. After the soil was removed it was found that there had been a loss of material from the surface of the base course in almost the complete length of the test section. The loss of material ranged from just a thin layer of the top surface being skimmed off to approximately 3/4 in. (Fig. 4). The loss of material was primarily due to traffic on the LFA base course. The cleaning of the base may have contributed slightly to the loss of the thin layer of material. Also a thin skim layer of material was picked up by the paver and trucks during the placement of the leveling course. The amount of material that was lost from the LFA base course due to traffic and during the placement of the leveling course should not affect the integrity in the shoulder cross-section.

During the next three years condition surveys and performance evaluations will be made on all test sections and core samples will be obtained for laboratory testing. The laboratory tests will be made on the core samples as well as the samples taken at the time of construction to determine the unit weight and tensile strength for the FAE material, and compressive strength and unit weight for the LFA material.

REFERENCES

1. Mainfort, R. C., "1962 Observations on Condition of Experimental Poz-O-Pac Shoulder Construction: Construction Projects BU 56044, C3UN and C4UN," Michigan State Highway Department Research Report No. R-410, January 1963.

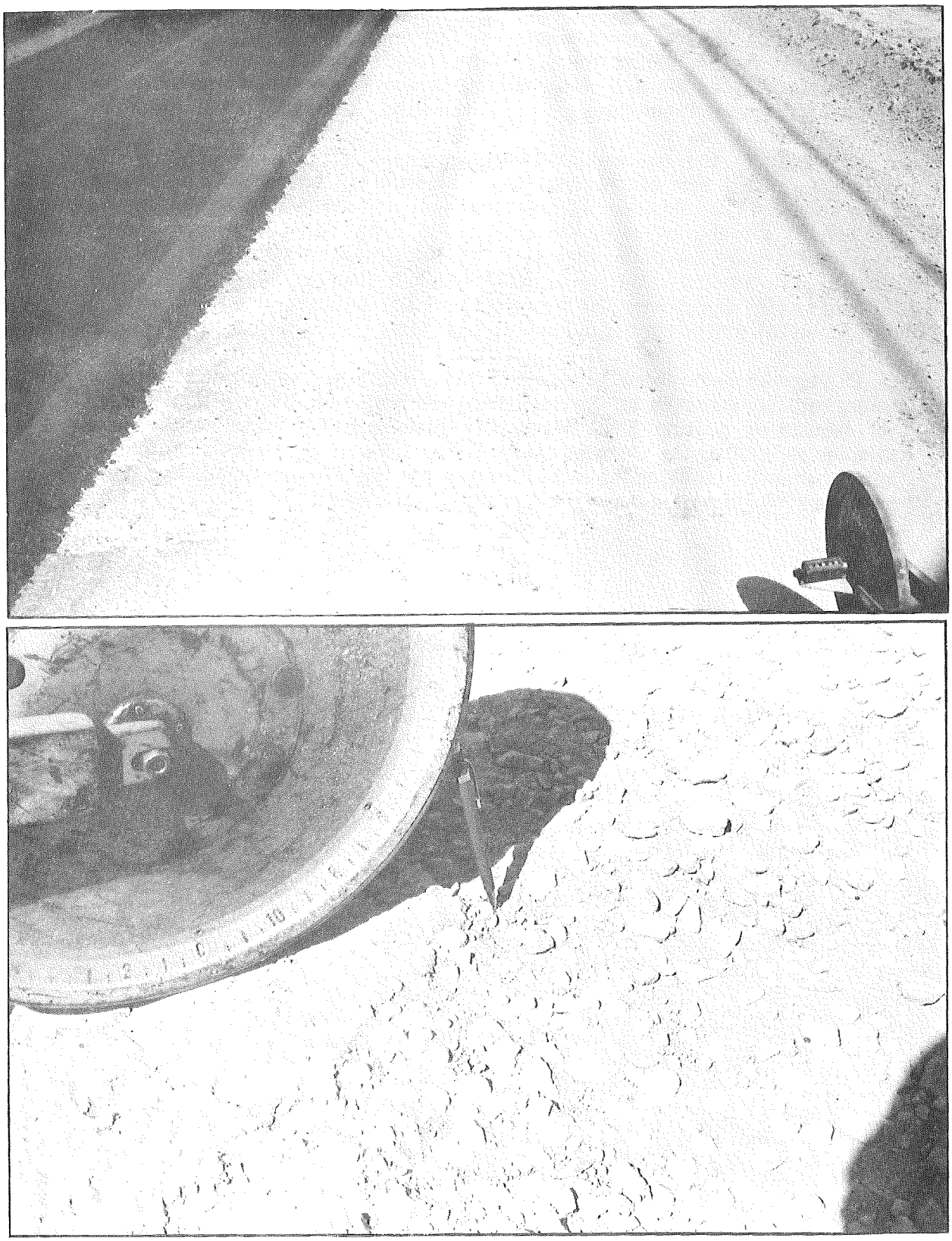

Figure 4. Loss of a thin layer of material from top surface of LFA base course is shown in the upper photo. Loss of approximately 3/4 in. of material from top surface of LFA base course is shown below.

APPENDIX A

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
CONSTRUCTION OF EXPERIMENTAL LIME-FLYASH-
AGGREGATE SHOULDER BASE
(77051- 24173)

DESCRIPTION:

A 1000 ft test section of shoulder base will be constructed using an experimental pozzolanic, lime-flyash-aggregate mixture, in a location as shown on the plans.

MATERIAL:

The pozzolanic mixture shall be obtained from Michigan Ash Sales Company of Bay City. The mixture will be delivered to the job site in 50 ton loads by Michigan Ash Sales ready for placement at the Contractor's request.

PLACEMENT:

The Contractor shall transfer the experimental mixture from the delivery truck to the shoulder trench immediately upon delivery using a shoulder spreader or other suitable equipment approved by the Engineer. The subbase material shall be compacted to at least 95% of Maximum Unit Weight and shall not contain more than optimum moisture at the time of placement of the pozzolanic mixture.

The base course mixture or any individual components of this mixture shall not be spread or placed when the aggregate or the subbase material is excessively wet, frozen, or is at a temperature of 40°F or less. No experimental mixture shall be placed or spread unless the air temperature is at least 40°F and rising. These operations shall be discontinued when the descending air temperature falls below 40°F. No base course shall be placed at a time where the 7 day strengths cannot be reached before temperatures drop to 40°F and are descending. This final placement date shall be determined by the Engineer.

The pozzolanic aggregate material shall be constructed between April 15 and October 1.

The pozzolanic base course mixture shall be constructed in layers not less than 3 inches (compacted) in thickness. If tests indicate that the desired results are being obtained, the compacted thickness of any layer may be increased to a maximum of 8 inches. When the thickness specified is more than 8 inches the mixture shall be placed in two or more approximately equal layers. Each layer shall be deposited, full width, on the prepared subgrade or on the preceding layer of compacted mixture with a mechanical spreader or spreader box of a type approved by the Engineer. Where the mixture must be placed in more than one layer, the previous layer shall be maintained in a moistened condition until the succeeding layer is placed. After having been tested for density and approved by the Engineer, the previous layer shall be dampened with water if required by the Engineer. The second must be placed the same

day as the first layer. When placed the pozzolanic base course mixture shall be free from segregation and shall require minimum blading and manipulation.

The pozzolanic base course shall be compacted to at least 97% of Maximum Unit Weight except that if more than one layer is required the first layer shall be compacted to 97% of Maximum Unit Weight and succeeding layers shall be compacted to 100% of Maximum Unit Weight.

All pozzolanic base course mixture shall be placed and compacted the same day it is mixed. Compaction must be completed as soon as possible after the mixture is placed on the grade.

In constructing the top layer, the grade shall be kept at sufficient height so that the top surface, when compacted, will be at or slightly above grade, rather than below grade. Finish grading shall be accomplished by removing excess material followed by recompaction by rolling. In the event that low areas occur, they shall be reconstructed to the satisfaction of the Engineer.

If any subgrade material is worked into the pozzolanic base course mixture during the compacting or finishing operations, all pozzolanic base course mixture within the affected area shall be removed and replaced with new material. The Engineer may restrict hauling over partially completed work after inclement weather or at any time when the subgrade is soft and there is a tendency for the subgrade material to work into the pozzolanic base course.

If for any reason construction operations are delayed or suspended and the Engineer orders any loose or uncompacted material removed and disposed of, the Contractor shall perform this work at his own expense. No pozzolanic base course may be salvaged.

CURING:

After the pozzolanic base course mixture has been constructed, the surface shall be kept continuously moist until the bituminous curing cover is applied. The bituminous curing cover shall be applied no later than 24 hours following final compaction unless in the judgment of the Engineer, it should be delayed. The materials and application of the curing cover shall be in accordance with the requirements of Section 4.00.08 for Bituminous Prime Coat, 0.1 gal/sy shall be applied.

CONSTRUCTION JOINTS AND MAINTENANCE:

At the end of each day's construction, a straight transverse construction joint shall be formed by cutting back into the completed work to form a vertical face. Damage to completed work shall be avoided. The pozzolanic base course mixture shall be constructed and finished full width each day without longitudinal joints.

The Contractor shall maintain, at his own expense, the entire base course in a manner satisfactory to the Engineer until the pavement has been completed. Maintenance shall include immediate repairs of any defective or damaged portions of the base course. Repairs or replacements shall be made in such a manner as to insure restoration of a uniform surface and durability of the portion

repaired or replaced. The Contractor shall also remove and replace, at his own expense, any pozzolanic base course mixture which is unsatisfactory due to its being placed over excessively wet or otherwise unstable subgrade; damaged by rain, freezing or other climatic conditions; damaged by traffic; or which is unsatisfactory due to failure to comply with any of the requirements specified herein.

The Contractor shall have at all times enough base course prepared ahead of the paving location so that paving will be a continuous operation.

If required by the Engineer, the base course shall be sprinkled with water ahead of placing the surface.

METHOD OF MEASUREMENT:

The pozzolanic mixture will be measured by weight in tons, and will include delivery to the site of placement.

Placement of the pozzolanic mixture will be measured in tons and will include transfer from the delivery truck to the trench, spreading, shaping, compaction, application of bituminous curing cover, and any necessary maintenance.

BASIS OF PAYMENT:

The completed work, as measured for Pozzolanic Mixture and Pozzolanic Base Construction, will be paid for at the contract unit prices for the following pay items.

Pay Item	Pay Unit
Pozzolanic Mixture	Tons
Pozzolanic Base Construction	Tons

Bituminous prime coat for curing cover will be incidental to Pozzolanic Base Construction and will not be paid for separately.

MICHIGAN
DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS

SPECIAL PROVISION
FOR
BITUMINOUS BASE COURSE - SPECIAL

DD/JRK 1 of 2 10/4/85

DESCRIPTION

This work shall consist of furnishing and placing a bituminous base course special using fly ash as an asphalt extender in the hot plant-mixed material on the shoulders using three different combinations of asphalt and fly ash as shown on the plans and/or in the proposal. All work shall be done in accordance with the provisions of Section 4.00 Bituminous Pavement of the 1984 Standard Specifications.

MATERIALS

The materials shall meet the requirements specified herein or shall meet the requirements specified in the Section designated of the 1984 Standard Specifications.

Dense-Graded Aggregate 20C Modified* 8.02
Mineral Filler 3MF 8.02
(Fly Ash)
Bituminous Materials 8.04

*Loss by washing plus fly ash additive shall not exceed 6% by weight as shown in Table B

COMPOSITION OF BITUMINOUS MIXTURE

The gradation of the bituminous mixture, including the fly ash added to extend the asphalt, shall meet the requirements specified in Table B.

TABLE B - MASTER GRADATION RANGE

Sieve Sizes	1-1/2 in.	1 in.	3/8 in.	No.8	No.30	No.200	% Bitumen in Mix.
Mixture	100	80-100	55-90	30-65	15-45	6 max.	**

**Based upon amount of asphalt replaced by fly ash.(See Table C)

ASPHALT REPLACEMENT

The asphalt content will be reduced from the standard 4.5 percent to as shown in Table C.

-69-(REVISED)

TABLE C - ASPHALT REPLACEMENT

Amt. of Asphalt Replaced by Vol.%	Asphalt in Mix. by Weight %	Fly Ash Added by Weight %
20	3.6	2.1
25	3.4	2.6
30	3.1	3.1

Each of the above mixtures shall be placed in equal amounts on the project or as directed by the Engineer.

MEASUREMENT AND PAYMENT

The completed work will be measured and paid for on the same basis as similar types of work in Section 4.00 of the 1984 Standard Specifications, for the following contract item (pay item).

Pay Item	Pay Unit
Bituminous Base Course Special	Ton

s.32a

APPENDIX B

MICHIGAN DEPARTMENT OF TRANSPORTATION
REPORT OF TEST
COMPUTERIZED BITUMINOUS MIX DESIGN
SHEET 1 OF 2 June 6, 1986

CONTROL SECTION:FRR 77051 JOB NO:24173A LAB NO:86MD- 64
DATE TESTED:05/26/86 BIT.MIX.BASE COURSE SPECIAL
INTENDED USE:BASE COURSE (20C BLEND) 4.00,1984 STD SPECS SUPP

MATERIALS USED

MATERIAL	TYPE	SOURCE	SP.GR.
ASPHALT CEMENT	AC-5	AMOCO	1.020
5/8" STONE		PIT #50-35	
MINERAL FILLER	3MF	LANSING BOARD WATER&LIGHT	2.190
SAND	3CS	PIT #50-35	

COMPACTIVE EFFORT 50 BLOWS
MIX DESIGN

ASPHALT %	3.6
P 8 %	49.5
P 200 %	2.6
OPTIMUM ASPHALT CONTENT=	3.61
@ OPTIMUM	
SPECIFIC GRAVITY=	2.303
STABILITY=	904.
AIR VOIDS=	9.70
V.M.A.=	17.85
FLOW=	6.00
VOIDS FILLED WITH ASPHALT=	45.66

24%CRUSH, MATERIAL SUBMITTED BY JOHN CARLO 330-2

THE ABOVE BITUMEN CONTENT & AGGREGATE ARE BASED ON THE SAMPLES OF MATERIALS SUBMITTED. VARIATIONS IN MATERIALS OR FIELD CONDITIONS MAY REQUIRE AN ADJUSTMENT OF THE BITUMEN CONTENT NOT TO EXCEED 0.4 PERCENT. TESTED FOR INFORMATION.

THIS MIX DESIGN APPROVED FOR USE ON THE FOLLOWING PROJECT(S):

PROJECT NUMBER	JOB NUMBER

BIT MIX INSP._____ DATE_____
SIGNATURE

Fred Coppola

ASSISTANT ENGINEER OF TESTING

CC: FILE
D.F. MALOTT
BIT FILE
MIX DESIGN (2)
H.ROYSTER (2)
J.LIJEWSKI (2)
R.LANGDON (CPE
J. DeFoe

MICHIGAN DEPARTMENT OF TRANSPORTATION
REPORT OF TEST
COMPUTERIZED BITUMINOUS MIX DESIGN
SHEET 2 OF 2

CONTROL SECTION:FRR 77051 JOB NO:24173A LAB NO:86MD- 64
DATE TESTED:05/28/86 BIT.MIX.BASE COURSE SPECIAL
INTENDED USE:BASE COURSE (20C BLEND) 4.00,1984 STD SPECS SUPP

MATERIALS USED

MATERIAL	TYPE	SOURCE	SP.GR.
ASPHALT CEMENT	AC-5	AMOCO	1.020
5/8" STONE		PIT #50-35	
MINERAL FILLER	3MF	LANSING BOARD WATER&LIGHT	2.190
SAND	3CS	PIT #50-35	

COMPACTIVE EFFORT 50 BLOWS

	AGG A	AGG B	AGG C	COMBINED
PIT #	50-35	50-35		RESULTS
TYPE OF AGGREGATE	3CS SAND	5/8 STONE	3MF	
AGGREGATE, %	60.0	37.9	2.1	
SIEVE SIZE				
1 1/2 INCH	100.0	100.0	100.0	100.0
1 INCH	100.0	98.5	100.0	99.4
3/4 INCH	100.0	85.9	100.0	94.7
1/2 INCH	110.0	58.1	100.0	90.1
3/8 INCH	100.0	33.3	100.0	74.7
NO. 4	97.6	4.0	100.0	62.2
NO. 8	78.3	1.2	100.0	49.5
NO. 30	48.1	.6	100.0	31.2
NO. 200	.9	.3	94.0	2.6
CRUSH,#4		28		27

ASPHALT	%	3.6
P8	%	49.5
P200	%	2.6
DENSITY LB/CU.F.		143.7

24%CRUSH, MATERIAL SUBMITTED BY JOHN CARLO 330-2

THE ABOVE BITUMEN CONTENT & AGGREGATE ARE BASED ON THE SAMPLES OF MATERIALS SUBMITTED. VARIATIONS IN MATERIALS OR FIELD CONDITIONS MAY REQUIRE AN ADJUSTMENT OF THE BITUMEN CONTENT NOT TO EXCEED 0.4 PERCENT. TESTED FOR INFORMATION.

CC: FILE
D.F. MALOTT
BIT FILE
MIX DESIGN (2)
H.ROYSTER (2)
J.LIJEWSKI (2)
R.LANGDON (CPE

Fred Copple

ASSISTANT ENGINEER OF TESTING

MICHIGAN DEPARTMENT OF TRANSPORTATION
REPORT OF TEST
COMPUTERIZED BITUMINOUS MIX DESIGN
SHEET 1 OF 2 June 6, 1986

CONTROL SECTION:FRR 77051 JOB NO:24173A LAB NO:86MD- 65
DATE TESTED:05/28/86 BIT.MIX.BASE COURSE SPECIAL
INTENDED USE:BASE COURSE (20C BLEND) 4.00,1984 STD SPECS SUPP

MATERIALS USED

MATERIAL	TYPE	SOURCE	SP.GR.
ASPHALT CEMENT	AC-5	AMOCO	1.020
5/8" STONE		PIT #50-35	
MINERAL FILLER	3MF	LANSING BOARD WATER&LIGHT	2.190
SAND	3CS	PIT #50-35	

COMPACTIVE EFFORT 50 BLOWS
MIX DESIGN

ASPHALT %	3.4
P 8 %	50.0
P 200 %	3.1
OPTIMUM ASPHALT CONTENT=	3.40
@ OPTIMUM	
SPECIFIC GRAVITY=	2.305
STABILITY=	1048.
AIR VOIDS=	9.85
V.M.A.=	17.53
FLOW=	6.00
VOIDS FILLED WITH ASPHALT=	43.83

27% CRUSH, MATERIAL SUBMITTED BY JOHN CARLO 330-2

THE ABOVE BITUMEN CONTENT & AGGREGATE ARE BASED ON THE SAMPLES OF MATERIALS SUBMITTED. VARIATIONS IN MATERIALS OR FIELD CONDITIONS MAY REQUIRE AN ADJUSTMENT OF THE BITUMEN CONTENT NOT TO EXCEED 0.4 PERCENT. TESTED FOR INFORMATION.

THIS MIX DESIGN APPROVED FOR USE ON THE FOLLOWING PROJECT(S):

PROJECT NUMBER	JOB NUMBER

BIT MIX INSP._____ DATE_____
SIGNATURE

ASSISTANT ENGINEER OF TESTING

CC: FILE
D.F. MALOTT
BIT FILE
MIX DESIGN (2)
H.ROYSTER (2)
J.LIJEWSKI (2)
R.LANGDON CPE
J.DeFoe

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* MICHIGAN DEPARTMENT OF TRANSPORTATION *
* REPORT OF TEST *
* COMPUTERIZED BITUMINOUS MIX DESIGN *
SHEET 2 OF 2

****

CONTROL SECTION:FRR 77051 JOB NO:24173A LAB NO:86MD- 65
DATE TESTED:05/28/86 BIT.MIX.BASE COURSE SPECIAL
INTENDED USE:BASE COURSE (20C BLEND) 4.00,1984 STD SPECS SUPP

MATERIALS USED

MATERIAL	TYPE	SOURCE	SP.GR.
ASPHALT CEMENT	AC-5	AMOCO	1.020
5/8" STONE		PIT #50-35	
MINERAL FILLER	3MF	LANSING BOARD WATER&LIGHT	2.190
SAND	3CS	PIT #50-35	

COMPACTIVE EFFORT 50 BLOWS

	AGG A	AGG B	AGG C	COMBINED
PIT #	50-35	50-35		RESULTS
TYPE OF AGGREGATE	3CS SAND	5/8 STONE	3MF	
AGGREGATE, %	60.0	37.4	2.6	
SIEVE SIZE				
1 1/2 INCH	100.0	100.0	100.0	100.0
1 INCH	100.0	98.5	100.0	99.4
3/4 INCH	100.0	85.9	100.0	94.7
1/2 INCH	110.0	58.1	100.0	90.3
3/8 INCH	100.0	33.3	100.0	75.1
NO. 4	97.6	4.0	100.0	62.7
NO. 8	78.3	1.2	100.0	50.0
NO. 30	48.1	.6	100.0	31.7
NO. 200	.9	.3	94.0	3.1
CRUSH,#4		28		27

ASPHALT	%	3.4
P8	%	50.0
P200	%	3.1
DENSITY	LB/CU.F.	143.8

27% CRUSH, MATERIAL SUBMITTED BY JOHN CARLO 330-2

THE ABOVE BITUMEN CONTENT & AGGREGATE ARE BASED ON THE SAMPLES OF MATERIALS SUBMITTED. VARIATIONS IN MATERIALS OR FIELD CONDITIONS MAY REQUIRE AN ADJUSTMENT OF THE BITUMEN CONTENT NOT TO EXCEED 0.4 PERCENT. TESTED FOR INFORMATION.

CC: FILE
D.F. MALOTT
BIT FILE
MIX DESIGN (2)
H.ROYSTER (2)
J.LIJEWSKI (2)
R.LANGDON CPE

Fred Copple

ASSISTANT ENGINEER OF TESTING

MICHIGAN DEPARTMENT OF TRANSPORTATION
REPORT OF TEST
COMPUTERIZED BITUMINOUS MIX DESIGN
SHEET 1 OF 2 June 6, 1986

CONTROL SECTION:FRR 77051 JOB NO:24173A LAB NO:86MD- 66
DATE TESTED:05/28/86 BIT.MIX.BASE COURSE SPECIAL
INTENDED USE:BASE COURSE (20C BLEND) 4.00,1984 STD SPECS SUPP

MATERIALS USED

MATERIAL	TYPE	SOURCE	SP.GR.
ASPHALT CEMENT	AC-5	AMOCO	1.020
5/8" STONE		PIT #50-35	
MINERAL FILLER	3MF	LANSING BOARD WATER&LIGHT	2.190
SAND	3CS	PIT #50-35	

COMPACTIVE EFFORT 50 BLOWS
MIX DESIGN

ASPHALT %	3.1
P 8 %	50.5
P 200 %	3.6
OPTIMUM ASPHALT CONTENT=	3.10
@ OPTIMUM	
SPECIFIC GRAVITY=	2.297
STABILITY=	1281.
AIR VOIDS=	10.50
V.M.A.=	17.48
FLOW=	6.33
VOIDS FILLED WITH ASPHALT=	39.94

27% CRUSH, MATERIAL SUBMITTED BY JOHN CARLO 330-2

THE ABOVE BITUMEN CONTENT & AGGREGATE ARE BASED ON THE SAMPLES OF MATERIALS SUBMITTED. VARIATIONS IN MATERIALS OR FIELD CONDITIONS MAY REQUIRE AN ADJUSTMENT OF THE BITUMEN CONTENT NOT TO EXCEED 0.4 PERCENT. TESTED FOR INFORMATION.

THIS MIX DESIGN APPROVED FOR USE ON THE FOLLOWING PROJECT(S):

PROJECT NUMBER	JOB NUMBER

BIT MIX INSP. _____ DATE _____
SIGNATURE

Fred Copple

ASSISTANT ENGINEER OF TESTING

CC: FILE
D.F. MALOTT
BIT FILE
MIX DESIGN (2)
H.ROYSTER (2)
J.LIJEWSKI (2)
R.LANGDON (PE)
J. DeFoe

MICHIGAN DEPARTMENT OF TRANSPORTATION
REPORT OF TEST
COMPUTERIZED BITUMINOUS MIX DESIGN
SHEET **2** OF **2**

CONTROL SECTION:FRR 77051 JOB NO:24173A LAB NO:86MD- 66
DATE TESTED:05/28/86 BIT.MIX.BASE COURSE SPECIAL
INTENDED USE:BASE COURSE (20C BLEND) 4.00,1984 STD SPECS SUPP

MATERIALS USED

MATERIAL	TYPE	SOURCE	SP.GR.
ASPHALT CEMENT	AC-5	AMOCO	1.020
5/8" STONE		PIT #50-35	
MINERAL FILLER	3MF	LANSING BOARD WATER&LIGHT	2.190
SAND	3CS	PIT #50-35	

COMPACTIVE EFFORT 50 BLOWS

	AGG A	AGG B	AGG C	COMBINED
PIT #	50-35	50-35		RESULTS
TYPE OF AGGREGATE	3CS SAND	5/8 STONE	3MF	
AGGREGATE, %	60.0	36.9	3.1	
SIEVE SIZE				
1 1/2 INCH	100.0	100.0	100.0	100.0
1 INCH	100.0	93.5	100.0	99.4
3/4 INCH	100.0	85.9	100.0	94.8
1/2 INCH	110.0	58.1	100.0	90.5
3/8 INCH	100.0	33.3	100.0	75.4
NO. 4	97.6	4.0	100.0	63.1
NO. 8	78.3	1.2	100.0	50.5
NO. 30	48.1	.6	100.0	32.2
NO. 200	.9	.3	94.0	3.6
CRUSH,#4		28		27

ASPHALT	%	3.1
P8	%	50.5
P200	%	3.6
DENSITY	LB/CU.F.	143.3

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