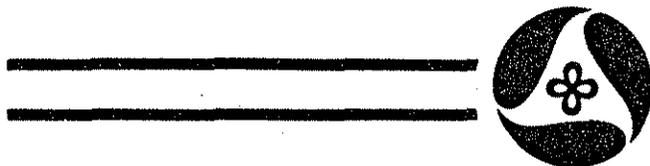


**IOWA RESEARCH
WITH
CHEM-CRETE
BITUMEN**

**FINAL REPORT
IOWA HIGHWAY RESEARCH BOARD
PROJECT HR-226**



Highway Division
**Iowa Department
of Transportation**

Disclaimer

The opinions, findings, and conclusions expressed in this report are those of the authors and not necessarily those of Story County or the Iowa Department of Transportation

FINAL REPORT
IOWA HIGHWAY RESEARCH BOARD
PROJECT HR-226

IOWA RESEARCH WITH CHEM-CRETE BITUMEN

by

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Story County Engineer
and
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Office of Materials
Iowa Department of Transportation
Ames, Iowa
515/239-1382

TABLE OF CONTENTS

| | |
|------------------------------|----|
| ACKNOWLEDGEMENTS | 1 |
| INTRODUCTION | 2 |
| OBJECTIVES | 3 |
| PROJECT DESCRIPTION | 3 |
| ASPHALT MIX DESIGNS | 5 |
| TEST SECTIONS | 5 |
| CONSTRUCTION | 6 |
| DISCUSSION | 6 |
| CONCLUSIONS | 7 |
| APPENDICES | |
| A - Test Reports | 10 |
| B - Contracts | 18 |
| - Special Provisions | |
| C - Asphalt Cement Test Data | 22 |
| D - Crack Survey | 24 |
| E - Road Rater Data | 27 |

ACKNOWLEDGEMENTS

Research project HR-226 was sponsored by the Iowa Highway Research Board and the Iowa Department of Transportation. Funding for this project was from the Secondary Road Research Fund in the amount of \$34,830.

The authors wish to extend appreciation to the Story County Board of Supervisors and the Iowa DOT for their support in the evaluation of new technology. We also wish to thank M. R. Johnson of Manatt's, Inc. for his cooperation on the project. Jim Grove of Story County and Steve Tritsch of the Iowa DOT were important participants in the development and construction of the project.

INTRODUCTION

With the spiraling cost of construction, coupled with inflation, engineers must develop and research new techniques to better utilize the public's dollar. One area in which these new technologies must be researched is in the field of highway construction; more specifically, asphalt products.

There are areas within the state of Iowa which do not have Class I aggregate readily available for asphalt concrete road construction. The cost of transporting higher quality aggregate specified in the "Standard Specifications for Highway and Bridge Construction"¹ for construction projects is escalating on a yearly basis. Many counties will be squeezed out of the construction of new roadways if an alternative to the high costs is not identified. The same high costs will curtail adequate upkeep on the existing paved system and will result in decreased serviceability. For this reason, a product is needed to better utilize the local aggregates for road construction and maintenance.

There is a product on the market which the promoters claim will improve the present asphalt to such a degree as to "upgrade deficient aggregates" to the level they can be used in today's standard construction techniques. This product is "Chem-Crete Bitumen," a "specially refined asphalt" that was promoted by Chem-Crete Corporation of Menlo Park, California. Chemcrete Technologies, Inc. of Wickliffe, Ohio; a wholly owned subsidiary of the Lubrizol Corporation has since purchased the U.S.

1 "Standard Specifications for Highway and Bridge Construction", Iowa Department of Transportation, 1977.

patents of Chem-Crete. Chem-Crete was promoted as a product which increases the stability of asphalt mixes at all temperatures, improves durability and upgrades the fatigue response of present materials by increasing the limiting stress and strain.

OBJECTIVES

The primary objective of the research was to determine if Chem-Crete Bitumen would provide significantly improved performance of the mix designs used. The secondary objective was to determine if a satisfactory asphalt concrete base could be made using a poorly graded sand.

PROJECT DESCRIPTION

Two roadways were selected in Story County to evaluate the performance of Chem-Crete Bitumen. The projects are a 1.046-mile section of county road E-57 and a 2.400-mile section of the North Dakota Street extension (Figure 1).

The existing roadbed of E-57 consisted of 2.5 inches of Type B asphalt cement concrete over a 6-inch rolled stone base with a 4-inch soil-aggregate subbase. The North Dakota Street extension roadbed was 4.5 inches of emulsion treated base.

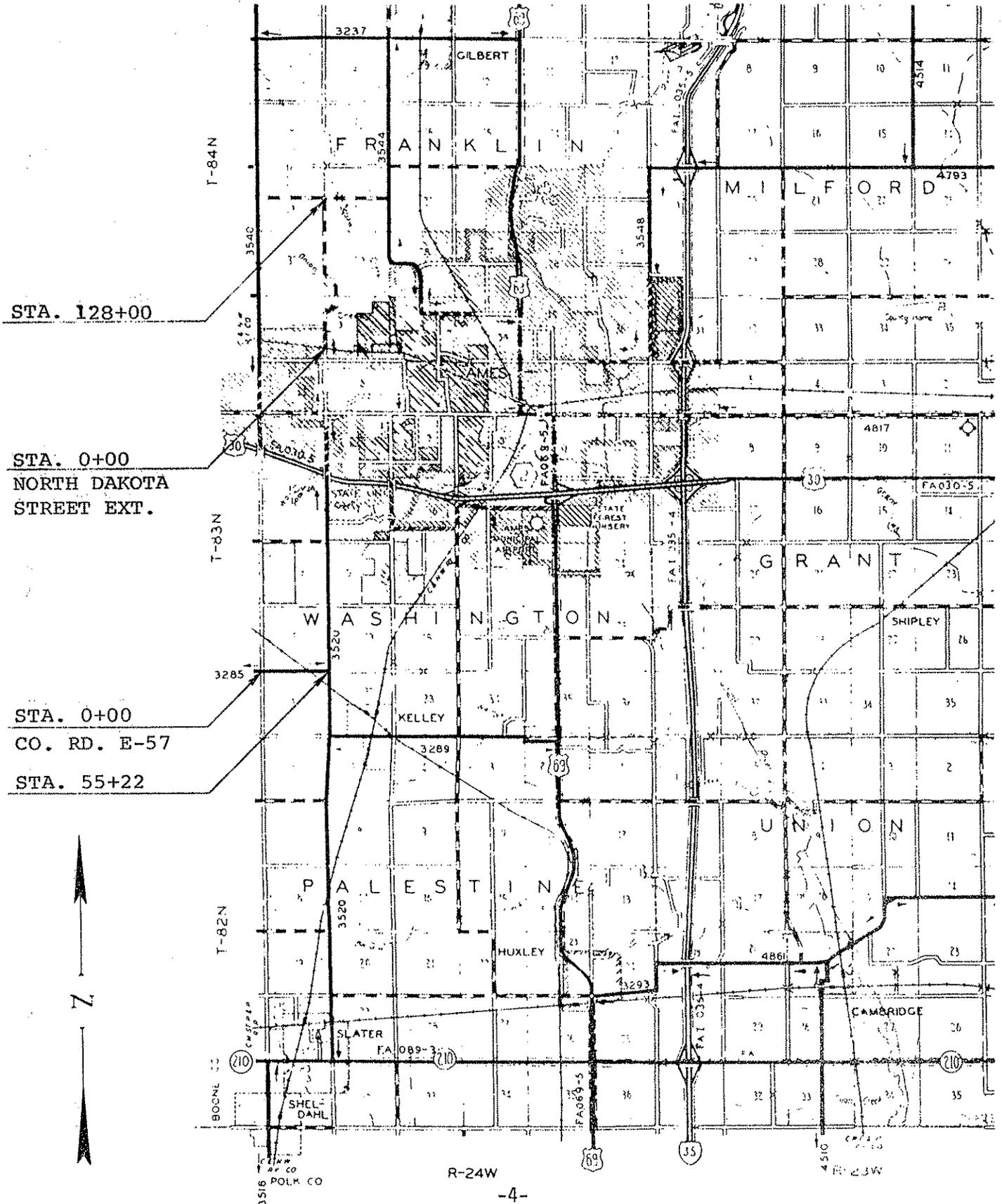
The traffic estimates are:

| | <u>1980 ADT</u> | <u>2000 ADT</u> | <u>Percent Trucks</u> |
|--------------|-----------------|-----------------|-----------------------|
| E-57 | 160 | 200 | 20 |
| North Dakota | 600 | 1000 | 10 |

Figure 1 - Project Locations

STORY COUNTY

IOWA



ASPHALT MIX DESIGNS

Chem-Crete was to be blended 1:9 with an AC-10 asphalt cement and mixed prior to use. The bid price for asphalt cement included the cost for supplying and blending the asphalt modifier. A hot sand mix and a Type B Class 2 asphaltic concrete mix were designed for the blend. Both mix designs were also specified for use with unmodified asphalt cement. The sand was from the Williams Pit in Story County and the gravel for the Type B mix was from the Peterson Pit in Story County. Appendix A contains the material test reports.

TEST SECTIONS

On E-57, the sand mix and the Type B Class 2 asphalt cement concrete were placed in two lifts for a total depth of 3 inches.

The placements are:

| | | |
|---------------------|------------|--------------------------|
| Type B | 6% asphalt | Sta. 0+00 to Sta. 32+75 |
| Type B w/Chem-Crete | 6% asphalt | Sta. 33+30 to Sta. 44+00 |
| Sand w/Chem-Crete | 7% asphalt | Sta. 44+00 to Sta. 55+22 |

The North Dakota Street extension is a nominal 1 1/2-inch lift of the sand mix and Type B Class 2 asphalt cement concrete.

The placements are:

| | | | |
|-------------------|------------|---------------------------|----------|
| Sand w/Chem-Crete | 6% asphalt | Sta. 0+00 to Sta. 29+50 | |
| | | Sta. 30+50 to Sta. 90+00 | Lt. Side |
| | | Sta. 30+60 to Sta. 69+70 | Rt. Side |
| Sand w/Chem-Crete | 8% asphalt | Sta. 29+50 to Sta. 30+50 | Lt. Side |
| | | Sta. 29+50 to Sta. 30+60 | Rt. Side |
| Sand | 6% asphalt | Sta. 69+70 to Sta. 90+20 | Rt. Side |
| Type B | 6% asphalt | Sta. 90+00 to Sta. 128+00 | Lt. Side |
| | | Sta. 90+20 to Sta. 128+00 | Rt. Side |

CONSTRUCTION

The construction began September 15, 1980 and was completed September 19, 1980. Iowa Road Builders Company was the contractor. Copies of the contracts and special provisions are in Appendix B.

A Barber Green plant in Ames, Iowa was used to batch mix the asphalt concrete. Haul distances to the projects were approximately 10 miles to E-57 and 6 miles to the North Dakota Street extension.

The construction procedure was standard practice with the exception of the rolling sequence. The hot asphalt mix with Chem-Crete appeared to retain the heat. The roller was held back from the Blaw-Knox laydown machine to allow the asphalt to cool to prevent the asphalt from creeping ahead of the roller.

Average high air temperature during construction was 72^o F and the average low air temperature was 47^o F. No measurable precipitation fell during construction.

DISCUSSION

Test cores were drilled in March and April 1981. The Iowa DOT determined the penetration and viscosity on the extracted asphalts (Appendix C). The test revealed low penetrations for the asphalt with Chem-Crete from the sand mixes, however, penetrations for the asphalt with Chem-Crete from the Type B mix were close to values obtained from assurance samples. Test cores were sent to the Chem-Crete Corporation for analysis. The evaluation by the Chem-Crete Corporation indicated a variation in treatment levels. The Chem-Crete Corporation attributed the variation to inadequate mixing of the Chem-Crete additive with the AC-10. Neither the Iowa DOT nor Story County were informed as to the mixing time required.

In October 1981, the Iowa DOT received a letter from Chem-Crete acknowledging that the mixing time was probably not the primary cause of the premature cracking.

A crack survey was completed during the first two weeks of March 1981 on the two Chem-Crete projects. The Chem-Crete sections exhibited severe cracking while the control sections did not (Figures 2-4). Cracks in the Chem-Crete sections were as wide as 3/4 of an inch. Appendix D is a summary of the crack survey. The Chem-Crete Corporation testing indicated that the primary problem was inadequate tensile strength in the Chem-Crete sections.

The Iowa DOT Road Rater was used to determine the relative strengths of the test segments before and after construction (Appendix E). The 1982 testing indicated lower deflections for the comparative Chem-Crete sections. On E-57, the 80th percentile deflection for the Type B mix with Chem-Crete was 3.3 mils and for the untreated Type B mix it was 3.7 mils. Similar results were found between the treated and untreated sand mix, however, only limited testing was conducted on North Dakota Street extension.

The severe cracking on the Chem-Crete sections required corrective action in 1982. North Dakota Street received a seal coat and the cracks on E-57 were sealed with emulsion in the summer of 1982. Chem-Crete Corporation funded the cost of the crack sealing and seal coating. A second seal coat was placed on North Dakota Street in 1983 to correct the earlier seal coat which had experienced loss of cover aggregate.

CONCLUSIONS

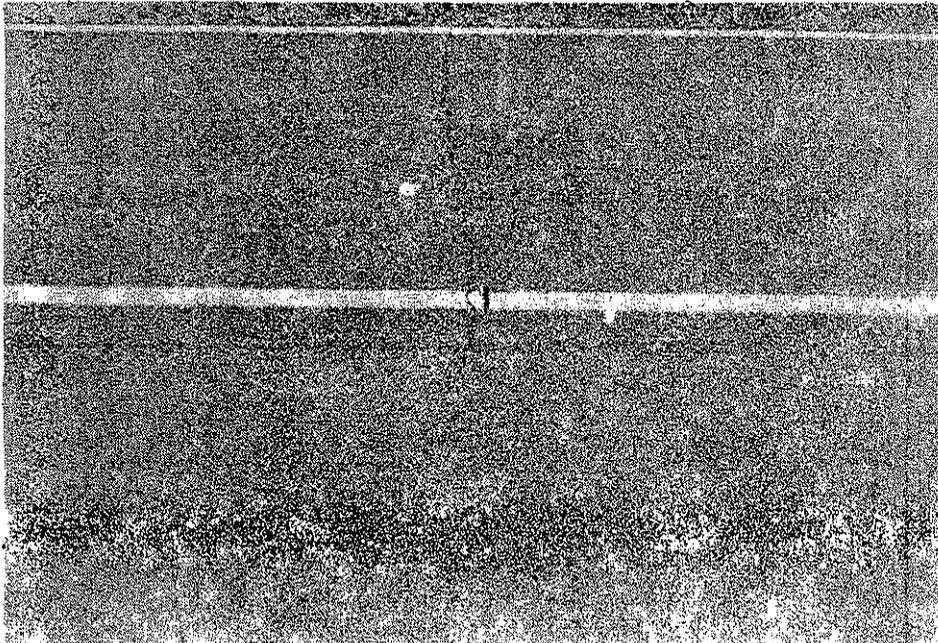
The following conclusions can be stated:

1. Based on the comparative test sections with and without the asphalt modifier, it can be concluded that Chem-Crete had a very detrimental effect on the Type B mix used.

Severe cracking on the Chem-Crete section developed in the first year of service.

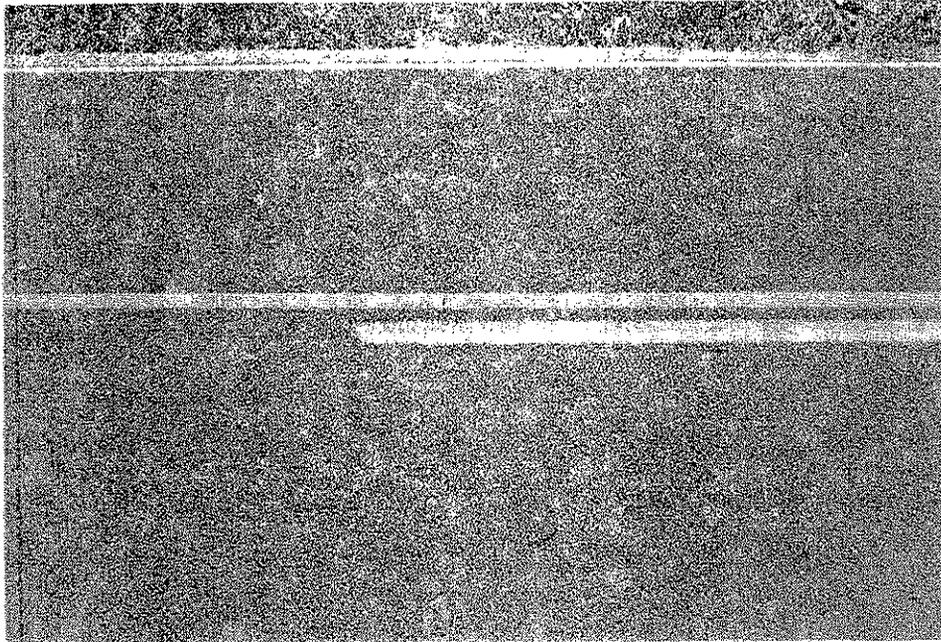
2. The asphalt concrete base mix using the Chem-Crete modifier and poorly graded sand was unsatisfactory. Severe cracking also developed in the first year of service.
3. The Chem-Crete sections will require substantial future maintenance. The seal coat applied to North Dakota will probably be inadequate and either overlay or removal will be required much earlier than normal. In January 1984 the crack filling on E-57 also appears to be inadequate and further work will be required.

Figure 2



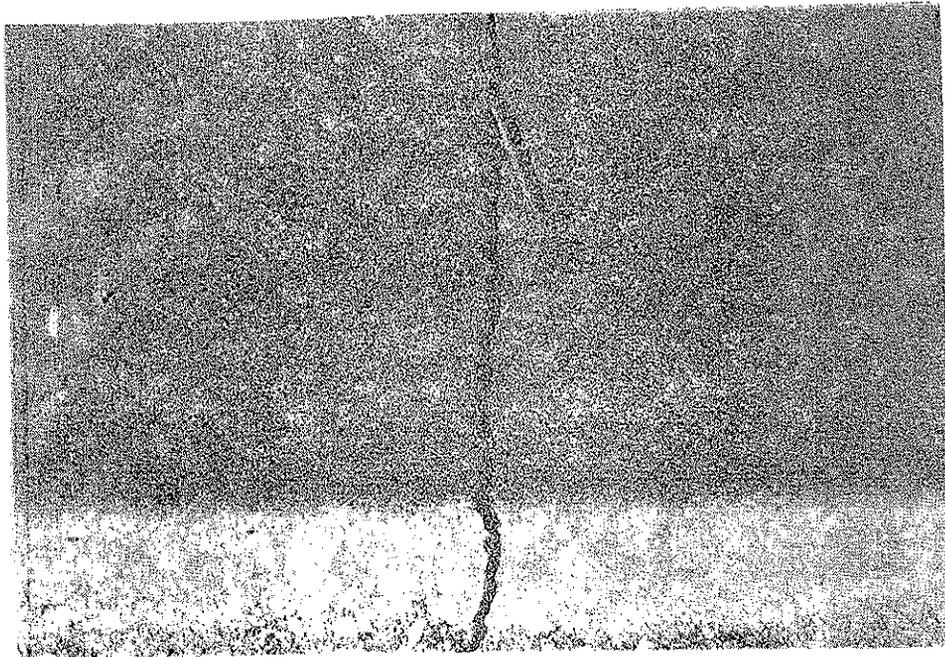
Crack extending into control section
from sand Chem-Crete section.

Figure 3



Crack in sand Chem-Crete section only.

Figure 4



Crack in Chem-Crete section.

Appendix A
Test Reports

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

MATERIAL ASPHALT CHEM-CRETE LAB NO. AB0-197
INTENDED USE SPECIAL SAND MIXTURE & TYPE B CLASS 2 ACC
COUNTY STORY PROJ NO. L-WA-180--73-85
DESIGN CONTRACT NO. L-F-180--73-85
PRODUCER CHEM-CRETE CORP. CONTRACTOR IOWA ROAD BUILDERS
SOURCE BEAUMONT, TEXAS
UNIT OF MATERIAL ONE TANKER. 38,440 LBS.
SAMPLED BY BOB HOBSON SENDER'S NO. 1FB0-149
DATE SAMPLED 9/10/80 REC'D 9/11/80 REPORTED 9/16/80

SPECIFIC GRAVITY AT 60 F/60 F. 0.994

SOFT. POINT: METHOD (R & B)

PENETRATION AT 77 F. 100 GMS. 5 SEC.

FLASH POINT

SOLUBLE IN TRICHLOROETHYLENE 99.49%

DUCTILITY AT 77 F.

SPOT TEST

KINEMATIC VISCOSITY @ 140 F., CENTISTOKES 3056

THIN FILM LOSS ON HEATING 5 HRS AT 325 F. 1.96%

% ORIGINAL PENETRATION (THIN FILM RES.)

PENETRATION OF RES. AT 77 F. 100 GMS. 5 SEC.

DUCTILITY AT 77 F. (THIN FILM RES.) 37 CMS.

ABSOLUTE VISCOSITY ORIGINAL 140 F. 30 CM HG 31 POISES

ABSOLUTE VISCOSITY THIN FILM RES. 140 F. 30 CM HG 532 POISES

KIN. VISCOSITY ORIGINAL @ 275 F.

COPIES:

~~ASPHALT~~

R. HUMPHREY

PROJECTS LISTED ABOVE

DISPOSITION:

SIGNED: BERNARD C. BROWN
TESTING ENGINEER

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

MATERIAL SAND (CHEMCRETE)

LAB NO. AAT0-469

INTENDED USE SPECIAL SAND MIXTURE (ACC)

L-WA-180--73-85

COUNTY STORY

PROJ NO. L-F-180--73-85

DESIGN

CONTRACT NO.

PRODUCER MCCALLISTER CONSTR. CO.

CONTRACTOR IOWA ROAD BUILDERS - NO. AMES

SOURCE WILLIAMS PIT (AGGR. FURNISHED BY STORY CO.) SE 22-83-22 STORY CO.

UNIT OF MATERIAL FROM STOCKPILE

SAMPLED BY BOB HOBSON

SENDER'S NO. 1FB0-137

DATE SAMPLED 8/19/80

REC'D 8/20/80

REPORTED 9/2/80

SIEVE ANALYSIS - PER CENT PASSING

| | |
|---------|-----|
| 1 1/2" | |
| 1" | |
| 3/4" | * |
| 1/2" | 100 |
| 3/8" | 96 |
| NO. 4 | 87 |
| NO. 8 | 72 |
| NO. 16 | 53 |
| NO. 30 | 35 |
| NO. 50 | 18 |
| NO. 100 | 6.5 |
| NO. 200 | 4.3 |

% PSG. NO. 8 AFTER 16 CYCLES F & T, WATER-ALCO. SOL.
% PSG. NO. 8 AFTER 25 CYCLES F & T, WATER SOLUTION
% OF WEAR, LOS ANGELES ABRASION, GRADING

LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX

* FIELD GRADING

COPIES:

~~RIT. AGG.~~
R. HUMPHREY
D. JESPERSEN
PROJECTS LISTED ABOVE
GEOLOGY

DISPOSITION:

SIGNED: BERNARD C. BROWN
TESTING ENGINEER

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

MATERIAL 3/4" GRAVEL

LAB NO. AAT0-472

INTENDED USE 3/4" TYPE B CLASS 2 ACC

BOONE

COUNTY STORY

3-80

PROJ NO. L-N-180--73-85

L-WA-180--73-85

DESIGN

CONTRACT NO.

PRODUCER MAUDLIN CONSTR.

CONTRACTOR IOWA ROAD BUILDERS

SOURCE PETERSON PIT NW 13-84-24 STORY CO.

UNIT OF MATERIAL 2 BAGS FROM STOCKPILE AT I.R.B. ASPH. PLANT

SAMPLED BY J HINRICHSSEN & R. PAULSON

SENDER'S NO. 1FB0-138

D' : SAMPLED 8-20-80

REC'D 8-21-80

REPORTED 8-28-80

SIEVE ANALYSIS - PER CENT PASSING

| | |
|---------|-----|
| 1 1/2" | * |
| 1" | 100 |
| 3/4" | 99 |
| 1/2" | 91 |
| 3/8" | 83 |
| NO. 4 | 68 |
| NO. 8 | 56 |
| NO. 16 | 44 |
| NO. 30 | 30 |
| NO. 50 | 16 |
| NO. 100 | 8.7 |
| NO. 200 | 6.7 |

% PSG. NO. 8 AFTER 16 CYCLES F & T, WATER-ALCO. SOL.

% PSG. NO. 8 AFTER 25 CYCLES F & T, WATER SOLUTION

% OF WEAR, LOS ANGELES ABRASION, GRADING

LIQUID LIMIT
PLASTIC LIMIT
PLASTICITY INDEX

* FIELD GRADING

COPIES:

BIT. AGG.

R. HUMPHREY

PROJECTS LISTED ABOVE

GEOLOGY

DISPOSITION:

SIGNED: BERNARD C. BROWN
TESTING ENGINEER

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: SPECIAL SAND LAB NO. ABD0-143

INTENDED USE:

SIZE SPEC. NO. 852-857-861E REPORTED 9-2-80

COUNTY STORY PROJECT L-WA-180--73-85
L-F-180--73-85

CONTRACTOR IA. ROAD BUILDERS

PROJ. LOCATION ON E57 ON N. LINE SEC. 31-83-24, 1 MI.; FROM W 1/4 COR. 29-84-24
SOUTH 2.4 MI. TO C & NW RAILROAD.

AGG. SOURCES SAND-WILLIAMS PIT - STORY CO.

JOB MIX FORMULA AGGREGATE PROPORTIONS: 100% AAT0-469

| JOB MIX FORMULA - COMBINED GRADATION | | | | | | | | | | | |
|--------------------------------------|----|------|------|------|------|------|-------|-------|-------|--------|--------|
| 1-1/2" | 1" | 3/4" | 1/2" | 3/8" | NO.4 | NO.8 | NO.16 | NO.30 | NO.50 | NO.100 | NO.200 |
| | | | 100 | 96 | 87 | 72 | 53 | 35 | 18 | 6.5 | 4.3 |

TOLERANCE:

| | |
|--|--------------------------|
| 75 BLOW MARSHALL DENSITY | 2.28 |
| ASPHALT SOURCE AND APPROXIMATE VISCOSITY | SUGAR CREEK - 914 POISES |
| PLASTICITY INDEX | N.F. |
| % ASPH. IN MIX | 6.0 7.0 8.0 |
| NUMBER OF MARSHALL BLOWS | 50 50 50 |
| MARSHALL STABILITY - LBS. | 698 852 917 |
| FLOW - 0.01 IN. | 6 7 9 |
| SP.GR. BY DISPLACEMENT(LAB DENS.) | 2.22 2.27 2.28 |
| BULK SP. GR. COMB. DRY AGG. | 2.658 2.658 2.658 |
| SP. GR. ASPH. @ 77 F. | 1.029 1.029 1.029 |
| CALC. SOLID SP.GR. | 2.45 2.41 2.38 |
| % YDS - CALC. | 9.3 5.9 4.1 |
| RILL SP. GR. | 2.43 2.40 2.36 |
| % VOIDS - RICE | 8.6 5.3 3.4 |
| % WATER ABSORPTION - AGGREGATE | 0.74 0.74 0.74 |
| % VOIDS IN THE MINERAL AGGREGATE | 21.5 20.6 21.1 |
| % V.M.A. FILLED WITH ASPHALT | 56.7 71.4 80.5 |
| CALCULATED ASPH.FILM THICKNESS(MICRONS) | 9.1 10.6 12.6 |
| FILLER/BITUMEN RATIO | 0.6 |

A CONTENT OF 7.0% ASPHALT IS RECOMMENDED TO START THE JOB.

COPIES:

ASPH. MIX DESIGN
PROJECTS LISTED ABOVE
JESPERSON
R. HUMPHREY
R. SHELQUIST
L. ZEARLEY
IA. ROAD BUILDERS
MARKS
C. JONES

SIGNED: BERNARD C. BROWN
TESTING ENGINEER

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: SPECIAL SAND-CHEMCRETE LAB NO. ABD0-144

INTENDED USE:

SIZE SPEC. NO. 852-857-DATE REPORTED 9/2/80
861
COUNTY STORY PROJECT L-WA-180--73-85
L-F-180--73-85

CONTRACTOR IOWA ROAD BUILDERS
ON E57 ON THE N. LINE SEC. 31-83-24, 1 MI.; FROM W 1/4 COR.
PROJ. LOCATION 20-84-24 SOUTH 2.4 MI. TO C.&N.W. RAILROAD

AGG. SOURCES SAND - WILLIAMS PIT - STORY CO.

JOB MIX FORMULA AGGREGATE PROPORTIONS: 100% AAT0-469

JOB MIX FORMULA - COMBINED GRADATION

| 1-1/2" | 1" | 3/4" | 1/2" | 3/8" | NO.4 | NO.8 | NO.16 | NO.30 | NO.50 | NO.100 | NO.200 |
|--------|----|------|------|------|------|------|-------|-------|-------|--------|--------|
| | | | 100 | 96 | 87 | 72 | 53 | 35 | 18 | 6.5 | 4.3 |

TOLERANCE:

| | |
|--|------------------------------------|
| 75 BLOW MARSHALL DENSITY | 2.26 |
| ASPHALT SOURCE AND APPROXIMATE VISCOSITY | SUGAR CREEK & CHEMCRETE-605 POISES |
| PLASTICITY INDEX | N. P. |
| % ASPH. IN MIX | 6.0 7.0 8.0 |
| NUMBER OF MARSHALL BLOWS | 50 50 50 |
| MARSHALL STABILITY - LBS. | 1260 1705 1642 |
| FLOW - 0.01 IN. | 8 8 9 |
| SP.GR. BY DISPLACEMENT(LAB DENS.) | 2.23 2.25 2.27 |
| BULK SP. GR. COMB. DRY AGG. | 2.658 2.658 2.658 |
| SP. GR. ASPH. @ 77 F. | 1.028 1.028 1.028 |
| CALC. SOLID SP.GR. | 2.45 2.41 2.38 |
| % VOIDS - CALC. | 8.9 6.7 4.5 |
| RICE SP. GR. | 2.43 2.40 2.36 |
| % VOIDS - RICE | 9.1 6.1 4.0 |
| % WATER ABSORPTION - AGGREGATE | 0.74 0.74 0.74 |
| % VOIDS IN THE MINERAL AGGREGATE | 21.1 21.3 21.4 |
| % V.M.A. FILLED WITH ASPHALT | 58.0 68.5 78.9 |
| CALCULATED ASPH.FILM THICKNESS(MICRONS) | 9.1 10.9 12.6 |
| FILLER/BITUMEN RATIO | 0.6 |

A CONTENT OF 7.0% ASPHALT - CHEMCRETE IS RECOMMENDED TO START THE JOB

COPIES:

ASPH. MIX DESIGN
PROJECTS LISTED ABOVE
R. HUMPHREY
D. JESPERSEN
D. JORDISON
R. SHELQUIST
L. ZEARLEY
IOWA ROAD BUILDERS
V. MARKS
C. JONES

SIGNED: BERNARD C. BROWN
TESTING ENGINEER

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE B CLASS 2

LAB NO. ABD0-140

INTENDED USE:

SIZE 3/4" SPEC. NO. 852-857-DATE REPORTED 8/28/80
BOONE 861 3-80
COUNTY STORY PROJECT L-N-180--73-85
STORY L-WA-180--73-85
CONTRACTOR IOWA ROAD BUILDERS

PROJ. LOCATION

AGG. SOURCES 3/4" GRAVEL - PETERSON PIT - STORY CO.

JOB MIX FORMULA AGGREGATE PROPORTIONS: 100% AAT0-472

| JOB MIX FORMULA - COMBINED GRADATION | | | | | | | | | | | | | |
|---|----|------|------|------|------|------|-------|--------------------------|-------|--------|--------|---|---|
| 1-1/2" | 1" | 3/4" | 1/2" | 3/8" | NO.4 | NO.8 | NO.16 | NO.30 | NO.50 | NO.100 | NO.200 | | |
| 100 | 99 | 91 | 83 | 68 | 56 | 44 | 30 | 16 | 8.7 | 6.7 | | | |
| TOLERANCE: | | | | | | | | 98/100 | 7 | 7 | 6 | 5 | 3 |
| 75 BLOW MARSHALL DENSITY | | | | | | | | 2.36 | | | | | |
| ASPHALT SOURCE AND APPROXIMATE VISCOSITY | | | | | | | | SUGAR CREEK - 914 POISES | | | | | |
| PLASTICITY INDEX | | | | | | | | N. P. | | | | | |
| % ASPH. IN MIX | | | | | | | | 5.0 | 6.0 | 7.0 | | | |
| NUMBER OF MARSHALL BLOWS | | | | | | | | 50 | 50 | 50 | | | |
| MARSHALL STABILITY - LBS. | | | | | | | | 1758 | 1737 | 1550 | | | |
| FLOW - 0.01 IN. | | | | | | | | 7 | 8 | 10 | | | |
| SP. GR. BY DISPLACEMENT (LAB DENS.) | | | | | | | | 2.29 | 2.34 | 2.35 | | | |
| BULK SP. GR. COMB. DRY AGG. | | | | | | | | 2.670 | 2.670 | 2.670 | | | |
| SP. GR. ASPH. @ 77 F. | | | | | | | | 1.029 | 1.029 | 1.029 | | | |
| CALC. SOLID SP. GR. | | | | | | | | 2.49 | 2.46 | 2.42 | | | |
| % VOIDS - CALC. | | | | | | | | 8.2 | 4.8 | 2.9 | | | |
| ...CE SP. GR. | | | | | | | | 2.48 | 2.43 | 2.40 | | | |
| % VOIDS - RICE | | | | | | | | 7.8 | 3.9 | 2.0 | | | |
| % WATER ABSORPTION - AGGREGATE | | | | | | | | 0.73 | 0.73 | 0.73 | | | |
| % VOIDS IN THE MINERAL AGGREGATE | | | | | | | | 18.5 | 17.6 | 18.2 | | | |
| % V.M.A. FILLED WITH ASPHALT | | | | | | | | 55.9 | 73.0 | 83.8 | | | |
| CALCULATED ASPH. FILM THICKNESS (MICRONS) | | | | | | | | 7.0 | 8.6 | 10.2 | | | |
| FILLER/BITUMEN RATIO | | | | | | | | | 1.1 | | | | |

A CONTENT OF 6.25% ASPHALT IS RECOMMENDED TO START THE JOB.

COPIES:

- ASPH. MIX DESIGN
- PROJECTS LISTED ABOVE
- R. HUMPHREY
- D. JESPERSEN
- C. SCHNOOR
- D. JORDISON
- R. SHELQUIST
- L. ZEARLEY
- IOWA ROAD BUILDERS
- C. JONES

SIGNED: BERNARD C. BROWN
TESTING ENGINEER

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
ASPHALT CONCRETE MIX DESIGN
LAB LOCATION AMES

MIX, TYPE AND CLASS: TYPE B CLASS 2 (CHEM-CRETE) NO. ABD0-141

INTENDED USE:

SIZE 3/4 SPEC. NO. 852-857 DATE REPORTED 8-28-80

COUNTY STORY PROJECT L-WA-180--73-85

CONTRACTOR IA. RD. BUILDERS

PROJ. LOCATION ON E57 ON N. LINE SEC. 31-83-24

AGG. SOURCES 3/4" GRAVEL-PETERSON PIT - STORY CO.

JOB MIX FORMULA AGGREGATE PROPORTIONS: 100% AAT0-472

| JOB MIX FORMULA - COMBINED GRADATION | | | | | | | | | | | |
|--|----|------|------|------|------|------|-------|-------|-------|--------|--------|
| 1-1/2" | 1" | 3/4" | 1/2" | 3/8" | NO.4 | NO.8 | NO.16 | NO.30 | NO.50 | NO.100 | NO.200 |
| 100 | 99 | 91 | 83 | 68 | 56 | 44 | 30 | 16 | 8.7 | 6.7 | |
| TOLERANCE: 98/100 | | | | | | | | | | | |
| | | | 7 | 7 | 6 | | 5 | | | | 3 |
| 75 BLOW MARSHALL DENSITY | | | | | | | | | | | |
| SUGAR-CREEK & CHEM-CRETE - 605 POISES | | | | | | | | | | | |
| ASPHALT SOURCE AND APPROXIMATE VISCOSITY | | | | | | | | | | | |
| PLASTICITY INDEX | | | | | | | | | | | |
| N.P. | | | | | | | | | | | |
| % ASPH. IN MIX | | | | | | | | | | | |
| 5.0 6.0 7.0 | | | | | | | | | | | |
| NUMBER OF MARSHALL BLOWS | | | | | | | | | | | |
| 50 50 50 | | | | | | | | | | | |
| MARSHALL STABILITY - LBS. | | | | | | | | | | | |
| 2175 1975 1762 | | | | | | | | | | | |
| FLOW - 0.01 IN. | | | | | | | | | | | |
| 8 9 11 | | | | | | | | | | | |
| SP.GR. BY DISPLACEMENT(LAB DENS.) | | | | | | | | | | | |
| 2.29 2.33 2.34 | | | | | | | | | | | |
| BULK SP. GR. COMB. DRY AGG. | | | | | | | | | | | |
| 2.670 2.670 2.670 | | | | | | | | | | | |
| SP. GR. ASPH. @ 77 F. | | | | | | | | | | | |
| 1.028 1.028 1.028 | | | | | | | | | | | |
| CALC. SOLID SP.GR. | | | | | | | | | | | |
| 2.49 2.46 2.42 | | | | | | | | | | | |
| % VOIDS - CALC. | | | | | | | | | | | |
| 8.2 5.2 3.3 | | | | | | | | | | | |
| RICE SP. GR. | | | | | | | | | | | |
| 2.47 2.42 2.38 | | | | | | | | | | | |
| % VOIDS - RICE | | | | | | | | | | | |
| 7.2 3.5 1.9 | | | | | | | | | | | |
| % WATER ABSORPTION - AGGREGATE | | | | | | | | | | | |
| 0.73 0.73 0.73 | | | | | | | | | | | |
| % VOIDS IN THE MINERAL AGGREGATE | | | | | | | | | | | |
| 18.5 18.0 18.5 | | | | | | | | | | | |
| % V.M.A. FILLED WITH ASPHALT | | | | | | | | | | | |
| 56.0 71.4 82.0 | | | | | | | | | | | |
| CALCULATED ASPH.FILM THICKNESS(MICRONS) | | | | | | | | | | | |
| 7.0 8.6 10.2 | | | | | | | | | | | |
| FILLER/BITUMEN RATIO | | | | | | | | | | | |
| 1.1 | | | | | | | | | | | |
| A CONTENT OF 6.25% ASPHALT - CHEM CRETE IS RECOMMENDED TO START THE JOB. | | | | | | | | | | | |

COPIES:

ASPH. MIX DESIGN
L-WA-180--73-85, STORY
JESPERSON
R. HUMPHREY
D. JORDISON
R. SHELQUIST
L. ZEARLEY
IA. RD. BLDRS.
C. JONES

SIGNED: BERNARD C. BROWN
TESTING ENGINEER

Appendix B
Contracts
Special Provisions

CONTRACT

Kind of Work Asphaltic Conc. Resurfacing
 Project No. L-WA-180--73-85

Miles 1.044
 County Story

THIS AGREEMENT made and entered by and between Story County, Iowa, by its Board of Supervisors consisting of the following members: Larry N. Larson, Fred L. Mathison and William G. Stucky

Iowa Road Builders Co., party of the first part, and of Des Moines, Iowa, party of the second part.

WITNESSETH: That the party of the second part, for and in consideration of sixty six thousand eight hundred thirty one and 83/100 Dollars (\$ 66,831.83) payable as set forth in the specifications constituting a part of this contract, hereby agrees to construct in accordance with the plans and specifications therefore, and in the locations designated in the notice to bidders, the various items of work as follows:

| Item No. | Item | Quantity | Unit Price | Amount |
|----------|--|--------------|--------------|--------------------|
| 1 | Base, Cleaning & Preparation of Old | 1.044 Miles | \$250.00 | \$ 261.00 |
| 2 | Special Sand Mixture | 399 Yons | \$ 24.60 | \$ 9,815.40 |
| 3 | Primer or Tack Coat Bitumen | 1,348 Gals. | \$.95 | \$ 1,280.60 |
| 4 | Base, Type B Class 2 Asph. Cement Concrete | 1,800 Tons | \$ 16.56 | \$29,808.00 |
| 5 | Asphalt Cement | 148 Tons | \$144.97 | \$21,455.56 |
| 6 | Shoulders, Granular Surfacing of | 89 Tons | \$ 20.00 | \$ 1,780.00 |
| 7 | Permanent Pavement Marking | 131.42 Stas. | \$ 18.50 | \$ 2,431.27 |
| | | | Total | \$66,831.83 |

Said specifications and plans are hereby made a part of and the basis of this agreement, and a true copy of said plans and specifications are now on file in the office of the County Auditor under date of July 30, 1980.

That in consideration of the foregoing, the party of the first part hereby agrees to pay to the party of the second part, promptly and according to the requirements of the specifications the amounts set forth, subject to the conditions as set forth in the specifications.

That it is mutually understood and agreed by the parties hereto that the notice to bidders, proposal, the specifications for Story County Project No. L-WA-180--73-85 Story County, Iowa, the within contract, the contractor's bond, and the general and detailed plans are and constitute the basis of contract between the parties hereto.

That it is further understood and agreed by the parties of this contract that the above work shall be commenced on or before, and shall be completed on or

| | | |
|---------|--|---|
| before; | Approx. or Specified Starting Date or Number of Working Days | Specified Completion Date or Number of Working Days |
| | <u>20</u> | <u>September 29, 1980</u> |

That time is the essence of this contract and that said contract contains all of the terms and conditions agreed upon by the parties hereto.

It is further understood that the second party consents to the jurisdiction of the courts of Iowa to hear, determine and render judgment as to any controversy arising hereunder.

IN WITNESS WHERE OF the parties herein have set their hands for the purpose herein expressed to this and three other instruments of like tenor, as of the 25th day of August, 1980.

Approved: [Signature]
 IOWA DEPARTMENT OF TRANSPORTATION
 By [Signature]
 Contract Engineer
 Date 7/30/80

Story County, Iowa
 Party of the first part
 By [Signature]
 Chairman
Iowa Road Builders Co.
 By [Signature] IOWA ROAD BUILDERS CO.
 Party of the second part

Kind of Work Asphaltic Conc. Resurfacing **CONTRACT** Miles 2.400
 Project No. L-F-180--73-85 County Story

THIS AGREEMENT made and entered by and between Story County, Iowa, by its Board of Supervisors consisting of the following members: Larry N. Larson, Fred L. Mathison and William G. Stucky, party of the first part, and Iowa Road Builders Co. of Des Moines, Iowa, party of the second part.

WITNESSETH: That the party of the second part, for and in consideration of one hundred twenty three thousand two hundred four and 34/100 Dollars (\$ 123,204.34) payable as set forth in the specifications constituting a part of this contract, hereby agrees to construct in accordance with the plans and specifications therefore, and in the locations designated in the notice to bidders, the various items of work as follows:

| Item No. | Item | Quantity | Unit Price | Amount |
|----------|-------------------------------------|-------------|------------|--------------|
| 1 | Base, Cleaning & Preparation of Old | 2.400 Miles | \$250.00 | \$ 600.00 |
| 2 | Special Sand Mixture | 3,370 Tons | \$ 23.83 | \$ 80,307.10 |
| 3 | Primer or Tack Coat Bitumen | 3,100 Gals. | \$.95 | \$ 2,945.00 |
| 4 | Asphalt Cement | 212 Tons | \$144.97 | \$ 30,733.64 |
| 5 | Shoulders, Granular Surfacing of | 137 Tons | \$ 13.00 | \$ 1,781.00 |
| 6 | Permanent Pavement Marking | 369.6 Stas. | \$ 18.50 | \$ 6,837.60 |
| | | | Total | \$123,204.34 |

Said specifications and plans are hereby made a part of and the basis of this agreement, and a true copy of said plans and specifications are now on file in the office of the County Auditor under date of July 30, 1980.

That in consideration of the foregoing, the party of the first part hereby agrees to pay to the party of the second part, promptly and according to the requirements of the specifications the amounts set forth, subject to the conditions as set forth in the specifications.

That it is mutually understood and agreed by the parties hereto that the notice to bidders, proposal, the specifications for Story County Project No. L-F-180--73-85, Story County, Iowa, the within contract, the contractor's bond, and the general and detailed plans are and constitute the basis of contract between the parties hereto.

That it is further understood and agreed by the parties of this contract that the above work shall be commenced on or before, and shall be completed on or

| | | |
|---------|--|---|
| before; | Approx. or Specified Starting Date or Number of Working Days | Specified Completion Date or Number of Working Days |
| | 20 | September 29, 1980 |

That time is the essence of this contract and that said contract contains all of the terms and conditions agreed upon by the parties hereto.

It is further understood that the second party consents to the jurisdiction of the courts of Iowa to hear, determine and render judgement as to any controversy arising hereunder.

IN WITNESS WHEREOF the parties hereto have set their hands for the purposes herein expressed to this and three other instruments, of like tenor, as of the 25th day of August, 1980.

Approved: [Signature]
 IOWA DEPARTMENT OF TRANSPORTATION
 by [Signature]
 Contracts Engineer
 Date AUG 26 1980

Story County, Iowa
 Party of the first part
 by [Signature]
 Chairman
Iowa Road Builders Co.
 by [Signature]
 Party of the second part

Special Provisions

for

Story County Project L-F-180--73-85

DELETE all of 2203.02B. and substitute in lieu thereof the following:

- B. Mineral aggregate will be furnished by the County. The aggregate is in the SE $\frac{1}{4}$ Sec. 22 R-22W T-83N and shall be loaded and hauled by contractor

ADD the following sentence to 2203.02.

- D. Special Additive. A specially processed and refined asphalt, as is manufactured by Chem-Crete Corporation of Menlo Park, California under the name of "Chem-Crete" or an approved equal, shall be added to the AC at the storage tank. The mixture shall be thoroughly mixed for no less than 30 minutes on the basis of: one part of Chem-Crete bitumen, by weight, is to nine parts of the regular paving asphalt cement.

ADD the following sentence to 2203.03.

When storage bins are used, the holding time shall be limited to 4 hours.

ADD the following new paragraph to 2203.23A.

The price bid per ton of Asphalt Cement Concrete shall include the cost of furnishing and incorporating the additive into the mixture placed on finished roadway.

The road shall be kept open to traffic. Not more than 200 ft. of center line joint shall be left open overnight.

Temporary Pavement Marking is not required. Permanent painted pavement markings are required.

Fabric reinforcement shall be placed over the existing bridge mat and is incidental to the work. A 1" thick mat placed over the fabric. Fabric shall be furnished and delivered to the site by the county.

The Special Sand Mix shall be completed no later than September 15, 1980.

Appendix C
Asphalt Cement Test Data

ASPHALT CEMENT CHARACTERISTICS

| | | <u>Penetration</u> | <u>Absolute Viscosity (poises.)</u> |
|---------------------------------|-------|--------------------|---|
| Extractions Mar. and Apr., 1981 | | | |
| Co. Rd. E-57 | | | |
| Type B, | 6% AC | 72 | 1160 |
| | | 91 | 835 |
| Type B w/Chem-Crete, | 6% AC | 92 | 740 |
| | | 105 | 587 |
| | | 68 | 1230 |
| Sand w/Chem-Crete, | 7% AC | 44 | 2400 |
| N. Dakota Street Ext. | | | |
| Sand w/Chem-Crete, | 6% AC | 24 | 8340 |
| Sand, | 6% AC | 73 | 1050 |
| Samples from Tanks | | | |
| AC-10 and Chem-Crete | | 116 | 577 |
| AC-10 | | 78 | 1018 |
| Chem-Crete | | -- | 31 |

Appendix D
Crack Survey

SUMMARY OF CRACK SURVEY

March 1981

E57 Sta 0+00 to Sta 32+75 Type B

Full width transverse cracks at approximately 300 foot intervals.

E57 Sta 33+30 to Sta 44+00 Type B w/Chem-Crete

Full width transverse cracks at approximately 100 foot intervals. Two foot transverse cracks at the center and the edge of slab spaced approximately 10 feet apart. Insignificant longitudinal cracking.

E57 Sta 44+00 to Sta 55+22 Sand w/Chem-Crete

Full width transverse cracks at approximately 30 foot intervals. Random transverse cracks ranging from 1 foot to 10 feet in length interspersed between full width cracks at approximately 6 foot intervals. Approximately 40% of the test section had centerline longitudinal cracking. Much of the crack pattern in this section appears to be reflective cracking.

North Dakota Street Extension Sta 0+00 to Sta 70+00
Sand w/Chem-Crete

Full width transverse cracks 30 to 40 feet apart in full width sections of Chem-Crete. The 8% sand mix with Chem-Crete had short (2 feet) transverse cracks at 10 foot spacings at the centerline.

North Dakota Street Extension Sta 70+00 to Sta 90+00
Sand Rt. Side Sand w/Chem-Crete Lt. Side

The control had no crack pattern except for the cracks which were extending from the Chem-Crete portion. The sand with Chem-Crete had transverse cracks at approximately 8 to 10 feet apart; of which approximately 50% extended 1 to 4 feet into the control segment.

CRACK SURVEY DATA

March 1981

Transverse Cracks
(Lin. Ft./Sta.)

Co. Rd. E-57

| | | | |
|------------------------|----------------------|-------|-----|
| Sta 0+00 to Sta 32+75 | Type B | 6% AC | 6 |
| Sta 33+30 to Sta 44+00 | Type B w/Chem-Crete, | 6% AC | 95 |
| Sta 44+00 to Sta 54+00 | Sand w/Chem-Crete, | 7% AC | 240 |

North Dakota Street Ext.

| | | | |
|------------------------|-----------------------------|-------|-----|
| Sta 3+00 to Sta 8+00 | Sand w/Chem-Crete, | 6% AC | 120 |
| Sta 26+00 to Sta 29+00 | Sand w/Chem-Crete | 6% AC | 124 |
| Sta 70+00 to Sta 89+90 | Lt. Side Sand w/Chem-Crete, | 6% AC | 155 |
| Sta 70+00 to Sta 89+90 | Rt. Side Sand, | 6% AC | 26 |

Appendix E
Road Rater Data

SUMMARY OF ROAD RATER TESTING

| | | 80% Deflection (mils) | | |
|--------------------------|-------|-----------------------|-------------------|-----------------|
| | | before resurfacing | after resurfacing | |
| | | <u>6/19/80</u> | <u>10/17/80</u> | <u>06/03/82</u> |
| Co. Rd. E-57 | | | | |
| Type B, | 6% AC | 7.6 | 3.3 | 3.7 |
| Type B W/Chem-Crete, | 6% AC | 6.5 | 3.0 | 3.3 |
| Sand W/Chem-Crete, | 7% AC | 7.2 | 3.3 | 4.1 |
| North Dakota Street Ext. | | <u>6/11/80</u> | <u>10/17/80</u> | <u>06/03/82</u> |
| Sand W/Chem-Crete, | 6% AC | 6.8 | 3.7 | 6.5 |
| Sand, | 6% AC | 4.0* | 4.5* | 7.2* |
| Type B, | 6% AC | 5.2 | 3.7 | 4.8 |

* average of three tests