A LABORATORY EVALUATION

OF

ASPHALTIC CONCRETE

CONTAINING

ASPHADUR

HIGHWAY DIVISION
OFFICE OF MATERIALS
DECEMBER 1978
A LABORATORY EVALUATION OF ASPHALTIC CONCRETE CONTAINING ASPHADUR

by

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December 1978

IOWA DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
OFFICE OF MATERIALS
Ames, Iowa 50010
Disclaimer

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A LABORATORY EVALUATION OF ASPHALTIC CONCRETE
CONTAINING ASPHADUR

SUMMARY

A laboratory evaluation of three asphaltic concrete, plant produced mixtures containing Asphadur has been made. The mixtures represent a type A asphaltic concrete and two type B asphaltic concretes.

The type A and one of the type B mixtures were used in pavements and will be evaluated later for durability and serviceability. The second type B mixture was made only for laboratory testing.

In each instance, control batches of the same mixtures but without Asphadur were made for comparison.

Type A is a high type asphaltic concrete, requires a minimum of 65% crushed particles and is generally used for higher traffic volume roads. Type B is used for intermediate or lower traffic volumes and requires a minimum of 30% crushed particles.

CONCLUSIONS

In each of the three projects, the addition of Asphadur to the asphalt mixtures increased the Marshall stability and the indirect tensile strength. These characteristics certainly would increase the resistance of the pavement to deformation due to heavy traffic loads or shoving due to accelerating or decelerating traffic.
We must also remain cognizant of the fact that the high temperature to which the mixture is subjected would also tend to give test results in the same direction as the Asphadur. If the Asphadur negates the hardening effect due to the overheating of the asphalt and does, in fact, improve the durability and temperature susceptibility of the asphalt, then Asphadur could become an important tool in certain areas of asphaltic concrete usage.

It appears, at this point, that the most meaningful and valid evaluation of the represented characteristics of Asphadur must come from performance reports, both visual and by laboratory testing, after the pavements have been in usage over periods of time.

It is recommended at this time, that for continued evaluation, that Asphadur be considered for additional projects in suitable and selected locations.

INTRODUCTION

Asphadur is the trade name of an Austrian manufactured mixture of polymers of unsaturated hydrocarbons of varying lengths used with asphaltic concrete to improve its properties. Asphadur when added to the asphalt mixture is represented as increasing resistance to deformation due to heavy traffic, increasing the durability of the pavement, increasing the resistance to wear, decreasing the temperature susceptibility of the asphalt, and influencing the structure of the asphalt so
that a favorable relationship between asphaltines and maltenes is achieved. This evaluation was directed primarily in studying the deformation problem through stability and indirect tensile strength and other related tests, i.e., asphalt content, aggregate gradations, etc. No effort was attempted to show any chemical change or shift in the composition of asphalt that might be effected by Asphadur.

Plastics can be classified broadly as thermosetting or thermoplastic. The thermosetting plastics remain solid at elevated temperatures until they reach a temperature at which they decompose. Thermoplastics have no definite melting point but become softer with an increase in temperature until they become liquid.

Asphadur is a thermoplastic and at a temperature of about 400° F. (204° C.), with sufficient shear force, can be mixed with asphalt cement or asphaltic concrete.

Figure 1 is a photomicrograph of 72X magnification showing the Asphadur particles recovered from a mix. These are the particles that were retained on a No. 325 sieve which has sieve openings of 0.045 mm. Note the irregularity of shape and the tendency toward elongation of the particles.

The most convenient method, at the present, to use Asphadur is to introduce the granulated material directly into the pugmill. The high shear force of the pugmill, the elevated temperature of the mix, and the increase in mixing time reduce the softened Asphadur into small sizes and shapes as shown in
Figure 1. Asphadur could be added directly to asphalt cement, but constant agitation would be required for dispersion and retaining the homogenous mixture.

Figure 1. Extracted Asphadur

SCOPE

An Asphadur mixture was produced from batch plants at the following paving plant sites:

1. Contractor: Iowa Road Builders Co.
   Location of plant: Ames
   Location of project: 
   Length and description of project: Three batches of Asphadur mix along with one control batch were produced for laboratory testing only.

2. Contractor: Brower Construction Co.
   Location of plant: Sioux City
Location of project: Two locations in Sioux City; (1) on Glenn Avenue between St. Aubin and Royce Streets and (2) on Floyd Street south of Dace Avenue.

Length and description of project: (1) The Glenn Avenue project was a one-block section on a steep incline in a residential area with a stop sign at the bottom of the section. It represented a typical problem area where movement and shoving occurred at the stop sign. (2) The one-block section on Floyd Street was in an industrialized area that received heavy truck traffic from an off ramp of Interstate 29.

3. Contractor: Cedar Rapids Asphalt and Paving Co.

Location of plant: Cedar Rapids

Location of project: At the intersection of U.S. 30 and West Post Road in Cedar Rapids. The Asphaltur section was in the westbound lane only, and was from the west edge of the intersection extending to the east 500 feet. The taper on the westbound lane also used the Asphaltur mix.

Six-percent Asphaltur based on the weight of the asphalt being used was added to the mixes for each of the 3 projects. For the Sioux City and the Cedar Rapids projects the mixing cycle consisted of 5 seconds of drymixing, 20 seconds of wet mixing and 60 seconds of mixing after the addition of the Asphaltur.

The mix temperature at delivery from the pugmill for the
Sioux City project averaged slightly over 400° F. while at Cedar Rapids it was about 385° F. The Asphadur mix produced at Ames had a temperature of 350° F. and additional mixing times of 2, 3 and 5 minutes.

The original mix designs, the three projects are based upon, are shown in Appendix A. In addition, a laboratory mix design containing Asphadur is included for the Sioux City project.

The laboratory test results of the three Asphadur mixes along with their control batches are shown in Appendix B. The indirect tensile strengths were run at 140° F.

RESULTS

Ames Project

Table 1 shows an increase of Marshall stability and indirect tensile strength with the addition of Asphadur, but it also indicates these properties along with the laboratory density are related to the additional mixing time. The highest stability and indirect tensile strength and the lowest density are obtained with 2 minutes of additional mixing. As the mixing time increases, the stability and tensile strength decrease while the density increases. Normally with a decrease in laboratory density the stability and tensile strength also decrease but this condition is reversed with Asphadur in this instance.
Table 1
Laboratory Test Results

<table>
<thead>
<tr>
<th></th>
<th>Control Batch</th>
<th></th>
<th>Asphadur Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lab Density (Sp. Gr.)</td>
<td>2.38</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marshall Stability - lbs.</td>
<td>1900</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ind. Tensile Strength p.s.i.</td>
<td>11.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Additional Mixing Time</td>
<td>--</td>
<td></td>
</tr>
</tbody>
</table>

Sioux City Project

The mixing time on this project was an additional one minute of mixing after the introduction of the Asphadur. Table 2 shows the test results obtained for this project. The same trends are followed as were shown in the Ames Project; although, the amount of increase in stability was not as great.
Table 2
Laboratory Test Results

<table>
<thead>
<tr>
<th></th>
<th>Control Batch</th>
<th>Avg.</th>
<th>Asphadur Mix</th>
<th>Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab Density (Sp. Gr.)</td>
<td>2.39</td>
<td>2.39</td>
<td>2.32</td>
<td>2.33</td>
</tr>
<tr>
<td>Marshall Stability - lbs.</td>
<td>2770</td>
<td>2720</td>
<td>3133</td>
<td>3007</td>
</tr>
<tr>
<td>Ind. Tensile Strength p.s.i.</td>
<td>21.7</td>
<td>26.0</td>
<td>34.1</td>
<td>30.2</td>
</tr>
</tbody>
</table>

Cedar Rapids Project (Linn County)

The mixing time on this project again was an additional one minute of mixing after the introduction of the Asphadur. The stability and the indirect tensile strength increased with the use of Asphadur but the laboratory density did not decrease as was the case with the other two mixes. The test results are shown in Table 3.

One area that appeared to give a problem that was evident, especially in the Sioux City Project, was the probable interference of the Asphadur in the sieve analysis. All the Asphadur mixes appeared different from the control batches in the "wash" portion of the sieve analysis procedure. A bulking effect became apparent and difficulty was experienced in washing the samples on the No. 200 sieve. The Sioux City Project gave varying and
### Table 3
Laboratory Test Results

<table>
<thead>
<tr>
<th></th>
<th>Control Batch</th>
<th>Asphadur Mix Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab Density (Sp. Gr.)</td>
<td>2.34</td>
<td>2.33 2.34 2.34 2.34 2.33</td>
</tr>
<tr>
<td>Marshall Stability - lbs.</td>
<td>2817</td>
<td>3408 3170 3045 2843 2948 3083</td>
</tr>
<tr>
<td>Ind. Tensile Strength p.s.i.</td>
<td>20.2</td>
<td>32.6 33.1 30.8 28.3 30.0 31.0</td>
</tr>
</tbody>
</table>

unexpected results of the -200 material, as shown in Appendix B (pp. 25-26, 27-28, 29-30). The bulking effect evidently carried over to the dry sieving because on the control samples the No. 200 sieve averaged 8.2% passing, with little deviation between the individual samples. The Asphadur samples on the No. 200 sieve averaged 4.1% passing and had a large deviation between individual samples.
ACKNOWLEDGEMENT

Through efforts initiated by the Iowa Development Commission it was possible to introduce Asphadur into two demonstration paving projects in Iowa.

The authors would also like to thank Shicker and Co. (Austria), Iowa Road Builders Co., Brower Const. Co., Cedar Rapids Asphalt and Paving Co., The City of Sioux City, and Linn County for the cooperation and contribution that made this research possible. Appreciation is also extended to Mr. Charles Huisman, Materials Engineer of the Iowa D.O.T., for his contribution and guidance in the development and accomplishment of the project.
APPENDIX A

MIX DESIGNS
MIX, TYPE AND CLASS: TYPE B BINDER

INTENDED USE:

SIZE 3/4"

BOONE

COUNTY STORY

CONTRACTOR IOWA ROAD BLDG.

FROM WOODWARD EASTERLY 3.4 MI., ON IA. 230 FROM I-35 WEST

PROJ. LOCATION 6.0 MI. TO SLATER; TYPE B BINDER SUBSTITUTED FOR A.T.B. ON INTERCHANGE AT AMES

AGG. SOURCES 3/4' CR. GRAVEL - HALLETT PIT - STORY CO., 3/4' PIT RUN GRAVEL - HALLETT PIT - STORY CO.

JOB MIX FORMULA AGGREGATE PROPORTIONS: 30% AAT8-299, 70% AAT8-300

JOB MIX FORMULA - COMBINED GRADATION

<table>
<thead>
<tr>
<th>SPEC. NO.</th>
<th>823</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE REPORTED</td>
<td>6/26/78</td>
</tr>
<tr>
<td>FN-89-2(2)--21-08</td>
<td></td>
</tr>
<tr>
<td>FN-89-3(1)--21-05</td>
<td></td>
</tr>
<tr>
<td>IN-35-4(35)112--15-85</td>
<td></td>
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</tbody>
</table>

TOLERANCE: 98/100

75 BLOW MARSHALL DENSITY 2.36

ASPHALT SOURCE AND APPROXIMATE VISCOSITY SUGAR CREEK - 1050 POISES

PLASTICITY INDEX N. P.

% ASPH. IN MIX 4.50 5.50 6.50

NUMBER OF MARSHALL BLOWS 50 50 50

MARSHALL STABILITY - LBS. 2133 2672 1613

FLOW - 0.01 IN. 6 7 9

SP. GR. BY DISPLACEMENT(LAB DENS.) 2.30 2.32 2.34

BULK SP. GR. COMB. DRY AGG. 2.683 2.683 2.683

SP. GR. ASPH. @ 77 F. 1.031 1.031 1.031

CALC. SOLID SP.GR. 2.52 2.48 2.45

% VOIDS - CALC. 8.8 6.6 4.4

%E SP. GR. 2.50 2.47 2.43

% VOIDS - RICE 7.9 6.1 3.8

% WATER ABSORPTION - AGGREGATE 0.67 0.67 0.67

% VOIDS IN THE MINERAL AGGREGATE 18.1 18.3 18.4

% V.M.A. FILLED WITH ASPHALT 51.4 63.8 76.1

CALCULATED ASPH. FILM THICKNESS(MICRONS) 6.6 8.2 9.9

A CONTENT OF 6.00% ASPHALT IS RECOMMENDED TO START THE JOB.

SIGNED: BERNARD C. BROWN
TESTING ENGINEER
MIX, TYPE AND CLASS: 1/2" TYPE B SURFACE  LAB NO. ABD8-210

INTENDED USE:

SIZE 1/2"  SPEC. NO.  DATE REPORTED 10-19-78

COUNTY WOODBURY  PROJECT  DEPT. INFO.

CONTRACTOR BROWER CONST.

PROJ. LOCATION TWO SECTIONS OF CITY STREETS IN SIoux CITY-STEep GRADE-INTERSEG.

AGG. SOURCES 3/8" CR. LST.-GILMORE CITY-PoCAHONTAS CO.; 5/8" QUaRTIZITE CHIPS-DELL RPAINS-S. DAK.; CONCRETE SAND-HAWARDEN-SIoux CO.

JOB MIX FORMULA AGGREGATE PROPORTIONS: 30% AAT8-559; 30% AAT8-550; 40% AAT8-551

---

<table>
<thead>
<tr>
<th>AGGREGATE</th>
<th>PROPORTION</th>
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</thead>
<tbody>
<tr>
<td>3/8&quot;</td>
<td>30%</td>
</tr>
<tr>
<td>5/8&quot;</td>
<td>30%</td>
</tr>
<tr>
<td>1&quot;</td>
<td>40%</td>
</tr>
</tbody>
</table>

---

| TOLERANCE: ASPHALT ADDED TO THE MIX IN THE AMOUNT OF 6.0% BY WT. OF ASPHALT |
| 75 BLOW MARSHALL DENSITY | 2.38 |
| ASPHALT SOURCE AND APPROXIMATE VISCOSITY | SUGAR CREEK - 1000 POISES |

| PLASTICITY INDEX | N.P. |
| FLOW - 0.01 IN. | 9 |
| BULK SP. | 2.657 |
| SP. GR. | 1.033 |
| CALC. SOLID SP. | 2.48 |
| # voids - calc. | 6.7 |
| RICE SP. | 2.48 |
| # voids - rice | 6.6 |
| % WATER ABSORPTION - AGGREGATE | 0.20 |
| % Voids in the mineral aggregate | 16.6 |
| % V.M.A. FILLED WITH ASPHALT | 59.5 |
| CALCULATED ASPH. FILM THICKNESS (MICRONS) | 7.1 |

ASPHALT WAS NOT CONSIDERED IN THE CALCULATIONS FOR THE TEST RESULTS. SEE ABD8-171 (WOODBURY FN-141) FOR COMPARISON

SIGNED: BERNARD C. BROWN  
TESTING ENGINEER
MIX, TYPE AND CLASS: TYPE B SURFACE

INTENDED USE:

SIZE 1/2"

SPEC. NO. 823

DATE REPORTED 8-31-78

COUNTY WOODBURY

PROJECT FN-141-1(10)--21-97

CONTRACTOR BROWER

PROJ. LOCATION FROM 3 MILES EAST OF HORWICK EAST 0.8 MI.

AGG. SOURCES 3/8" CR. LST.-GILMORE CITY - POCOHONTAS CO.; 5/8" QUARTZITE CHIPS - DELL RAPIDS, S. DAK.; CONC. SAND-HAWARDEN - SIOUX CO.

JOB MIX FORMULA AGGREGATE PROPORTIONS: 30% AAT8-559; 30% AAT8-550; 40% AAT8-551

---

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 82 66 55 42 28 15 8.5 5.0

TOLERANCE: 98/100 7 7 6 5 3

75 BLOW MARSHALL DENSITY 2.38

ASPHALT SOURCE AND APPROXIMATE VISCOSITY SUGAR CREEK - 960 POISES

PLASTICITY INDEX N.P.

% ASPH. IN MIX 4.50 5.50 6.50

NUMBER OF MARSHALL BLOWS 59 50 50

MARSHALL STABILITY - LBS. 2207 2237 1822

FLOW - 0.01 IN. 7 8 11

SP. GR. BY DISPLACEMENT(LAB DENS.) 2.32 2.36 2.37

BULK SP. GR. COMB. DRY AGG. 2.657 2.657 2.657

SP. GR. ASPH. @ 77 F. 1.033 1.033 1.033

CALC. SOLID SP. GR. 2.48 2.45 2.42

% Voids - Calc. 6.7 3.7 1.9

% JE SP. GR. 2.48 2.44 2.41

% voids - RICE 6.6 3.5 1.7

% WATER ABSORPTION - AGGREGATE 0.20 0.20 0.20

% Voids in the MINERAL AGGREGATE 16.6 16.1 16.6

% V.M.A. FILLED WITH ASPHALT 59.5 76.9 88.6

CALCULATED ASPH. FILM THICKNESS(MICRONS) 7.1 8.8 10.5

A CONTENT OF 5.25% ASPHALT IS RECOMMENDED TO START THE JOB.

COPIES:

ASPH. MIX DESIGN
FN-141-1(10)--21-97, WOODBURY
J. BUMP
R. BOLTON
R. SHELQUIST
D. JORDISON
BROWER
C. JONES
D. HINES

SIGNED: BERNARD C. BROWN
TESTING ENGINEER
MIX, TYPE AND CLASS: TYPE A SURFACE  
LAB NO. ARDE-107

INTENDED USE:

SIZE 1/2"  
SPEC. NO. 773.  
DATE REPORTED 7/2/76

COUNTY LINN  
PROJECT RF-970-2(2)--35-57

CONTRACTOR CEDAR RAPIDS ASPHALT

PROJ. LOCATION ON US 30 FROM BENTON CO. LINE EAST 4.0 MI.

AGG. SOURCES 1/2" CR. LST. - S. CEDAR RAPIDS QR. - LINN CO.,  
SAND - BAIRED PIT - LINN CO.

JOB MIX FORMULA AGGREGATE PROPORTIONS: 65% AAT6-307, 35% AAT6-308

<table>
<thead>
<tr>
<th>JOIIX MIX FORMULA - COMBINED GRADATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2&quot; 1&quot; 3/4&quot; 1/2&quot; 3/8&quot; NO.4 NO.8 NO.16 NO.30 NO.50 NO.100 NO.200</td>
</tr>
<tr>
<td>100 95 75 55 40 26 13 9.5 8.5</td>
</tr>
</tbody>
</table>

TOLERANCE: +0R- 98/100  
75 BLOW MARSHALL DENSITY 2.37  
75 BLOW MARSHALL DENSITY 2.37  
ASPHALT SOURCE AND APPROXIMATE VISCOSITY SIGCLAIR - 980 POISES (AC-10)

PLASTICITY INDEX  
% ASPH. IN MIX 5.0 6.0 7.0

NUMBER OF MARSHALL BLOWS 50 50 50

MARSIIALL STABILITY - LBS. 2692 2617 2092

FLOW - 0.01 IN. 7 8 9

SP.GR. BY DISPLACEMENT(LAB DENS.) 2.31 2.36 2.36

BULK SP. GR. COMB. DRY AGG. 2.717 2.717 2.717

SP. GP. ASPH. @ 77 F. 1.031 1.031 1.031

CALC. SOLID SP.GR. 2.52 2.49 2.45

% VOIDS - CALC. 8.6 5.2 3.8

ICE SP. GR. 2.49 2.45 2.41

% VOIDS - RICE 7.3 3.7 2.2

% WATER ABSORPTION - AGGREGATE 0.57 0.57 0.57

% VOIDS IN THE MINERAL AGGREGATE 19.2 18.4 19.2

% V.M.A. FILLED WITH ASPHALT 55.1 71.5 80.2

CALCULATED ASPH. FILM THICKNESS(MICRONS) 6.8 8.3 9.8

A CONTENT OF 5.50% OF ASPHALT IS RECOMMENDED TO START THE JOB.

COPIES:
asper. mix design  
RF-970-2(2)--35-57, LINN  
VAN SNYDER  
D. DAVICK  
B. ORTGIES  
C. HUISMAN  
L. ZEARLEY  
C. R. ASPHALT  
C. JONES  
D. HINES

SIGNED: BERNARD C. BROWN  
TESTING ENGINEER.
IOWA DEPARTMENT OF TRANSPORTATION
Highway Division
Office of Materials

TEST REPORT — BITUMINOUS MATERIALS

Material: Asph. Concrete (Asphadur)  Laboratory No. ABCB-383

Intended Use: Laboratory Evaluation

Project No.: Department Information  County

Contractor:

Producer: Iowa Road Builders

Plant: North of Ames

Unit of Material: Sample #1 regular mix sample

Sampled by: Producer  Sender's No.

Date Sampled: 9-8-78  Date Rec'd: 9-11-78  Date Reported: 10-5-78

SIEVE ANALYSIS — PER CENT PASSING

<table>
<thead>
<tr>
<th>Size (inches)</th>
<th>1½</th>
<th>1''</th>
<th>3 4</th>
<th>1/2''</th>
<th>3/8''</th>
<th>No. 4</th>
<th>No. 8</th>
<th>No. 16</th>
<th>No. 30</th>
<th>No. 50</th>
<th>No. 100</th>
<th>No. 200</th>
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<tr>
<td></td>
<td>100</td>
<td>93</td>
<td>81</td>
<td>64</td>
<td>53</td>
<td>44</td>
<td>35</td>
<td>20</td>
<td>9.2</td>
<td>6.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

% Aggregate—By Extraction: 93.6%

% Bitumen—By Extraction: 6.4%

% Peg. No. 8 after 16 Cycles F&T, Water-Alco. Sol.

% Peg. No. 8 after 25 Cycles F&T, Water Solution

% of Wear, Los Angeles Abrasion, Grading

Liquid Limit

Plastic Limit

Plasticity Index

COMPACATION & STABILITY TESTS

Laboratory Density (Specific Gravity): 2.38

Marshall Stability (lbs.): 1900

Marshall Flow (Ins.): 10

Hveem Side Pressure (PSI): Rice Sp. Gr. 2.441

Indirect tensile strength: 11.4

DISPOSITION: By Testing Engineer
TEST REPORT — BITUMINOUS MATERIALS

Material __ Asphalitic Concrete (Asphadur) __ Laboratory No. ABC8-384

Intended Use __ Laboratory Evaluation

Project No. __ Department Information __ County

Contractor __

Producer __ Iowa Road Builders__

Plant __ North of Ames

Unit of Material __ 2 contained asphadur mixed @ 350°F. mixed for 2 minutes

Sampled by Producer Sender's No.

Date Sampled __ 9-8-78 __ Date Rec'd __ 9-11-78 __ Date Reported __ 10-5-78

SIEVE ANALYSIS — PER CENT PASSING

<table>
<thead>
<tr>
<th>No.</th>
<th>1⅛</th>
<th>1'</th>
<th>3/4'</th>
<th>1/2'</th>
<th>3/8'</th>
<th>No. 4</th>
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<th>No. 16</th>
<th>No. 30</th>
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<td>93</td>
<td>82</td>
<td>70</td>
<td>58</td>
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<td>37</td>
<td>20</td>
<td>8.9</td>
<td>6.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

% Aggregate—By Extraction __ 95.0 %
% Bitumen—By Extraction __ 5.0 %

% Peg. No. 8 after 16 Cycles F&T, Water-Alco. Sol.
% Peg. No. 8 after 25 Cycles F&T, Water Solution
% of Wear, Los Angeles Abrasion, Grading

Liquid Limit
Plastic Limit
Plasticity Index

COMPACTION & STABILITY TESTS

Laboratory Density (Specific Gravity) __ 2.33
Marshall Stability (lbs.) __ 3020
Marshall Flow (Ins.) __ 8
Hveem Side Pressure (PSI)
Rice Sp. Gr. __ 2.463
Indirect tensile strength p.s.i. __ 24.4

DISPOSITION:

By [Signature] Co. [Signature]
**TEST REPORT — BITUMINOUS MATERIALS**

<table>
<thead>
<tr>
<th>Material</th>
<th>Asphaltic Concrete (Asphadur)</th>
<th>Laboratory No.</th>
<th>ABC8-385</th>
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</table>

**Intended Use:** Laboratory Evaluation

**Project No.:**

**Department Information:**

**Contractor:**

**Producer:** Iowa Road Builders

**Plant:** North of Ames

**Unit of Material:** 3 contained asphadur mixed @ 350° F.
mixed for 3 minutes

**Sampled by:** Producer

**Date Sampled:** 9-8-78 **Date Rec'd:** 9-11-78 **Date Reported:** 10-5-78

### SIEVE ANALYSIS — PER CENT PASSING

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**% Aggregate—By Extraction** 94.1 %

**% Bitumen—By Extraction** 5.9 %

**% P.e. No. 8 after 16 Cycles F&T, Water-Alco. Sol.**

**% P.e. No. 8 after 25 Cycles F&T, Water Solution**

**% of Wear, Los Angeles Abrasion, Grading**

**Laboratory Density (Specific Gravity)** 2.38

**Marshall Stability (lbs.)** 2567

**Marshall Flow (ins.)** 12

**Hveem Side Pressure (PSI)**

**Rice Sp. Gr.** 2.422

**Indirect tensile strength p.s.i.** 18.3

**DISPOSITION:**

By Testing Engineer
IOWA DEPARTMENT OF TRANSPORTATION
Highway Division
Office of Materials

TEST REPORT — BITUMINOUS MATERIALS

Material: Asphallic Concrete (Asphadur)
Laboratory No.: ABC8-386

Intended Use: Laboratory Evaluation

Project No.: Department Information
County:

Contractor:

Producer: Iowa Road Builders

Plant: North of Ames

Unit of Material: 4 contained asphadur mixed @ 350°F.
mixed for 5 minutes

Sampled by: Producer
Sender's No.:

Date Sampled: 9-8-78
Date Rec'd: 9-11-78
Date Reported: 10-5-78

SIEVE ANALYSIS — PER CENT PASSING

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% Aggregate — By Extraction: 94.0%
% Bitumen — By Extraction: 6.0%

% Pug. No. 8 after 16 Cycles F&T, Water-Alco. Sol.
% Pug. No. 8 after 25 Cycles F&T, Water Solution
% of Wear, Los Angeles Abrasion, Grading

Liquid Limit
Plastic Limit
Plasticity Index

COMPACTION & STABILITY TESTS

Laboratory Density (Specific Gravity): 2.39
Marshall Stability (lbs.): 2175
Marshall Flow (ins.): 14
Hveem Side Pressure (PA)
Rice Sp. Gr.: 2.424
Indirect tensile strength p.s.i.: 14.2

DISPOSITION:

By: [Signature]
IOWA DEPARTMENT OF TRANSPORTATION
Highway Division
Office of Materials

TEST REPORT — BITUMINOUS MATERIALS

Material: Asphalitic Concrete @ 5.5%
Laboratory No. ABC8-723

Intended Use: U-7 (Dept. Info.)
County: Linn

Contractor: 
Producer: 
Plant: 
Unit of Material: Sample Without Asphalt for Central Laboratory for experimental testing and analysis

Sampled by: 
Sender’s No.: 1
Date Sampled: Date Rec’d: 11-14-78 Date Reported: 11-15-78

SIEVE ANALYSIS — PER CENT PASSING

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% Aggregate—By Extraction: 94.3%
% Bitumen—By Extraction: 5.7%

% Peg. No. 8 after 16 Cycles F&T, Water-Alco. Sol.
% Peg. No. 8 after 25 Cycles F&T, Water Solution
% of Wear, Los Angeles Abrasion, Grading:

Liquid Limit: 
Plastic Limit: 
Plasticity Index: 

COMPACCIÓN & STABILITY TESTS

Laboratory Density (Specific Gravity): 2.41
Marshall Stability (lbs.): 3603
Marshall Flow (ins.): 9
Hveem Side Pressure (PSI): 
Rice Sp. Gr.: 2.485
Indirect tensile strength psi: 24.3
Recovered Asphalt: 
Penetration @ 77°F. 100 gms. 5 Sec.: 64
Abs. Vis. @ 140°F. 300 MM. Hg. By (poises): 1660

DISPOSITION: 

[Signature]
Testing Engineer
TEST REPORT - BITUMINOUS MATERIALS

MATERIAL PLANT MIX (ASPHADUR RESEARCH)  LAB NO ABCB-708
INTENDED USE ASPH. CONC. PAVING
PROJECT NO CITY OF SIOUX CITY STS.
CONTRACTOR BROWER CONSTR. CO.
PRODUCER CONTRACT NO
PLANT
UNIT OF MATERIAL SAMPLED FROM TRUCK & PLANT SITE (CONTAINS NO ASPHADUR)
SENDERS NO 3ELB-21626
SAMPLED BY E. LAMOUREUX
DATE SAMPLED 10/25/78 DATE RECD 11/1/78 DATE REPORTED 11/9/78

SIEVE ANALYSIS PERCENT PASSING

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<th>RET %</th>
<th>PSG %</th>
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<tr>
<td>3/4</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
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| 3/8      | 143.0 | 9.84  | 90.16 |
| 4        | 224.5 | 15.44 | 74.72 |
| 8        | 213.5 | 14.68 | 66.04 |
| 16       | 245.0 | 16.85 | 43.19 |
| 30       | 239.5 | 15.86 | 27.33 |
| 50       | 181.5 | 12.49 | 14.84 |
| 100      | 66.0  | 4.54  | 10.30 |
| 200      | 30.5  | 2.10  | 8.20  |
| WASH     | 91.0  | 8.20  | 0.09  |
| PAN      | 38.0  | 0.00  | 0.00  |

DRY WT. 1451.999
SUM OF RETAINED WTS. 1453.500

% AGGREGATE BY EXTRACTION 94.800
% BITUMEN BY EXTRACTION 5.200
SPECIFIC GRAVITY 2.390
MARSHALL STABILITY 2770.000
MARSHALL FLOW 0.01 IN. 10.000

INDIRECT TENSILE STRENGTH, P.S.I. 21.7
RICE SP. GR. 2.467
RECOVERED ASPHALT
PENETRATION @ 77 F. 100 GMS. 5 SEC. 32
ABS. VIS. @ 140 F. 300 MM HG, POISES 3920

COPIES TO:
ASPH. CONC.
J. BUMP
R. SHELQUIST
Z. ZEARLEY

BY BERNARD C. BROWN
TESTING ENGINEER
MATERIAL: PLANT MIX (ASPHADUR RESEARCH)
INTENDED USE: ASPH. CONC. PAVING
PROJECT NO: CITY OF SIOUX CITY STS.
CONTRACTOR: GROWER CONSTR. CO.
PRODUCER:
PLANT:
UNIT OF MATERIAL: SAMPLED FROM TRUCK & PLANT SITE. (CONTAINS NO ASPHADUR)
SAMPLER NO: 3678-21926
SAMPLED BY: E. LABUREUX
DATE SAMPLED: 10/25/78
DATE RECEIVED: 11/4/78
DATE REPORTED: 11/9/78

SIEVE ANALYSIS

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DRY WT. 1442.000
SUM OF RETAINED WTS. 1443.000

% AGGREGATE BY EXTRACTION 94.900
% BITUMEN BY EXTRACTION 5.100
SPECIFIC GRAVITY 2.390
MARSHALL STABILITY 2729.000
MARSHALL FLOW 0.01 IN. 9.000

INDIRECT TENSILE STRENGTH-P.S.I. 260
RECOVERED ASPHALT
PENETRATION 077 F. 190 018. 5 SEC.
ABS. VIS. @ 140 F. 300 MM HG, POISES 4260

COPIES TO: ASPH. CONC.
J. DUHP
K. SHELBOUST
L. ZEARLEY
MATERIAL PLANT MIX (ASPHALT RESEARCH) LAB NO. ABQ-710
INTENDED USE ASPH. CONC. PAVING PROJECT NO. CITY OF STOOL CITY STS.
CONTRACTOR BROWER CONSTR. CO.
PRODUCER CONTRACT NO.
PLANT
UNIT OF MATERIAL SAMPLED FROM TRUCK @ PLANT SITE. (CONTAINS NO ASPHALT)
SENDERS NO. 3ELB-21626
SAMPLED BY E. LAMOREUX
DATE SAMPLED 10/25/73 DATE RECEIVED 11/1/73 DATE REPORTED 11/27/73

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DRY WT. 1441.000 SUM OF RETAINED WTS. 1441.500

% AGGREGATE BY EXTRACTION 94.899
% BITUMEN BY EXTRACTION 5.200
SPECIFIC GRAVITY 2.390
MARSHALL STABILITY 2783.000
MARSHALL FLOW 0.01 IN. 9.000

INDIRECT TENSILE STRENGTH, P.S.I. 23.8
Strength Retention
Marshall Stability (original) 2623
Marshall Stability (after soak) 2627
% strength retention 100

COPIES TO:
- ASPH. CONC.
- J. RUMP
- R. SHELQUIST
- L. ZEARLEY
INDRIGENT TENSILE STRENGTH PSI 24.1

MIN: 3.133 3.099
MAX: 2.020
SPECIFIC GRAVITY:

% RETAINED BY EXHAUSTION
30.000
% APPROXIMATE: EXHAUSTION
95.060

SUM OF RETAINED WTS. 14.514.560

SIEVE GRAYT % RET. % PSD

SIEVE ANALYSIS PERCENT PASSING

DATE RECORDED 11-1-78
DATE RECORDED 11-1-78
SAMPLED AT: ALTA FALL TURF
SEEDS NO. 2-48-79 3-1-77
PLANT: SOUTH CITY LTD.
PRODUCT : PROPER COAST
MATERIAL: ASPHALT MIX-TYPE A SURFACE 1/4" 1/2"
MATERIAL: ASPHALT MIX-TYPE B SURFACE 1/2"
MATERIAL: ASPHALT MIX-TYPE C SURFACE 3/4"
MATERIAL: ASPHALT MIX-TYPE D SURFACE 1"

TEST REPORT - BLANTANOOS MATERIALS

Iowa Department of Transportation

- 25 -
MATERIAL: ASPHALT MIX-TYPE B SURFACE 1/2"  Lab No: ABC8-712
INTENDED USE  TO BE USED ON CITY STREETS
PROJECT No: DEPT. INFO.  COUNTY: WOODBURY
CONTRACTOR: BROWER CONST. CO.  CONTRACT No:
PRODUCER: BROWER CONST. CO.
PLANT: SIoux CITY, IA
UNIT OF MATERIAL: ONE BLOCK SECTION OF STREET (CONTAINS 0.32% ASPHALT)
SENDERS No: 3-R48-37
SAMPLED BY: ALLAN AND TUTTLE
DATE SAMPLED: 10-24-78  DATE RECD: 11-1-78  DATE REPORTED: 11-9-78

SIEVE ANALYSIS PERCENT PASSING

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DRY WT: 1482.000
SUM OF RETAINED WTS: 1481.500

% AGGREGATE BY EXTRACTION: 95.00
% BITUMEN BY EXTRACTION: 5.00
SPECIFIC GRAVITY: 2.320
MARSHALL STABILITY: 3007.000
MARSHALL FLOW 0.01 IN: 9.000

INDIRECT TENSILE STRENGTH PSI: 30.2
RICE SP. GR: 2.458
RECOVERED ASPHALT
PENETRATION @ 77 F. 100 GMS 5 SEC 26
ABS. VIS. @ 140 F. 300 MM. HG. (POISES) 9320

COPIES TO:
ASPHALTIC CONCRETE
J. BUMP
C. ZEARLEY
R. SHELQUIST
IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
AMES LABORATORY
TEST REPORT - BITUMINOUS MATERIALS

MATERIAL: ASPHALT MIX - TYPE B SURFACE 1/2" I
INTENDED USE: TO BE USED ON CITY STREETS
PROJECT NO: DEPT. INF.
CONTRACTOR: BROWER CONSTR. CO.
PRODUCER: BROWER CONSTR. CO.
PLANT: SIOUX CITY, IOWA
UNIT OF MATERIAL: ONE LOCK SECTION OF STREET
SENDERS NO: 3-RAB-37
SAMPLED BY: ALLAN AND TUTTLE
DATE SAMPLED: 10/24/78

REPORTED DATE: 11/9/78

SIEVE ANALYSIS PERCENT PASSING

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DRY WT. | 1430.000
SUM OF RETAINED WTS. | 1437.500

% AGGREGATE BY EXTRACTION | 94.900
% BITUMEN BY EXTRACTION | 5.100
SPECIFIC GRAVITY | 2.330
MARTHEL STABILITY | 2890.000
MARTHEL FLOW 0.01 IN. | 9.000

INDIRECT TENSILE STRENGTH, F.SI. | 29.2
RECOVERED ASPHALT
PENETRATION @ 77 F. 150 GMS. 5 SEC. | 28
ABS. VIS. @ 140 F. 500 MM HG. POISES | 8450

COPIES TO:
ASPH. CONC.
J. BUMP
F. SHELQUIST
L. ZEARLEY
IUWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
AMES LABORATORY
TEST REPORT - BITUMINOUS MATERIALS

MATERIAL: ASPHALT MIX-TYPE B SURFACE 1/2"
INTENDED USE: TO BE USED ON CITY STREETS
PROJECT NO: DEPT. INFO.
CONTRACTOR: BROWER CONSTR. CO.
PRODUCER: BROWER CONSTR. CO.
PLANT: SIOUX CITY, IA
UNIT OF MATERIAL: ONE BLOCK SECTION OF STREET (CONTAINS 0.32% ASPHALUR)
SENDERS NO: 3-RA8-37
SAMPLED BY: ALLAN AND TUTTLE
DATE SAMPLED: 10-24-78
DATE RECEIVED: 11-1-78
DATE REPORTED: 11-9-78

SIEVE ANALYSIS

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DRY WT. 1447.000
SUM OF RETAINED WTS. 1445.500

% AGGREGATE BY EXTRACTION 94.600
% BITUMEN BY EXTRACTION 5.400
SPECIFIC GRAVITY 2.330
MARSHALL STABILITY 3083.000
MARSHALL FLOW 0.01 IN. 9.600

INDIRECT TENSILE STRENGTH PSI 35.3
Strength Retention
Marshall Stability (original) 3122
Marshall Stability (after soak) 2692
% strength retention 86.2

COPIES TO:

ASPHALTIC CONCRETE
J. BUMP
R. SHEQUIST
L. ZEARLEY
MATERIAL : ASPHALT MIX - TYPE B SURFACE 1/2"  
INTENDED USE : TO BE USED ON CITY STREETS - SIoux CITY  
PROJECT NO : DEPT. TRAN.  
CONTRACTOR : BROWER CONSTR. CO.  
PRODUCER : BROWER CONSTR. CO.  
PLANT : SIoux CITY, IOWA  
UNIT OF MATERIAL : ONE BLOCK SECTION OF STREET (CONTAINS 0.32% ASPHALT)  
SENDERS NO : 3-RA8-37  
SAMPLED BY : ALLAN & TUTTLE  
DATE SAMPLED : 10/24/78  
DATE REC'D : 11/4/78  
DATE REPORTED : 11/9/78

SIEVE ANALYSIS  PERCENT PASSING

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SUM OF RETAINED UTS. : 1454.000

% AGGREGATE BY EXTRACTION : 95.000
% BITUMEN BY EXTRACTION : 5.000
SPECIFIC GRAVITY : 2.330
MARSHALL STABILITY : 2965.000
MARSHALL FLOW 0.01 IN. : 9.000

INDIRECT TENSILE STRENGTH - P.S.I. : 31.7
RICE SP. GR. : 2.457
RECOVERED ASPHALT

COPY TO:

ASHC. CONC.  
J. DREW  
R. SHELOHIST  
F. ZEIRLEY

BY BERNARD C. DROWN  
TESTING ENGINEER
MATERIAL: ASPHALT MIX-TYPE B SURFACE 1/2" INTENDED USE: TO BE USED ON CITY STREETS
PROJECT NO: DEPT. INFO.
CONTRACTOR: BROWER CONST. CO.
PRODUCER: BROWER CONST. CO.
PLANT: SIOUX CITY, IA
UNIT OF MATERIAL: ONE BLOCK SECTION OF STREET (CONTAINS 0.32% ASPHALTUR)
SENDERS NO: 3-RA0-37
SAMPLED BY: ALLAN AND TUTTLE
DATE SAMPLED: 10-24-78
DATE RECEIVED: 11-1-78
DATE REPORTED: 11-9-78

SIEVE ANALYSIS PERCENT PASSING

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DRY WT.: 1457.000
SUM OF RETAINED WTS.: 1454.500

% AGGREGATE BY EXTRACTION 95.100
% BITUMEN BY EXTRACTION 4.900
SPECIFIC GRAVITY 2.330
MARRSHALL STABILITY 3190.000
MARRSHALL FLOW 0.01 IN. 8.000

INDIRECT TENSILE STRENGTH PSI 32.8

COPIES TO:
- ASPHALTIC CONCRETE
  J. BUMP
  R. SHELUQUST
  ZEARLEY

BY BERNARD C. BROWN
TESTING ENGINEER
TEST REPORT — BITUMINOUS MATERIALS

Material: Asphaltic concrete @ 5.5%  Laboratory No. ABC8-724
Intended Use: 

Project No.: U-7 Department Information  County: Linn
Contractor: 
Producer: 
Plant: 

Unit of Material: Sample without asphalt for central lab. for experimental testing and analysis.

Sampled by:  Sender's No. 2
Date Sampled:  Date Rec'd: 11-6-78  Date Reported: 11-14-78

SIEVE ANALYSIS — PER CENT PASSING

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% Aggregate—By Extraction: 94.4%
% Bitumen—By Extraction: 5.6%

% Peg. No. 8 after 16 Cycles F&T, Water-Alco. Sol.
% Peg. No. 8 after 25 Cycles F&T, Water Solution
% of Wear, Los Angeles Abrasion, Grading

Liquid Limit: 
Plastic Limit: 
Plasticity Index: 

COMPACATION & STABILITY TESTS

Laboratory Density (Specific Gravity): 2.34
Marshall Stability (lbs.): 2817
Marshall Flow (in.): 8
Hveem Side Pressure (PSI): 
Indirect tensile strength (p.s.i.): 20.2

DISPOSITION: By Testing Engineer
IOWA DEPARTMENT OF TRANSPORTATION
Highway Division
Office of Materials

TEST REPORT — BITUMINOUS MATERIALS

Material: Asphaltic Concrete @ 5.5%
Laboratory No.: ABC9-725

Intended Use:

Project No.: U-7 Department Information
County: Linn

Contractor:
Producer:
Plant:

Unit of Material: Sample with asphalt for central lab for experimental testing and analysis.

Sampled by: Sender's No.: 3
Date Sampled: Date Rec'd: 11-6-78 Date Reported: 11-14-78

SIEVE ANALYSIS — PER CENT PASSING

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% Aggregate—By Extraction: 94.7%
% Bitumen—By Extraction: 5.3%

% Peg. No. 8 after 16 Cycles F&T, Water-Alco. Sol.: _______________________
% Peg. No. 8 after 25 Cycles F&T, Water Solution: _______________________
% of Wear, Los Angeles Abrasion, Grading: _______________________

Liquid Limit: _______________________
Plastic Limit: _______________________
Plasticity Index: _______________________

COMPACCTION & STABILITY TESTS

Laboratory Density (Specific Gravity): 2.34
Marshall Stability (lbs.): 3045
Marshall Flow (in.): 8
Hveem Side Pressure (PSI): _______________________
Indirect tensile strength p.s.i.: 30.8
Retained stability percent: 90.5

DISPOSITION: By: Testing Engineer
Asphaltic Concrete @ 5.5%  Laboratory No. ABC8-726

Intended Use

Project No. U-7 (Dept. Info.)  County Linn

Contractor

Producer

Plant

Unit of Material Sample with Asphadur for Central Lab for experimental testing and analysis.

Sampled by

Sender's No. 4

Date Sampled  11-6-78  Date Rec'd  11-6-78  Date Reported  11-14-78

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% Aggregate—By Extraction  94.7 %
% Bitumen—By Extraction  5.3 %

% Peg. No. 8 after 16 Cycles F&T, Water-Alco. Sol.
% Peg. No. 8 after 25 Cycles F&T, Water Solution
% of Wear, Los Angeles Abrasion, Grading

Liquid Limit
Plastic Limit
Plasticity Index
Rice Sp. Gr.  2.480
Indirect tensile strength 30.0

COMPACCTION & STABILITY TESTS
Laboratory Density (Specific Gravity)  2.33
Marshall Stability (lbs.)  2948
Marshall Flow (ins.)  8
Hveem Side Pressure (PSI)

RECOVERED ASPHALT
Penetration @ 77° F. 100 gms. 5 sec.  33
Abs. Vis. @ 140° F. 300 mm. hg. (Poises)  7900

DISPOSITION:  By  Testing Engineer
TEST REPORT — BITUMINOUS MATERIALS

Material: Asphaltic Concrete @ 5.5 %  
Laboratory No.: ABCB-727

Intended Use:

Project No.: U-7  
Department: Information  
County: Linn

Contractor:

Producer:

Plant:

Unit of Material: Sample with Asphadur for Central Lab for experimental Testing and analysis.

Sampled by:  
Sender's No.: 5

Date Sampled:  
Date Rec'd: 11-6-78  
Date Reported: 11-14-78

SIEVE ANALYSIS — PER CENT PASSING

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% Aggregate—By Extraction: 94.6 %  
% Bitumen—By Extraction: 5.4 %

% 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

COMPACATION & STABILITY TESTS

Laboratory Density (Specific Gravity): 2.34
Marshall Stability (lbs.): 2843
Marshall Flow (Ins.): 7
Hveem Side Pressure (PSI): 
Indirect tensile strength p.s.i.: 28.3

DISPOSITION: By Testing Engineer
TEST REPORT — BITUMINOUS MATERIALS

Material: Asph. Concrete @ 5.5 %
Laboratory No.: ABC8-728

Intended Use: Sample with asphalt for Central Lab for experimental testing and analysis.

Project No.: U-7 Department Information County: Linn

Contractor:

Producer:

Plant:

Unit of Material:

Sampled by:

Date Sampled:

Date Rec'd: 11-6-78

Date Reported: 11-14-78

SIEVE ANALYSIS — PER CENT PASSING

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% Aggregate — By Extraction: 94.8 %
% Bitumen — By Extraction: 5.2 %

% Peg. No. 8 after 16 Cycles F&T, Water-Alco. Sol.
% Peg. No. 8 after 25 Cycles F&T, Water Solution
% of Wear, Los Angeles Abrasion, Grading

Liquid Limit
Plastic Limit
Plasticity Index

Rice Sp. Gr.: 2.478
Indirect tensile strength p.s.i.: 33.1

COMPACCTION & STABILITY TESTS

Laboratory Density (Specific Gravity): 2.34
Marshall Stability (lbs.): 3170
Marshall Flow (Ins.): 8
Hveem Side Pressure (PSI)

RECOVERED ASPHALT
Penetration @ 77°F. 100 gms 5 Sec.: 35
Abs. Vis. @ 140°F. 300 mm. hg. (Poises): 5570

DISPOSITION:
By Testing Engineer
TEST REPORT — BITUMINOUS MATERIALS

Material: Asph. Concrete @ 5.5 %
Laboratory No.: ABCB-729

Intended Use:

Project No.: U-7 (Department Information) County: Linn

Contractor:

Producer:

Plant:

Unit of Material: Sample with Asphalt for Central Lab, for experimental testing and analysis

Sampled by:

Sender’s No.

Date Sampled: __________ Date Rec’d: 11-6-78 Date Reported: 11-14-78

SIEVE ANALYSIS — PER CENT PASSING

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% Aggregate—By Extraction: 94.7 %

% Bitumen—By Extraction: 5.3 %

% Peg. No. 8 after 16 Cycles F&T, Water-Alco. Sol.

% Peg. No. 8 after 25 Cycles F&T, Water Solution

% of Wear, Los Angeles Abrasion, Grading

Liquid Limit:

Plastic Limit:

Plasticity Index:

COMPACATION & STABILITY TESTS

Laboratory Density (Specific Gravity): 2.33

Marshall Stability (lbs.): 3408

Marshall Flow (ins.): 8

Hveem Side Pressure (PSI):

Indirect tensile strength psi: 32.6

DISPOSITION:

By: Testing Engineer