BRAZOS COUNTY SULFUR EXTENDED ASPHALT
FIELD TRIALS ON MH 153

A SHORT COURSE ON

SULFUR UTILIZATION AND
ASPHALT CONSERVATION

PRESENTED BY -

TEXAS TRANSPORTATION INSTITUTE
TEXAS A&M UNIVERSITY
RUDDER CONFERENCE TOWER
COLLEGE STATION, TEXAS

JUNE 19, 1978
This demonstration seminar has now been scheduled for the afternoon of June 19 and the morning of June 20, 1978, at College Station, Texas, and the tentative program is attached for your information. Note that this seminar has been coordinated with the Quality in Construction Seminar in Austin, Texas.

Attendance at this demonstration seminar is open to those who have an interest in the potential use of sulfur in construction of highway pavements.

The specific project which will be under construction involves the Sulfur Extended Asphalt (SEA) concept. The purpose of this demonstration will be to provide design construction, material, laboratory and research engineers an opportunity to become better acquainted with new technology advances in the use of sulfur in pavements.

The conference coordinators are Bob Prochaska or Andy Muñoz in the FHWA Office of Construction and Maintenance in Fort Worth, telephone 817/334-2143.
Acknowledgements

to

Participative Organizations

The following is a list of those who made major contributions to the success of the sulfur extended asphalt field trials on MH 153 in Brazos County, Texas.

U. S. Department of Transportation - FHWA
U. S. Department of Interior - Bureau of Mines
Texas State Department of Highways and Public Transportation
The Sulphur Institute
Texasgulf, Inc.
Young Brothers, Inc.
Slurry Seal Inc.
Texas Air Control Board
Texas A&M University, Texas Transportation Institute

These field trials have been made possible only by the coordinated efforts of the many individuals involved. The support of each is sincerely appreciated.
AGENDA
USE OF SULFUR IN PAVEMENTS
REGION 6 DEMONSTRATION SEMINAR
COLLEGE STATION, TEXAS
ROOM 401 - RUDDER TOWER - TEXAS A&M CAMPUS
TENTATIVE PROGRAM
JUNE 19-20, 1978

<table>
<thead>
<tr>
<th>June 19</th>
<th>Time</th>
<th>Event</th>
<th>Presenter(s)</th>
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<tbody>
<tr>
<td></td>
<td>2:00</td>
<td>Welcome and Opening Remarks</td>
<td>C. V. Wootan</td>
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<tr>
<td></td>
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<td>Bob Prochaska</td>
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<td></td>
<td>2:10-2:40</td>
<td>Sulfur as a Waste Product</td>
<td>Dave Bixby,</td>
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<td>Sulphur Institute</td>
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<td>2:40-3:15</td>
<td>Sulfur as an Engineering Construction Material - An FHWA Overview</td>
<td>Bill Besselievre</td>
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<td>3:15-3:30</td>
<td>Break</td>
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<td>3:30-4:00</td>
<td>Case Histories of Experimental Uses of Sulfur in Pavement</td>
<td>Don Saylak</td>
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<td>4:00-5:00</td>
<td>Design Construction Quality Control and Evaluation Criteria on the College Station Project</td>
<td>Bob M. Gallaway</td>
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<td></td>
<td>5:00-5:30</td>
<td>Discussion, Questions, Etc.</td>
<td>Bob M. Gallaway</td>
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<td>5:30</td>
<td>Dismiss</td>
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<tr>
<th>June 20</th>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td></td>
<td>8:30</td>
<td>Assemble at Ramada Inn Lobby for Tour of Plant and Construction Project</td>
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<td></td>
<td>8:30-12:00</td>
<td>Close observation of construction equipment, quality control methods, etc.</td>
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<td>Noon</td>
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Summary of Work for

Brazos County, Texas (MH 153)

Sulfur-Asphalt Field Trials
A. **STUDY PROBLEM STATEMENT**

To evaluate post construction in-service performance of test sections constructed with sulfur-asphalt binder.

B. **BACKGROUND AND SIGNIFICANCE OF WORK**

Over the past fifty years, asphalt and paving technologists have used sulfur to modify the properties of paving asphalt. These efforts were on a limited basis as there was an abundance of crude oil, and continual improvements in refining technology. Recently, renewed interest in the use of sulfur-asphalt has been stimulated by the projected over-supply of sulfur, limitations of hydrocarbon resources, and the need for energy conservation.

The significance of the work is apparent in the area of hydrocarbon conservation, and sulfur utilization. Additionally, it is believed the marginal materials used with the sulfur-asphalt binder will result in a pavement structurally equal to material with pure asphalt as the binder. If the enhancement is documented, then consideration can be given to using aggregates that have previously been by-passed and reduce the reliance on the dwindling supply of high quality aggregates.

C. **OBJECTIVES OF STUDY**

To evaluate and report in-service performance on test sections of pavement constructed with sulfur asphalt binder as shown in Figures 1 through 4.

D. **SCOPE**

This study will include the use of a conventional batch type asphaltic concrete mixing plant, placing and compaction equipment with addition of a colloid mill. The colloid mill will be used to emulsify the liquid asphalt and sulfur prior to introduction into the mixer as depicted in Figure 5, "Mixing Station". Also included will be a subsection involving direct substitution of the sulfur in mixture at the pugmill, that is, the colloid mill will be by-passed.

E. **IMPLEMENTATION**

1. If the results justify implementation after evaluation, the finding will be reported in the form of laboratory test procedures and design techniques.

2. The logical organizations for the application of the results are the FHWA and State Highway Departments.
3. Results that would merit adoption would require modification of some states' highway department specifications.

4. The research findings will be conveyed to interested parties upon request.

F. BENEFITS

The benefits are primarily of an economy-energy saving nature and the utilization of marginal materials. Details are:

1. For a similar aggregate, approximately 30% and 40% by weight of the asphalt binder can be replaced by sulfur.

2. HMAC paving can be produced at lower temperatures resulting in a lower energy consumption of an estimated 15 to 25%.

3. For similar pavement design characteristics, the use of sulfur-asphalt binder allows for the replacement of conventional aggregate with a lower quality aggregate that may be available locally. If lower quality aggregates are not available, a reduction of the layer of pavement thickness may be effected and maintain the same strength characteristics.

G. WORK PLAN

The work will consist of the post testing and evaluation of previously placed hot mixed sulfur-asphalt binder concrete pavement test sections. The test sections will be placed on a current project, Project MJ021(4), Control No. 8021-17-2, on MH 153 Brazos County, Texas, by the contractor based on a mix design developed by TTI (Texas Transportation Institute) with the extra cost of the test sections borne by The Sulphur Institute. (See attached map site, Figure 1).

The post construction testing evaluation and reporting work will be performed jointly by the Texas Transportation Institute and Texas State Department of Highways and Public Transportation.
Fig. 1 Test Site
**Figure 2**

**General Layout of Field Test Sections**

MH 153 Brazos County, Texas

(Station 48 + 00 to Station 75 + 00) (South Bound Lanes)

**Estimated Tons of Mixture Required:**

Pavement 26' wide by 2700' long = 70,200 sq. ft. = 7,800 sq. yds.

Using 660 lbs/sq. yd. = (660) (7800) = 5,148,000 lbs. mix = 2574 Tons mix (Add 5% for change over - Giving total of 2700 Tons)

(Estimating production at 675 Tons/day = 4 days of effort)

**Layout:**

<table>
<thead>
<tr>
<th>Section 1 (Control)</th>
<th>48 + 00</th>
<th>Section 2</th>
<th>52 + 50</th>
<th>450 ft.</th>
<th>450 ft.</th>
<th>450 ft.</th>
<th>450 ft.</th>
<th>450 ft.</th>
<th>450 ft.</th>
<th>75 + 00</th>
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</thead>
</table>

- Use Colloid Mix to form SEA
- Direct Substitution

Note: Sulfur-Asphalt binder to be optimized on a volume substitution basis.
Table 1. Materials Quantities

<table>
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<tr>
<th>Materials Estimates:</th>
<th>Calculated</th>
<th>Rounded</th>
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<tbody>
<tr>
<td>Bank Run Gravel -</td>
<td>1245 Tons</td>
<td>1300</td>
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<tr>
<td>Concrete Sand -</td>
<td>453 Tons</td>
<td>450</td>
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<tr>
<td>Field Sand -</td>
<td>832 Tons</td>
<td>830</td>
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<tr>
<td>Asphalt -</td>
<td>113 Tons</td>
<td>115</td>
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<tr>
<td>Sulfur -</td>
<td>57 Tons</td>
<td>60</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>2700 Tons</strong></td>
<td><strong>2755 Tons</strong></td>
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HALF SECTION
Sta 0+465 to 8+100 (Lt Side)
Sta 76+50 to 8+100 (Rt Side)

Fig. 3 TYPICAL SECTION
Showing Grading - Sta 0+32 to 8+100

HALF-SECTION
Sta 0+465 to 76+50 (Lt Side)
See Plan Profile Sheets for Limits of Sidewalk

Backfill

Approx. 6" Lime Slab, Subgrade Stabilized with approx. 4% Lime by weight

Curb & Gutter Half-Section
To be used: Site 01455 to 81+00 Lt
Site 78+50 to 81+00 Rt

Fig. 4 Typical Section
Showing Completed Roadway

Note: Concrete Curb & Gutter to tie to existing curb @ Site 82+85 (Lt) / 82+90 (Rt).
Approx. 66 Tons Asph Slab Base
Level-Up to be placed over Lt Half of existing Roadway Pavement from Site 81+00 to approx. 81+400 and 1.5-CST
over entire roadway from 81+00 to 82+90

Estimated 650 Lb/5Y Selected Aggregates and Sulfur-Asphalt Binders
Figure 5

MIXING STATION

Asphalt Tank

Sulfur Tank

Colloid Mill

Batch Weigher

Aggregate

Pug Mill

Loading area

Mill By Pass for SEA
Figure 6. Testing Matrix

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Initial</th>
<th>( T )</th>
<th>( T_0 + ) 6 mo.</th>
<th>( T_0 + ) 12 mo.</th>
<th>( T_0 + ) 18 mo.</th>
<th>( T_0 + ) 36 mo.</th>
<th>( T_0 + ) 42 mo.</th>
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<td>a. Average Daily Traffic Count</td>
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<td>b. Truck and Axle Weight Distribution</td>
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<td>Visual Evaluation</td>
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<td>c. Stability, Hveem at each test</td>
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* Loadometer survey, 1-week duration

O Evaluations on both sulfur-asphalt binder and asphalt binder pavement sections

* Initial evaluation of paving materials
Attachments
Laboratory Properties of Various Mixture Designs and Other Information
Hveem & Marshall Stabilities

50 Percent Concrete Sand
50 Percent Field Sand
AC-20 Asphalt

Marshall

Hveem

Point Omitted

Binder Content, Percent

MR, PSI 140,000 240,000 250,000

Voids, % 13.7 13.6 9.7
Hydrom & Marshall Stabilities

75 Percent Bank Run Gravel
25 Percent Field Sand
40-60 Sulfur-Asphalt

Hydrom

Marshall
Hveem & Marshall Stabilities

50 Percent Concrete Sand
50 Percent Field Sand
40-60 Sulfur-Asphalt

Hveem & Marshall Stabilities

Marshall

Hveem

Binder Content, Percent

M, Rs, %
330,000
525,000
315,000

Vol. Oil, %
12.7
8.8
7.1
Air Voids Vs. Binder Content

50% Coarse Sand
50% Fine Sand

Air Voids, Percent

Binder Content, Percent

50-50 SAE
30-70 SAE
40-60 SAE
Pure Asphalt
Specific Gravity of Sulfur-Asphalt Binders

Versus

Weight Percent Sulfur Present

Temperature: 300°F

Specific Gravity

Percent Sulfur in Binder

Spec. Grav. = 1.8

Spec. Grav. = 2.0