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

REGION 6 DEMONSTRATION SEMINAR

USE OF SULFUR IN PAVEMENTS

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

June 19

2:00	Welcome and Opening Remarks	C. V. Wootan Bob Prochaska
2:10 - 2:40	Sulfur as a Waste Product	Dave Bixby, Sulphur Institute
2:40 - 3:15	Sulfur as an Engineering Construction Material - An FHWA Overview	Bill Besselievre Ed Harrigan
3:15 - 3:30	Break	
3:30 - 4:00	Case Histories of Experimental Uses of Sulfur in Pavement	Don Saylak
4:00 - 5:00	Design Construction Quality Control and Evaluation Criteria on the College Station Project	Bob M. Gallaway
5:00 - 5:30	Discussion, Questions, Etc.	Bob M. Gallaway
5:30	Dismiss	

June 20

8:30	Assemble at Ramada Inn Lobby for Tour of Plant and Construction Project
8:30 - 12:00 Noon	Close observation of construction equipment, quality control methods, etc.

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 dwlindling 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 sub-section 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.

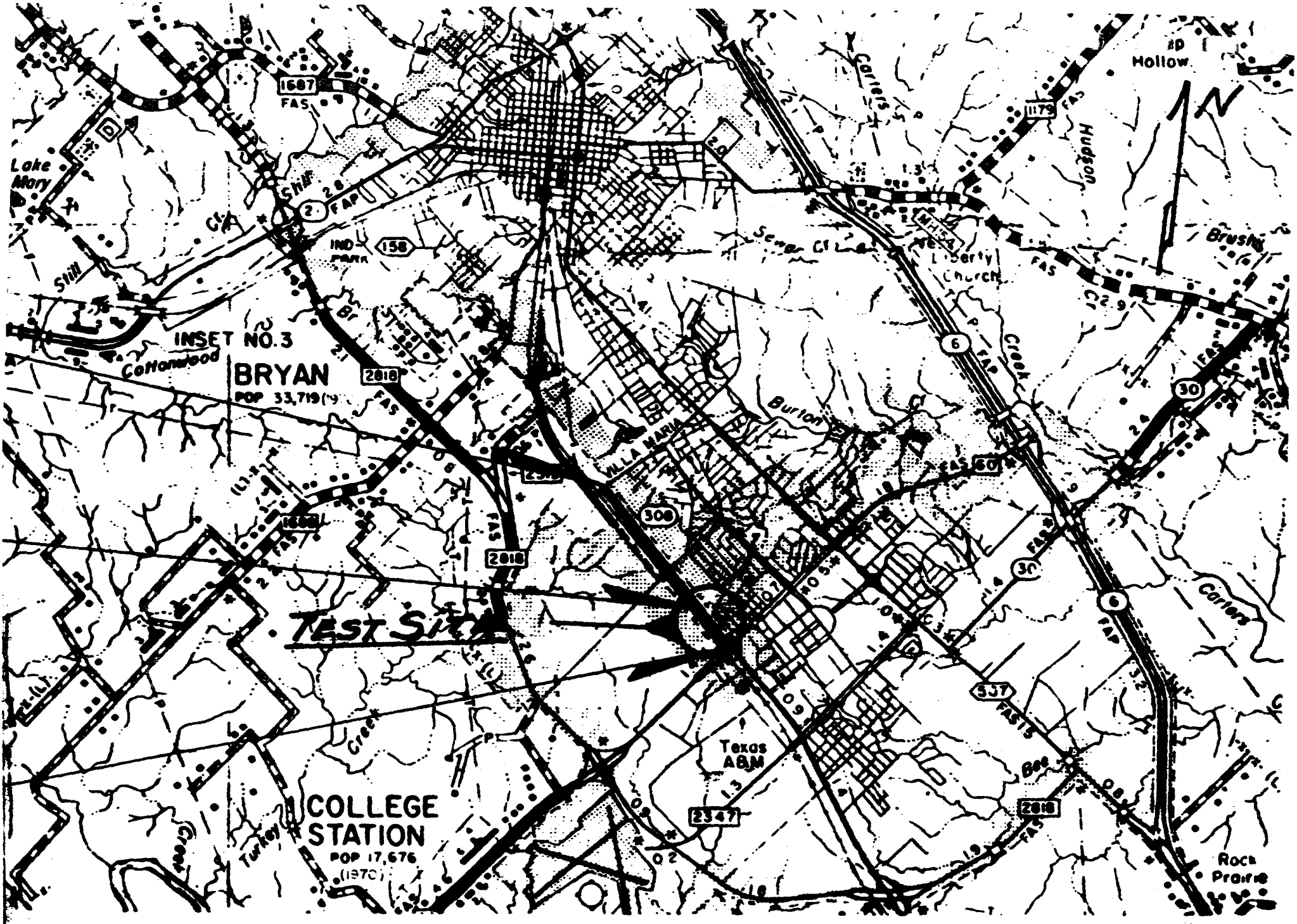


FIG. 1 TEST SITE

Revised 6-13-78

Figure 2

General Layout of Field Test Sections

MH 153 Brazos County, Texas

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

N

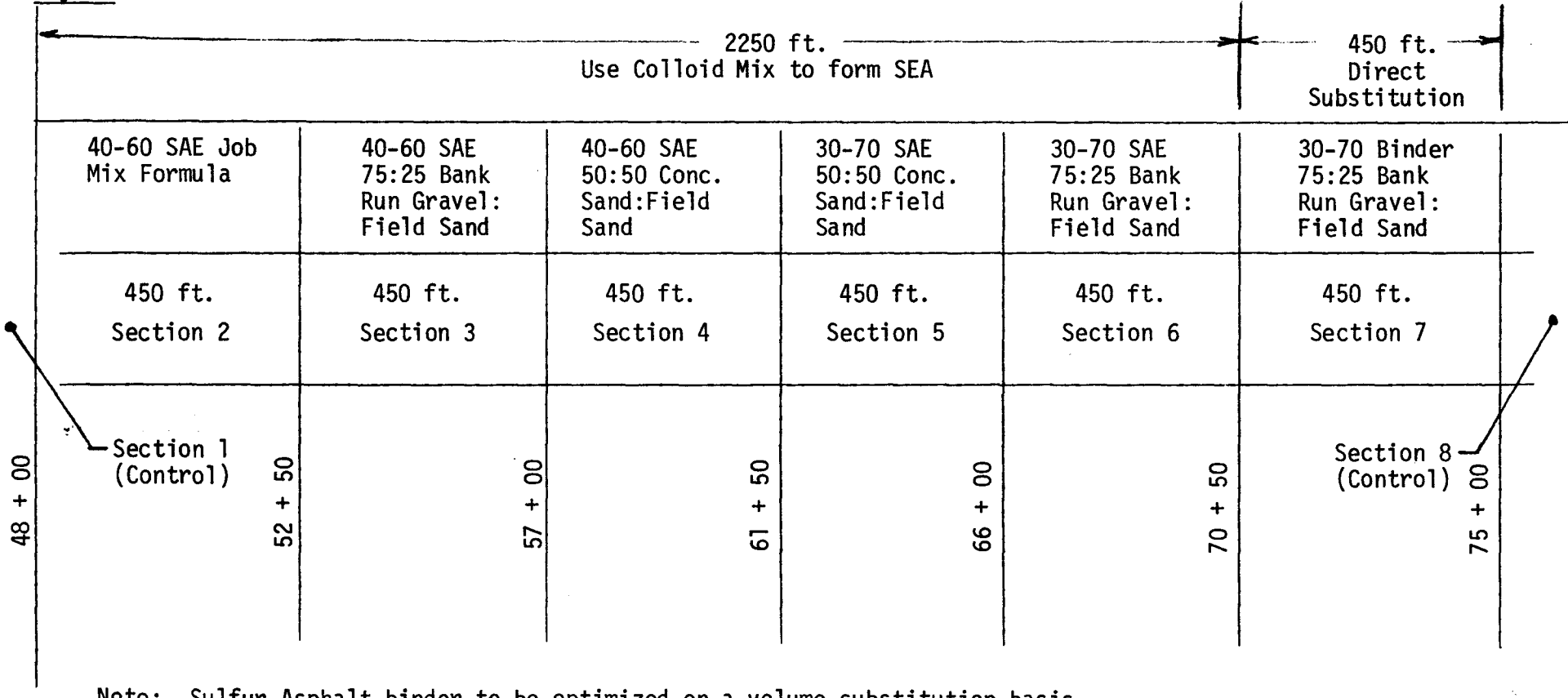
Estimated Tons of Mixture Required:

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)

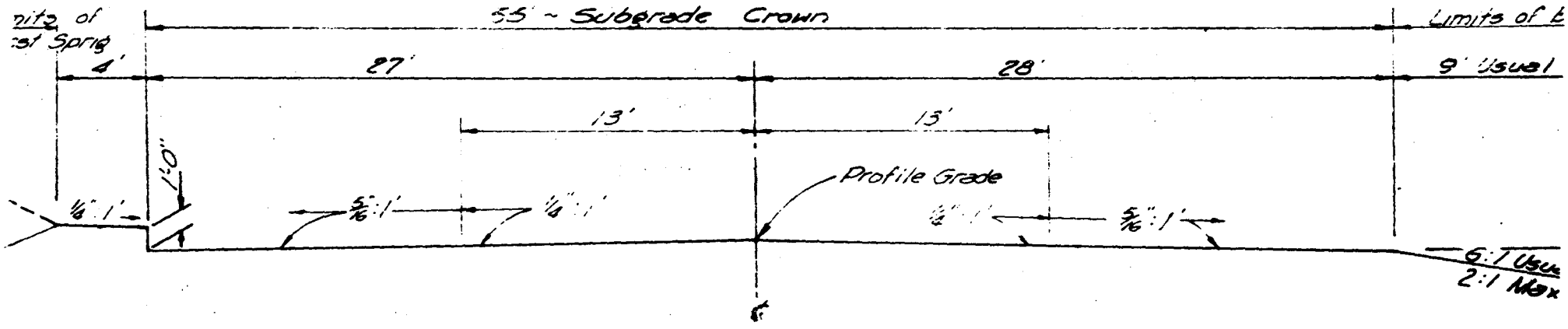
Layout:



Note: Sulfur-Asphalt binder to be optimized on a volume substitution basis.

Table 1. Materials Quantities

Materials Estimates:	Calculated	Rounded
Bank Run Gravel -	1245 Tons	1300
Concrete Sand -	453 Tons	450
Field Sand -	832 Tons	830
Asphalt -	113 Tons	115
Sulfur -	57 Tons	60
Total	2700 Tons	2755 Tons

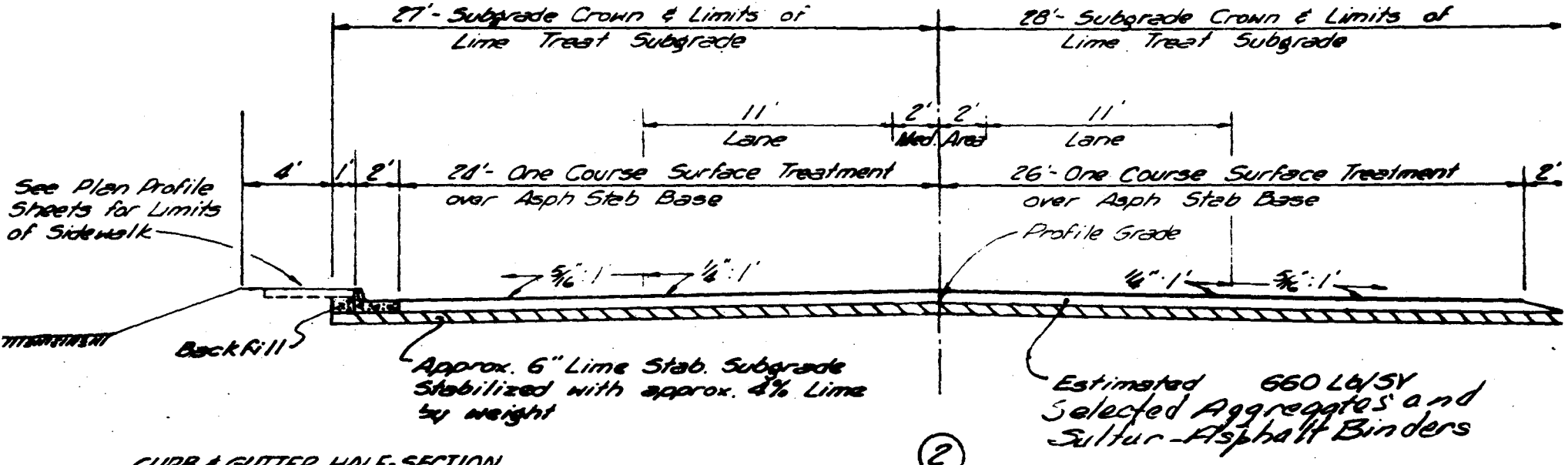


HALF SECTION
Sta. 0+46.5 to 81+00 (Lt Side)
Sta. 76+50 to 81+00 (Rt Side)

HALF-SECTION
Sta. 0+46.5 to 76+50 (Rt Side)

(1)

FIG. 3 TYPICAL SECTION
Showing Grading - Sta. 0+32 to 81+00



CURB & GUTTER HALF-SECTION
To be used: Sta 0+46.5 to 81+00 Lt
Sta 75+50 to 81+00 Rt

(2)

FIG. 4 TYPICAL SECTION
Showing Completed Roadway

Note: Concrete Curb & Gutter to tie to existing curb @ Sta 82+85 (Lt) & 82+90 (Rt).
Approx. 66 Tons Asph Stab Base Level-Up to be placed over Lt Half of existing Roadway Pavement from Sta. 81+00 to approx. 82+00 and 1-CST over entire roadway from 81+00 to 82+90

Figure 5

MIXING STATION

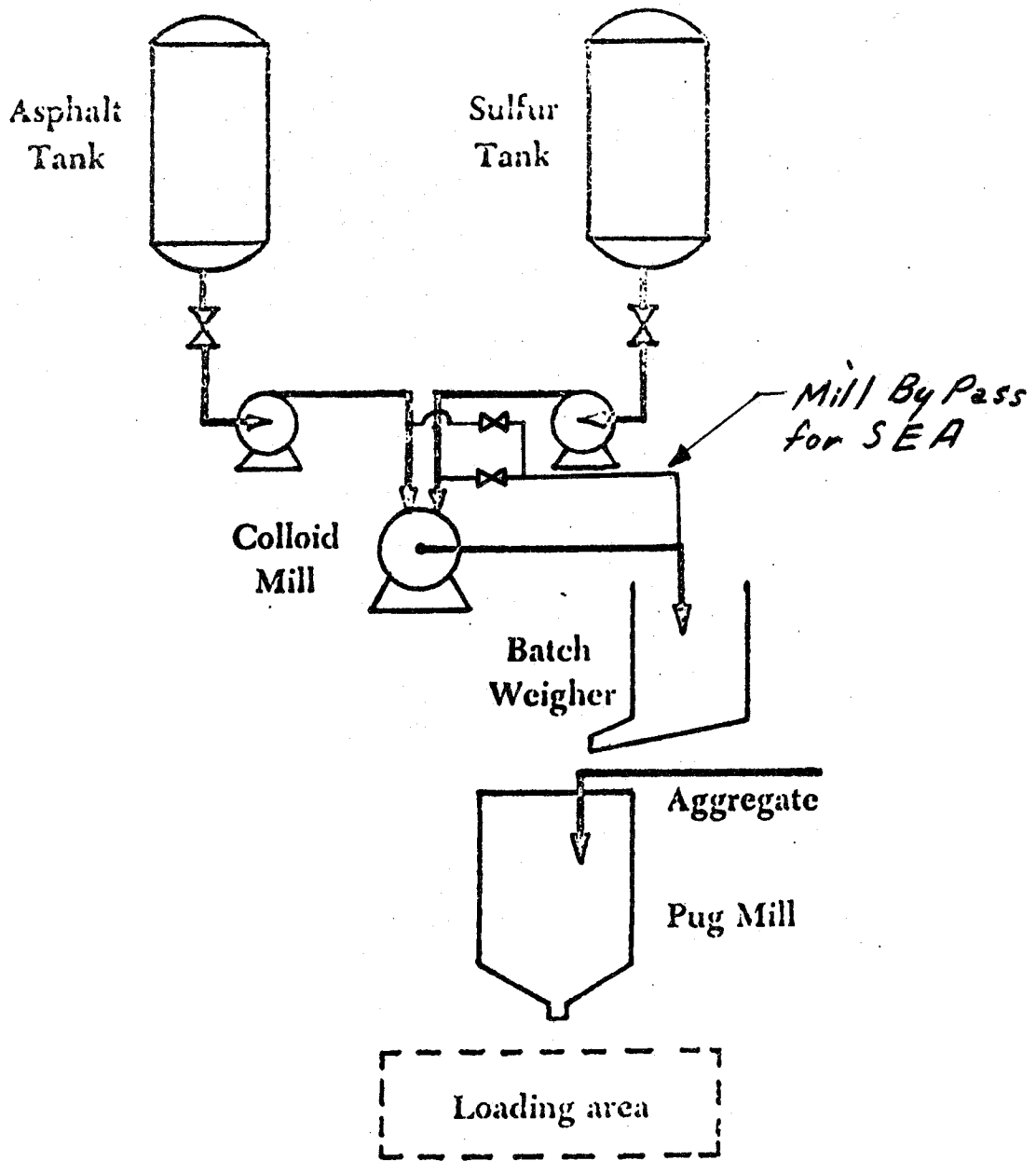


Figure 6. Testing Matrix

Test Description	Time Intervals					
	Initial T	T_o + 6 mo.	T_o + 12 mo.	T_o + 18 mo.	T_o + 36 mo.	T_o + 42 mo.
1. Traffic Analysis						
a. Average Daily Traffic Count	continuous					
b. Truck and Axle Weight Distribution	*				*	
2. Visual Evaluation	0	0	0	0	0	
3. Mays Meter (PSI)	0	0	0	0	0	
4. Benkelman Beam	0	0	0	0	0	
5. Dynaflect Deflections	0	0	0	0	0	
6. Cored Samples						
a. Density (set of 3 cores (min) at each test section per sampling period)	0	0	0	0	0	
b. Stability, Marshall						
c. Stability, Hveem						
d. Resilient Modulus						
e. Indirect Tension						
f. Rice Specific Gravity	*					
7. Interim and Final Reports	0	0	0	0	0	0

* Loadometer survey, 1-week duration
0 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

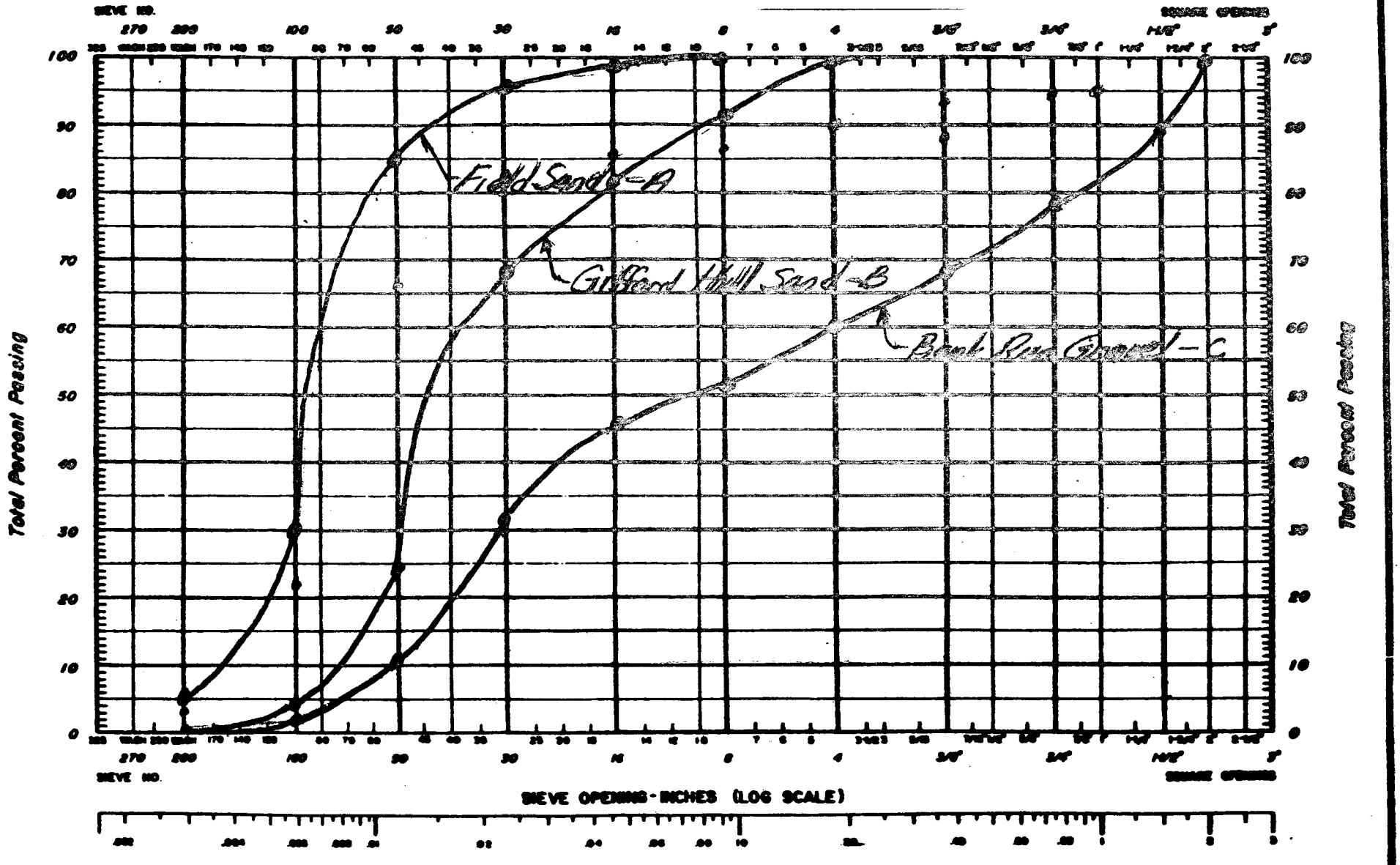
Sample No. _____
Source Brazos County
Materials Sands & Gravel

TEXAS A&M UNIVERSITY

CIVIL ENGINEERING DEPARTMENT

COLLEGE STATION TEXAS 77843

Project RF3698
Location MH 153
Date 1977-78



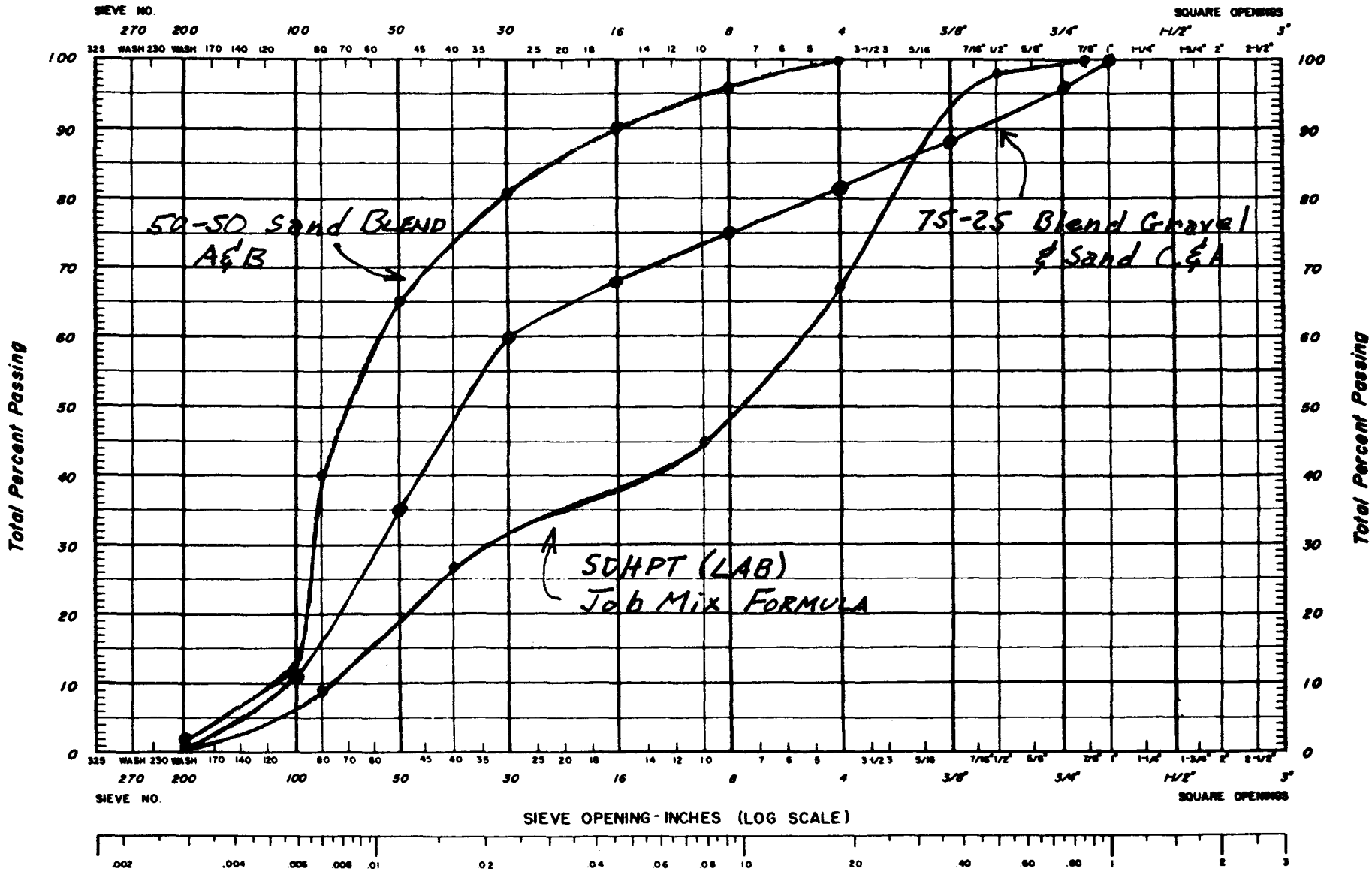
U. S. STANDARD SIEVES - ASTM DESIGNATION E 11-61

Sample No. _____
Source BRAZOS COUNTY
Materials BLENDS

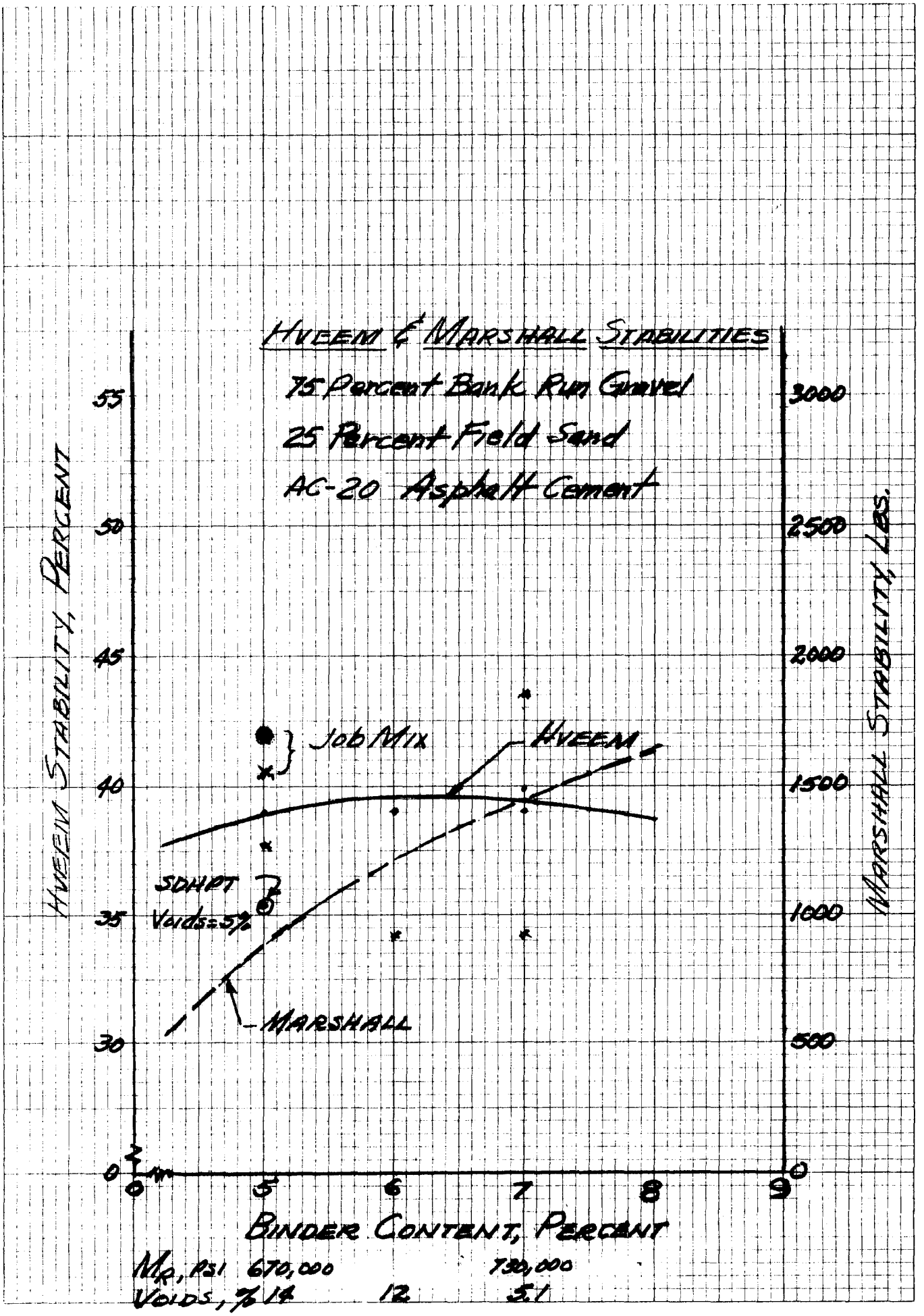
TEXAS TRANSPORTATION INSTITUTE

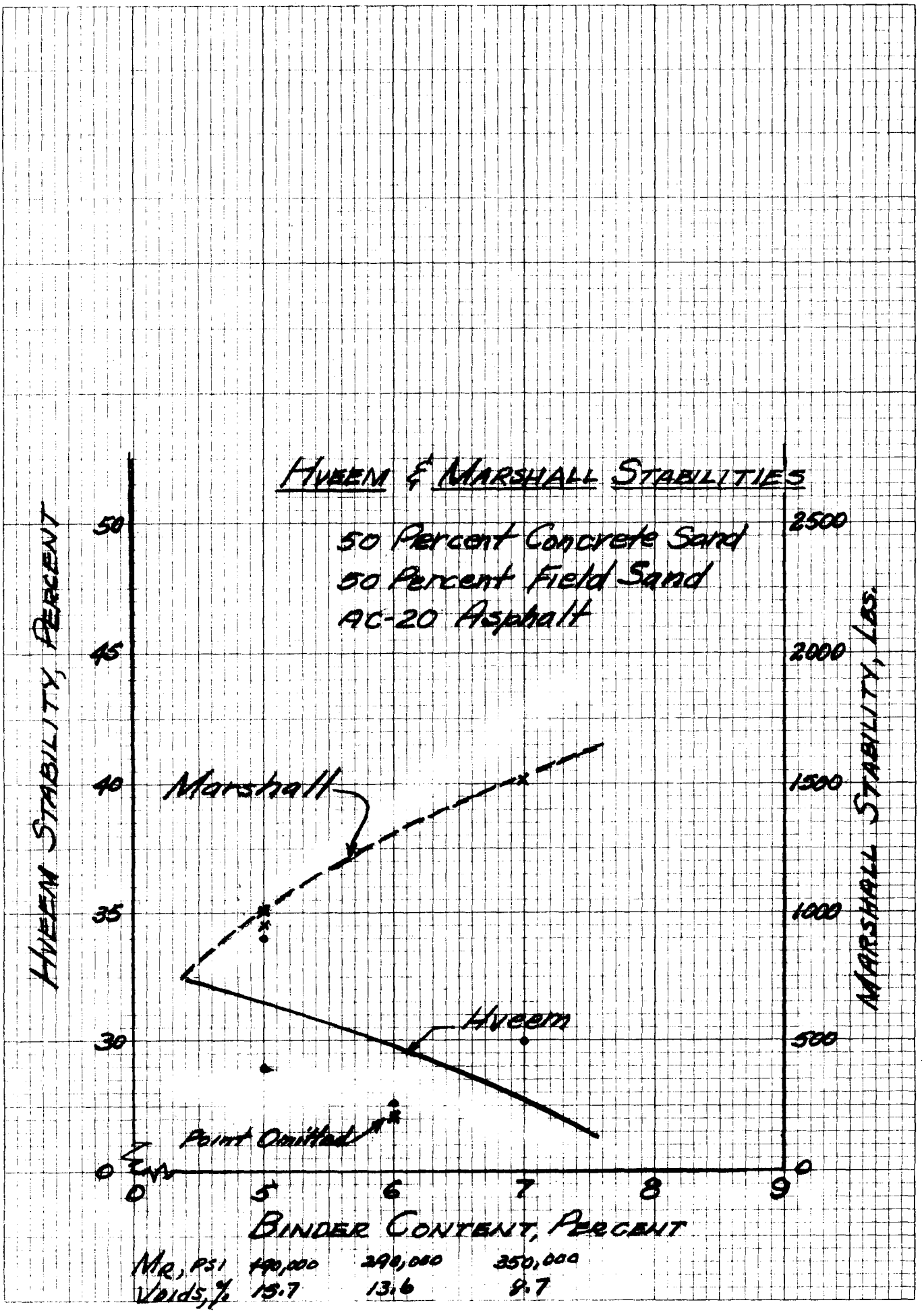
Project RF 3698
Location MH 153
Date 1977-78

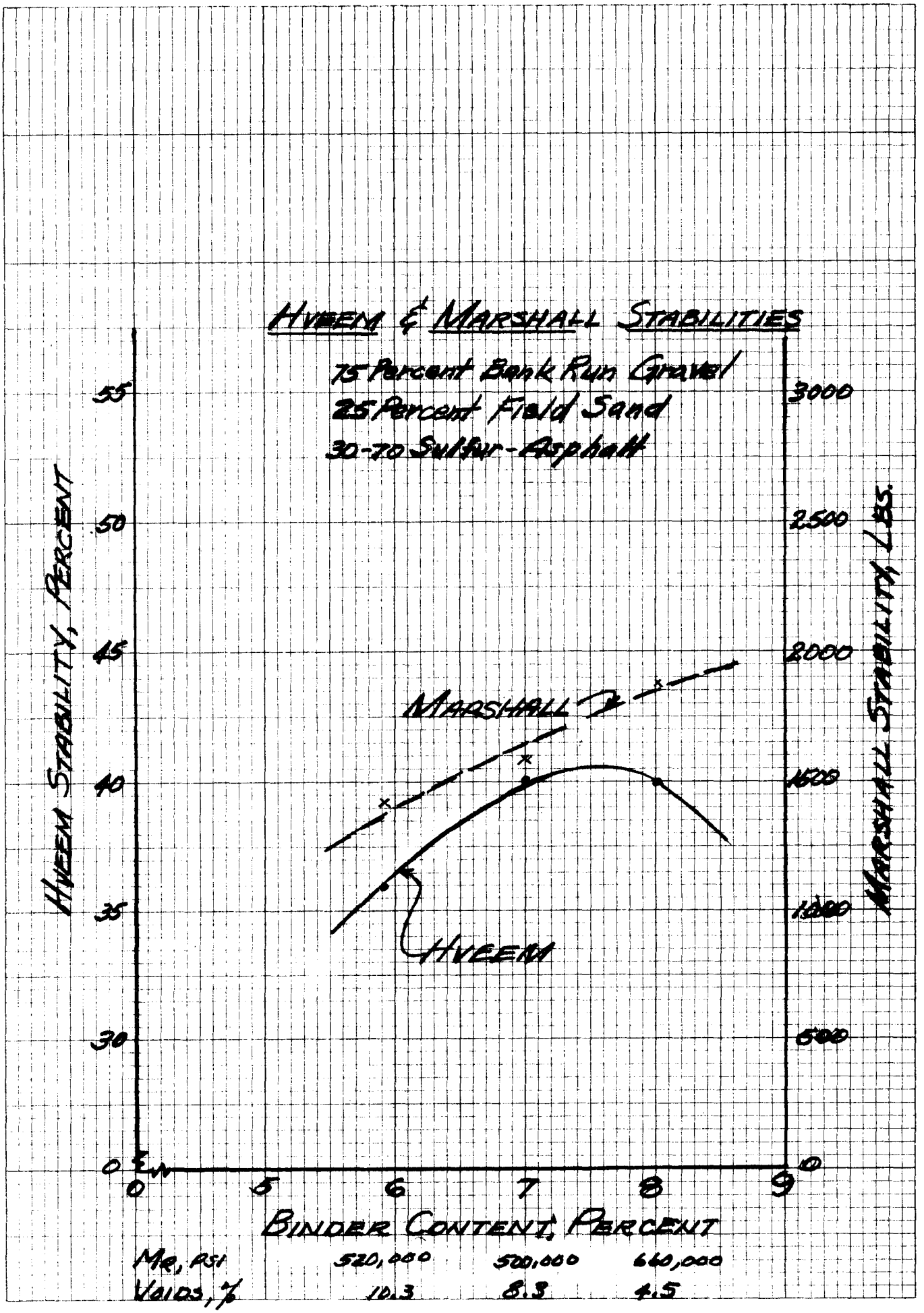
AGGREGATE GRADING CHART

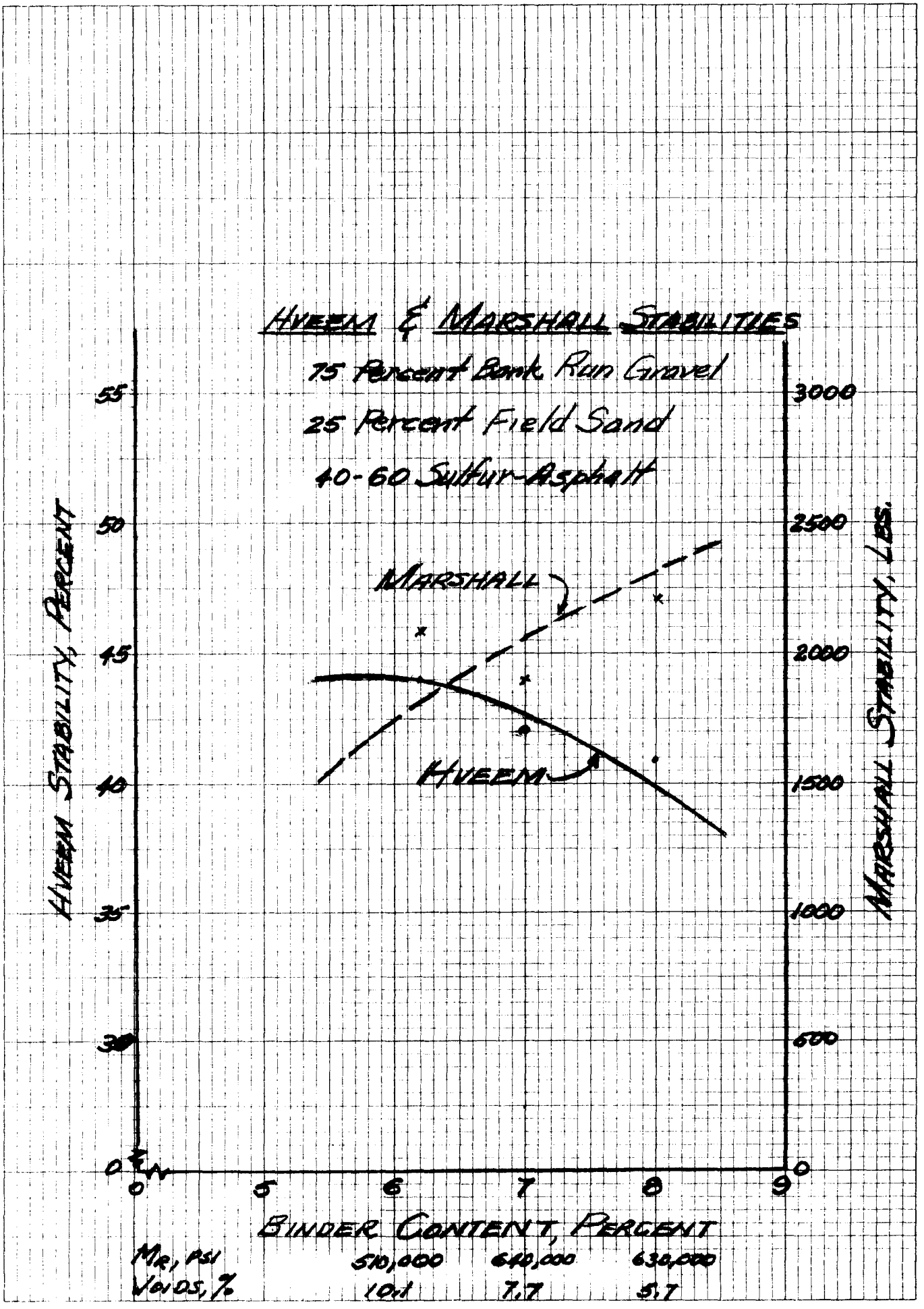


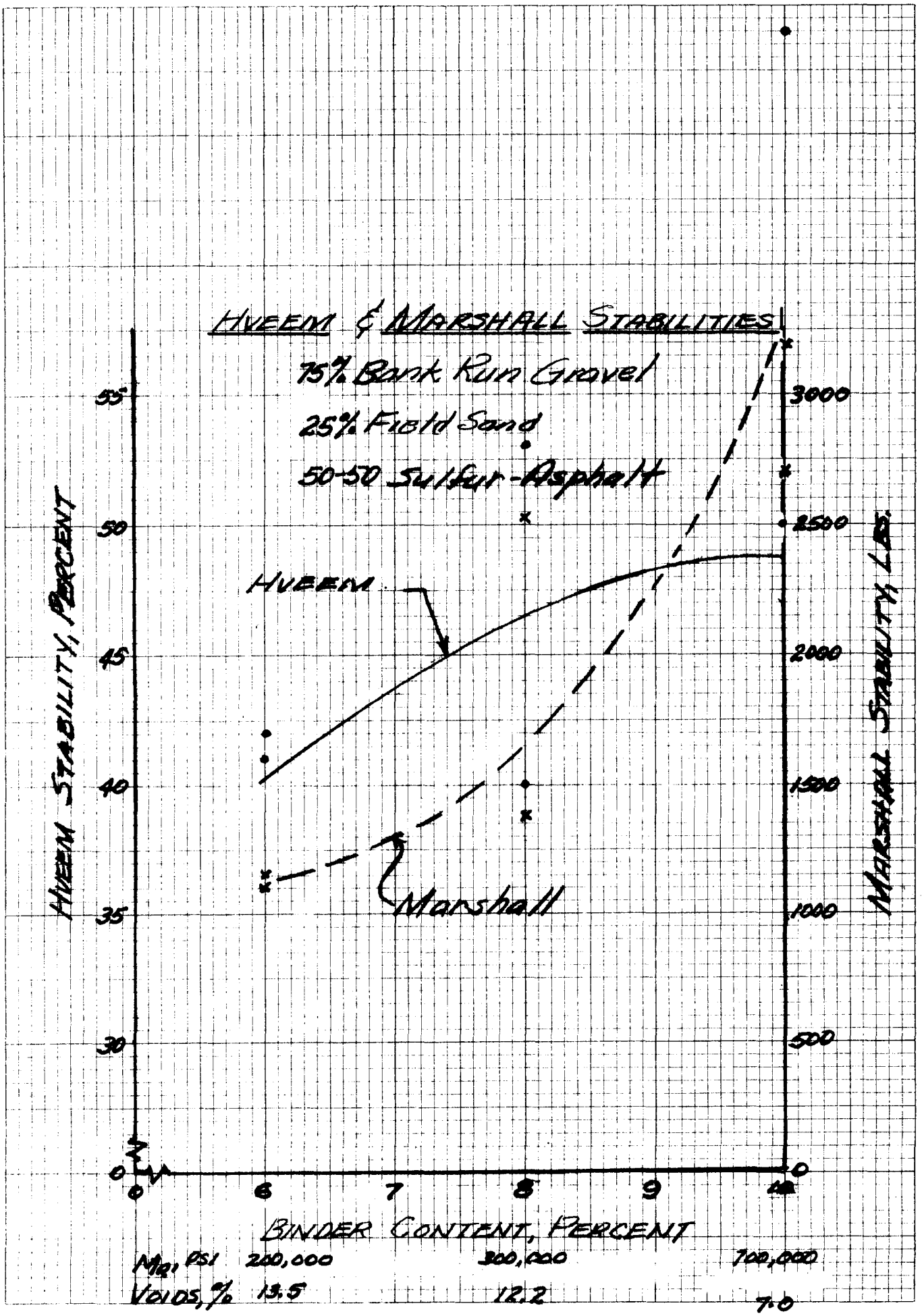
U. S. STANDARD SIEVES - ASTM DESIGNATION E 11-61

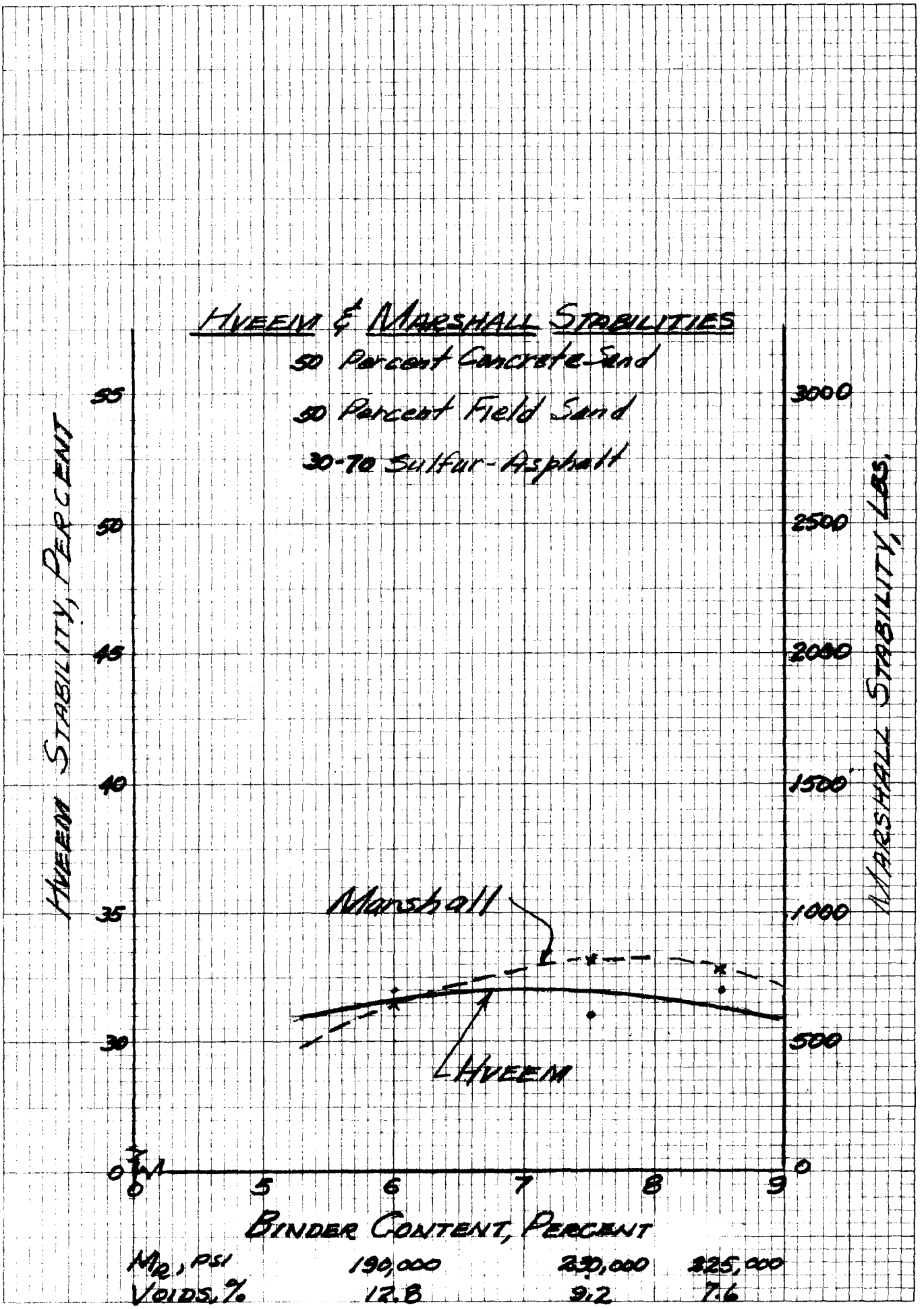

HVEEM & MARSHALL STABILITIES
75 Percent Bank Run Gravel
25 Percent Field Sand
AC-20 Asphalt Cement
HVEEM STABILITY, PERCENT
MARSHALL STABILITY, LBS.
55
50
45
40
35
30
0
3000
2500
2000
1500
1000
500
0
Job Mix
HVEEM
SOHPT
Voids=5%
MARSHALL
5
6
7
8
9
BINDER CONTENT, PERCENT
MR, PSI 670,000 730,000
VOIDS, % 14 12 5.1

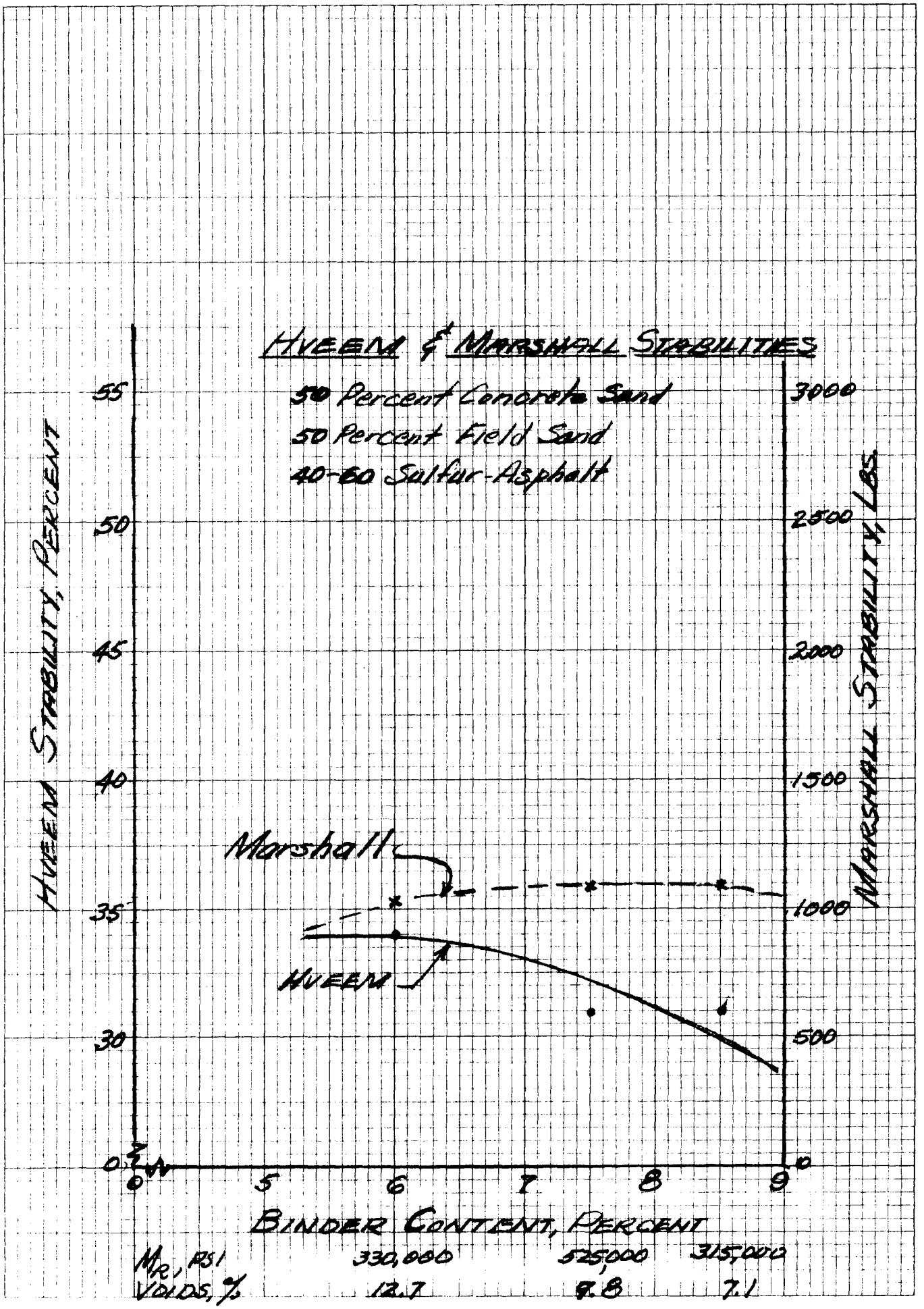

HVEEM & MARSHALL STABILITIES
50 Percent Concrete Sand
50 Percent Field Sand
AC-20 Asphalt
HVEEM STABILITY, PERCENT
MARSHALL STABILITY, Lbs.
50
45
40
35
30
0
2500
2000
1500
1000
500
0
Marshall
Hveem
Point Omitted
0
5
6
7
8
9
BINDER CONTENT, PERCENT
MR, PSI 190,000 290,000 350,000
Voids, % 15.7 13.6 9.7

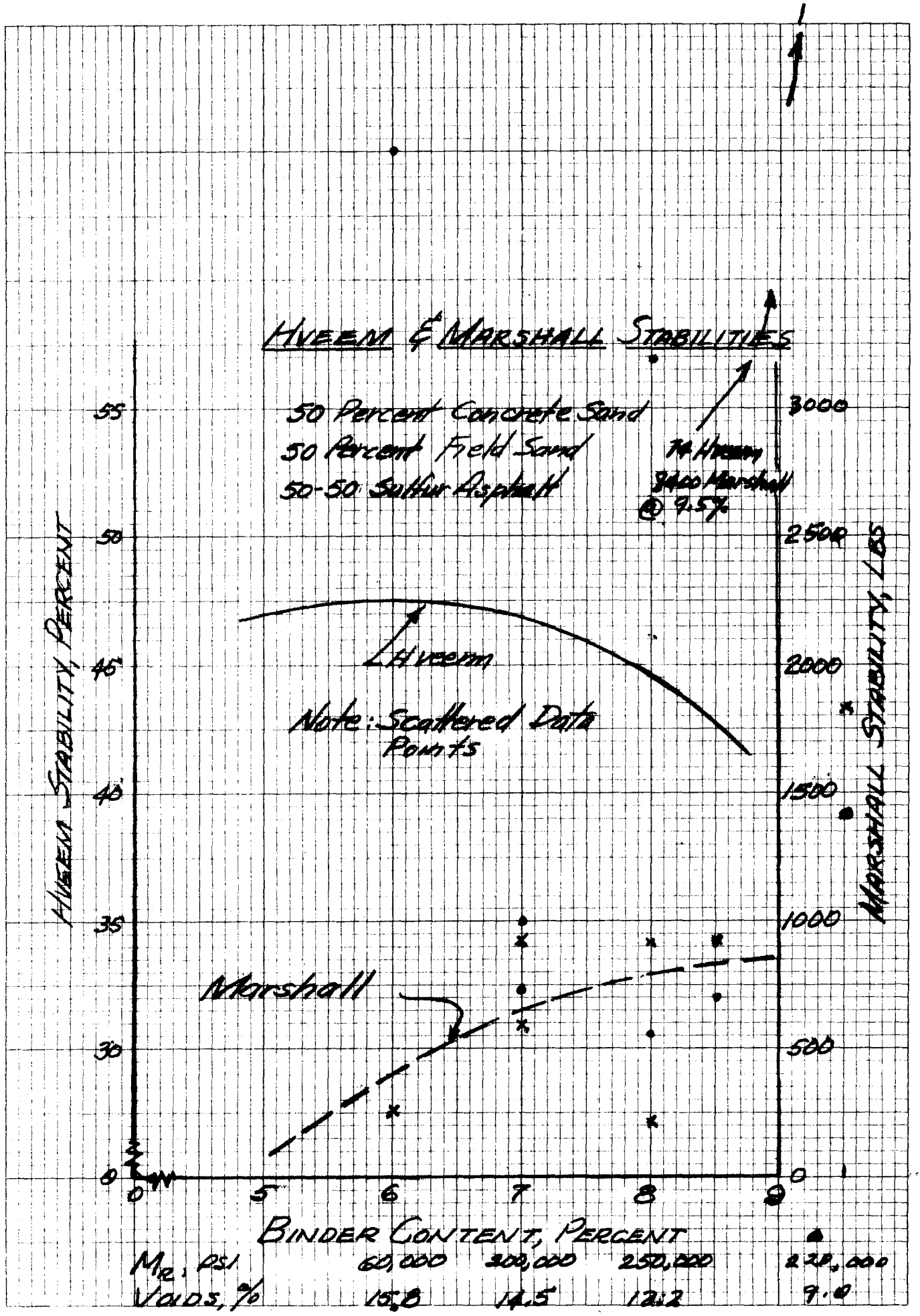

HVEEM & MARSHALL STABILITIES
75 Percent Bank Run Gravel
25 Percent Field Sand
30-70 Sulfur-Asphalt
HVEEM STABILITY, PERCENT
MARSHALL STABILITY, LBS.
55
50
45
40
35
30
0
3000
2500
2000
1500
1000
500
0
MARSHALL
HVEEM
5
6
7
8
9
BINDER CONTENT, PERCENT
MR, PSI
520,000
500,000
660,000
VOIDS, %
10.3
8.3
4.5


HVEEM & MARSHALL STABILITIES
75 Percent Bank Run Gravel
25 Percent Field Sand
4.0-6.0 Sulfur-Asphalt
MARSHALL
HVEEM
HVEEM STABILITY, PERCENT
MARSHALL STABILITY, LBS.
55
50
45
40
35
30
0
3000
2500
2000
1500
1000
600
0
5
6
7
8
9
BINDER CONTENT, PERCENT
Mr, psi
Voids, %
510,000
10.1
640,000
7.7
630,000
5.7


HVEEM & MARSHALL STABILITIES
75% Bank Run Gravel
25% Field Sand
50-50 Sulfur-Asphalt
HVEEM
Marshall
HVEEM STABILITY, PERCENT
MARSHALL STABILITY, LBS.
55
50
45
40
35
30
0
3000
2500
2000
1500
1000
500
0
6
7
8
9
10
BINDER CONTENT, PERCENT
MR, PSI 200,000 300,000 700,000
VOIDS, % 13.5 12.2 7.0

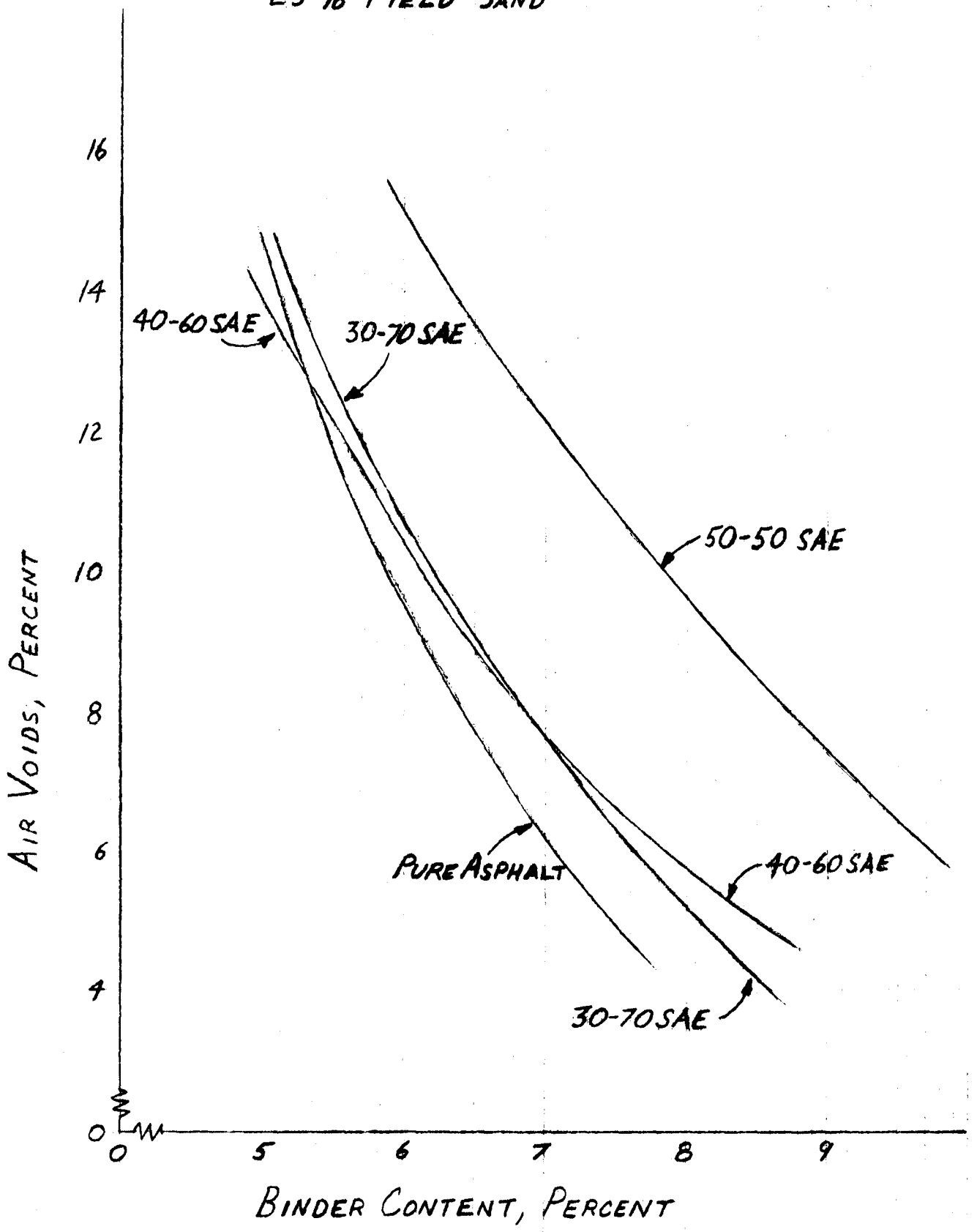

HVEEM & MARSHALL STABILITIES
50 Percent Concrete-Sand
50 Percent Field Sand
30-70 Sulfur-Asphalt
HVEEM STABILITY, PERCENT
MARSHALL STABILITY, LBS.
55
50
45
40
35
30
3000
2500
2000
1500
1000
500
0
Marshall
HVEEM
5
6
7
8
9
BINDER CONTENT, PERCENT
M_R, PSI 190,000 230,000 325,000
VOIDS, % 12.8 9.2 7.6

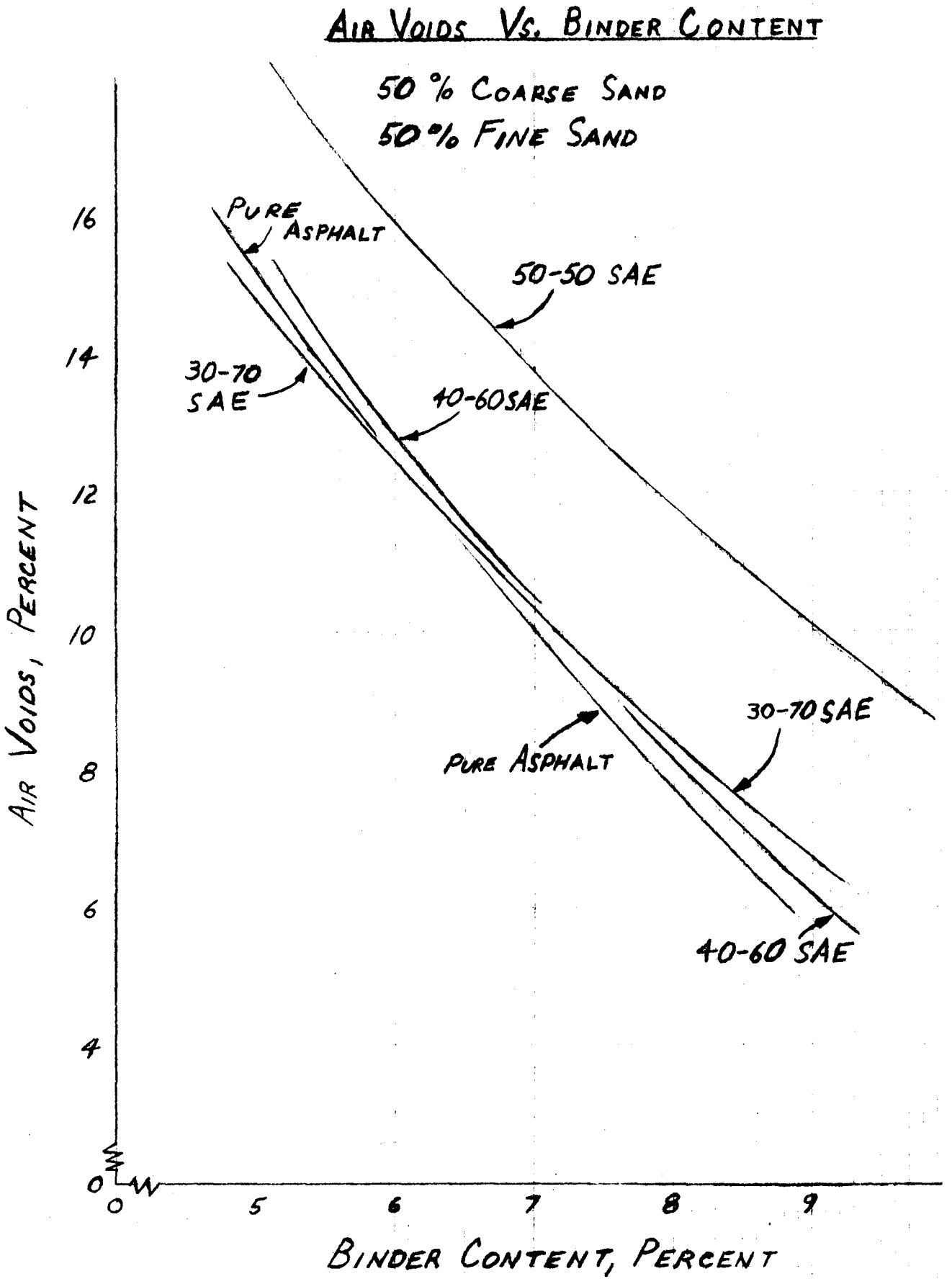

HVEEM & MARSHALL STABILITIES
50 Percent Concrete Sand
50 Percent Field Sand
40-60 Sulfur-Asphalt
HVEEM STABILITY, PERCENT
MARSHALL STABILITY, LBS.
55
50
45
40
35
30
3000
2500
2000
1500
1000
500
0
Marshall
Hveem
5
6
7
8
9
BINDER CONTENT, PERCENT
MR, PSI
VOIDS, %
330,000
12.7
525,000
9.8
315,000
7.1

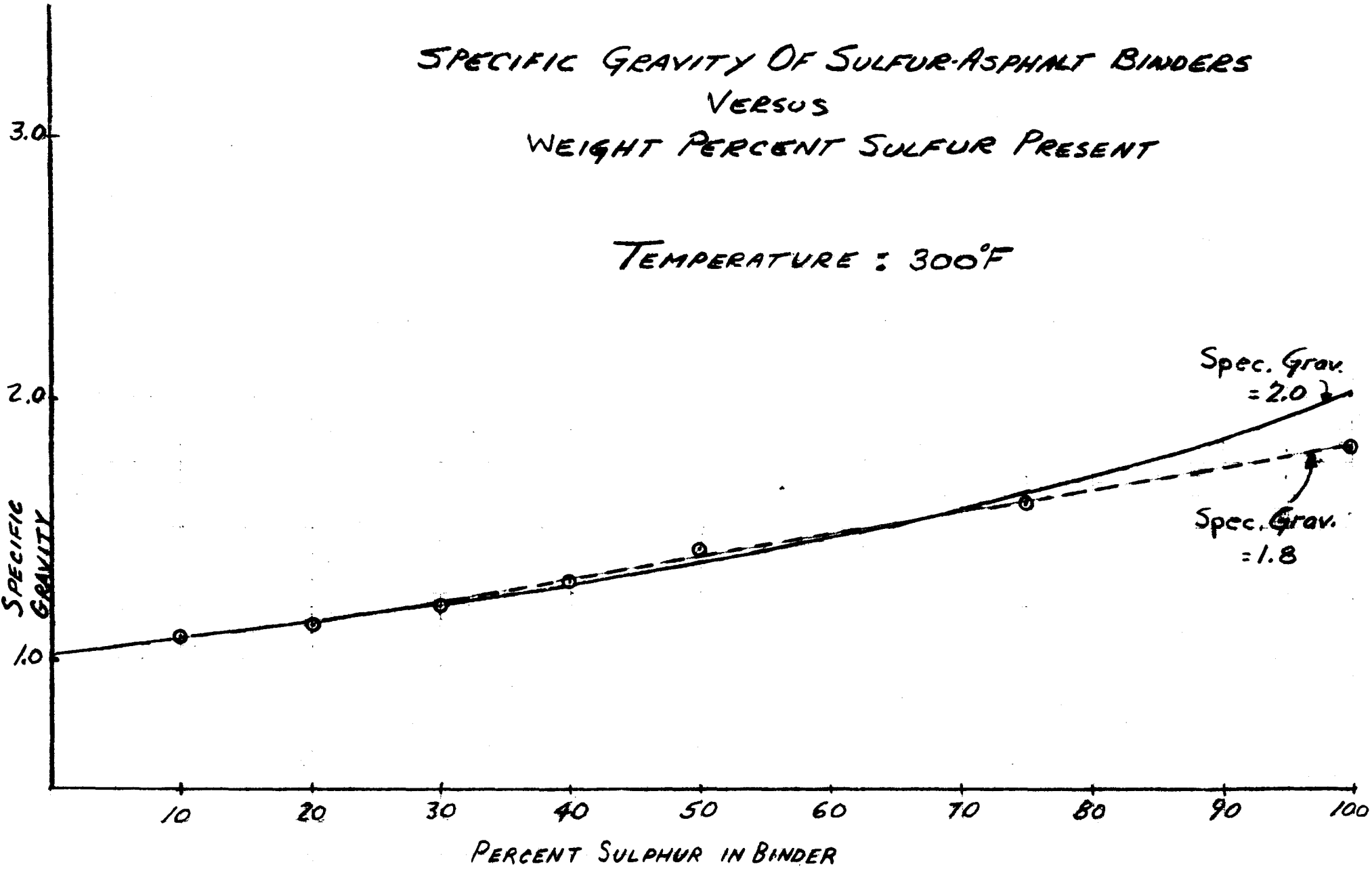

HVEEM & MARSHALL STABILITIES
50 Percent Concrete Sand
50 Percent Field Sand
50-50 Sulfur Asphalt
74 Hveem
3400 Marshall
@ 9.5%
Hveem
Note: Scattered Data Points
Marshall
HVEEM STABILITY, PERCENT
MARSHALL STABILITY, LBS
55
50
45
40
35
30
0
3000
2500
2000
1500
1000
500
0
5
6
7
8
9
BINDER CONTENT, PERCENT
M_R, PSI
60,000
300,000
250,000
220,000
VOIDS, %
15.8
14.5
12.2
9.0

Air Voids Vs. Binder Content

75% Bank Run Gravel
25% Field Sand




AIR VOIDS VS. BINDER CONTENT
50 % COARSE SAND
50 % FINE SAND
PURE ASPHALT
50-50 SAE
30-70 SAE
40-60 SAE
30-70 SAE
PURE ASPHALT
40-60 SAE
AIR VOIDS, PERCENT
BINDER CONTENT, PERCENT
0
4
6
8
10
12
14
16
5
6
7
8
9


SPECIFIC GRAVITY OF SULFUR-ASPHALT BINDERS
VERSUS
WEIGHT PERCENT SULFUR PRESENT
TEMPERATURE : 300°F
3.0
2.0
1.0
SPECIFIC GRAVITY
Spec. Grav. = 2.0
Spec. Grav. = 1.8
10
20
30
40
50
60
70
80
90
100
PERCENT SULPHUR IN BINDER