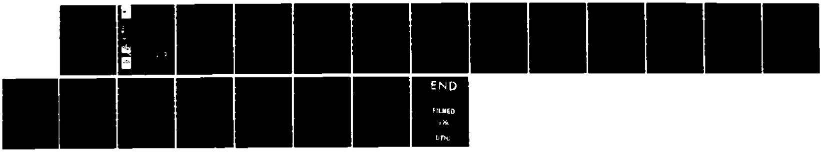
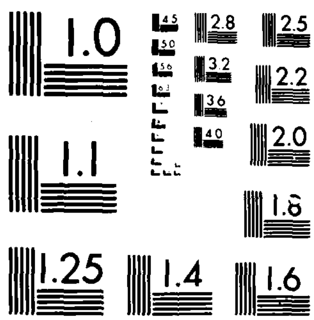
AD-A164 197 POTENTIAL FOR USING LOESS IN SAND ASPHALT MIXTURES(U) 1/1
ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MS
GEOTECHNICAL LAB E R BROWN ET AL. SEP 85

UNCLASSIFIED WES/MP/GL-85-23 F/G 8/7 NL

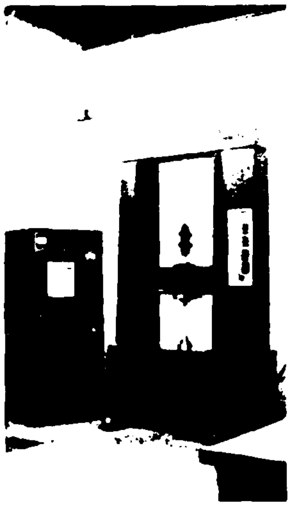




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

US Army Corps of Engineers

AD-A164 197



GEOTECHNICAL LABORATORY

2

MISCELLANEOUS PAPER GL-85-23

POTENTIAL FOR USING LOESS IN SAND ASPHALT MIXTURES

by

Elton R. Brown, Rogers T. Graham

Geotechnical Laboratory

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
PO Box 631, Vicksburg, Mississippi 39180-0631

US ARMY ENGINEER WATERWAYS EXPERIMENT STATION

September 1985

Final Report

Approved For Public Release; Distribution Unlimited

DTIC FILE COPY

DTIC ELECTE FEB 1 3 1986 S D B

Prepared for

DEPARTMENT OF THE ARMY
US Army Corps of Engineers
Washington, DC 20314-1000

86 2 12 013

Destroy this report when no longer needed. Do not return it to the originator.

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

The contents of this report are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Miscellaneous Paper GL-85-23	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) POTENTIAL FOR USING LOESS IN SAND ASPHALT MIXTURES		5. TYPE OF REPORT & PERIOD COVERED Final report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Elton R. Brown Rogers T. Graham		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Engineer Waterways Experiment Station Geotechnical Laboratory PO Box 631, Vicksburg, Mississippi 39180-0631		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEPARTMENT OF THE ARMY US Army Corps of Engineers Washington, DC 20314-1000		12. REPORT DATE September 1985
		13. NUMBER OF PAGES 16
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Available from National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Loess (LC) | Sand (LC)
Aggregates (Building materials) (LC) | Limestone (LC)
Concrete--Additives (LC)
Asphalt [illegible]

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This study was conducted to evaluate the relative benefits of using loess filler in sand asphalt mixtures. Mixtures were prepared at optimum asphalt content [illegible] amounts of [illegible] filler and limestone dust filler. [illegible] to determine the relative quality of [illegible] mix. The results of this study indicate that the mixtures prepared with [illegible] filler performed as well as or better than the samples prepared with [illegible] filler.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Preface

The study reported herein was conducted by the Pavement Systems Division (PSD), Geotechnical Laboratory (GL), US Army Corps of Engineers, Waterways Experiment Station (WES), Vicksburg, Miss., for the US Army Corps of Engineers as a part of the Facilities and Investigation Studies, O&MA, during the period April through October 1983.

This report was prepared by Dr. Elton R. Brown and Mr. Rogers T. Graham, under the general supervision of Mr. Harry H. Ulery, Jr., Chief, PSD, GL, and Dr. William F. Marcuson III, Chief, GL.

Commanders and Directors of WES during the conduct of this study and the preparation of this report were COL Tilford C. Creel, CE, and COL Robert C. Lee, CE: Technical Director was Mr. Fred R. Brown. During the publication of this report, COL Allen F. Grum, USA, was Director of WES; Dr. Robert W. Whalin was Technical Director.

Accession For
NTIS GRA&I
Dist
A-1

Contents

	Page
Preface	1
Conversion Factors, Non-SI to SI (Metric) Units of Measurement.	3
Introduction.	4
Test Plan	4
Test Results	5
Discussion of Results	6
Conclusions	7
Recommendations	7
Tables 1-3	
Figures 1-10	

Conversion Factors, Non-SI to SI (Metric) Units of Measurement

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
Fahrenheit degrees	5/9	Celsius degrees or Kelvins*
inches	2.54	centimetres
pounds (mass)	0.4535924	kilograms
pounds (force) per square inch	6894.757	pascals
pounds (mass) per cubic foot	16.01846	kilograms per cubic metre

* To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula: $C = (5/9)(F - 32)$. To obtain Kelvin (K) readings, use: $K = (5/9)(F - 32) + 273.15$.

POTENTIAL FOR USING LOESS IN SAND ASPHALT MIXTURES

Introduction

1. More than 30 years ago the US Army Engineer District, New Orleans, used loess asphalt mixtures for waterproofing purposes. At that time test results indicated that the loess mixtures were more impervious to water than other types of asphalt mixtures. Because of this improved ability to provide a waterproof layer and other possible uses, a limited study was initiated to look at the potential use of loess asphalt mixtures for pavements.

2. Dense graded asphalt concrete mixtures do not generally require additional filler; therefore, the use of loess in these mixtures was not evaluated in this study. The use of sand mixes has received much attention in recent years because of the availability and low overall costs. Sand mixes do need additional filler to fill the excessive voids in the aggregate and to improve mix stability. This study was limited to a laboratory study of sand asphalt mixtures with loess and limestone dust evaluated as fillers. The limestone dust is a good filler for comparison because of the large amount of data available for this type of filler.

Test Plan

3. A plan of test was developed to compare sand asphalt mixtures using loess filler with sand asphalt mixtures using limestone dust filler. Sand mixtures were evaluated with no filler and with 4, 8, and 12 percent of mineral matter for each filler type. To evaluate these mixtures, the following properties were determined: compactibility, voids, stability, flow, tensile strength, and water susceptibility.

4. The sand and loess material were obtained locally. The sand was a naturally occurring material. The limestone filler was lab-stock material which had been obtained from Vulcan Materials in Alabama. The asphalt binder used for these tests was an asphalt cement (AC-20) grade meeting the requirements of the American Society for Testing and Materials (ASTM) D-3381. This asphalt cement was obtained from Southland Oil Company, Lumberton, Mississippi.

5. After obtaining the materials, mix designs were conducted for 100 percent sand and sand with 4, 8, and 12 percent limestone dust. The

optimum asphalt contents (AC) determined for the three sand-limestone mixes were used for preparing the three sand-loess mixes.

6. Seven mixtures were investigated in this study. After the mix designs were conducted, 12 samples of each mix type were prepared for determining unit weight, voids, stability, flow, retained stability (vacuum saturation), retained stability (static saturation), and indirect tensile strength. Sample preparation was performed with a gyratory testing machine with normal pressure set at 100 psi* and 1-deg angle which is equivalent to 50-blow Marshall compactive effort. All tests were conducted in accordance with Military Standard 620A** with the exception of retained stability after vacuum saturation and indirect tensile strength which were both conducted in accordance with proposed standards under jurisdiction of ASTM Subcommittee D04.20 on bituminous mix analysis.

Test Results

7. The physical properties of the sand, limestone dust, loess, and asphalt are shown in Table 1. The mix design curves developed for the sand mix and the three sand-limestone dust mixes are shown in Figures 1 through 4. The optimum asphalt content is more difficult to select for sand mixes than for dense graded mixes because the best asphalt content for the five mix design properties varies considerably for sand mixes. For this study optimum asphalt content was selected as that asphalt content that produces 6 percent voids in the total mix. A list of the seven mixtures and the asphalt content used for preparing mixtures for this study is shown in Table 2.

8. A summation of the average test results for each of the seven mixtures is shown in Table 3. A review of the density results shows that an increase in loess filler actually decreases the mix density slightly while an increase in limestone filler increases the density significantly. This is shown graphically in Figure 5. This indicates that the limestone filler fills the voids in the sand mix while the loess filler bulks the sand and thus prevents densification. The relationship between voids in mineral aggregate

---

* A table of factors for converting non-SI to SI (metric) units of measurement is presented on page 3.

** Department of Defense, "Test Methods for Bituminous Paving Materials," MIL-STD-620A.

(VMA) and filler content is another way of showing the effect of filler on compaction (Figure 6).

9. The data (Figure 7) show that the stability increases with increasing filler contents. The stability increase is greater for the limestone filler than for the loess filler (Figure 7). This greater increase in stability for limestone filler mixtures is a result of increased density for higher filler contents.

10. Two types of water susceptibility tests were conducted; one was the static immersion used by the Corps of Engineers and the other was a vacuum saturation method developed by the Asphalt Institute and proposed as a standard to the ASTM. The static immersion tests on the asphalt concrete samples showed very little loss in stability after soaking in water for 24 hr. The values of retained stability ranged from 75 percent for mix F to 110 percent for mix B. The criterion used by the Corps of Engineers is 75 percent minimum retained stability, and every mix met this requirement. A review of the test results for the static immersion test indicated that the mixes containing limestone filler generally performed better than the mixes containing loess.

11. The vacuum saturation test is more severe than the static immersion test. There are no universally accepted criteria developed for this method, but 50 percent minimum retained stability is often used as acceptable criteria. This test appears to divide the mixes into three categories. Mix A, which contains 100 percent sand, had the lowest retained stability of all mixes (6 percent). The three mixes prepared with loess material had retained stabilities of 21, 24, and 18 percent, indicating some improvement over the sand mix. The mixes prepared containing limestone dust on the other hand had stabilities of 32, 39, and 38 percent, showing considerable improvement over the mixes containing loess.

12. The tensile strength test results show that an increase in filler content increases the tensile strength, but the use of limestone filler increases the tensile strength more than the increase provided when loess filler is used (Figure 8). The indirect tensile strength results show the same trends as those shown by the stability tests.

Discussion of Results

13. The mixes prepared with limestone filler performed better than the

mixes prepared with loess filler for every mix property evaluated. The major reason for this improved performance was the ability of the mixes prepared with limestone filler to be compacted to higher densities than the mixes prepared with loess filler. This indicates that the shape and/or size of the limestone filler particles improved the ability of the mixture to be compacted. The stability and indirect tensile strength for all seven mixes were plotted as a function of VMA in Figures 9 and 10, respectively. These plots indicated that the stability and indirect tensile strength are closely related to VMA which is inversely related to density. This supports the fact that the difference in compactibility is the major reason for differences in stability and indirect tensile strength properties.

14. The retained stability after vacuum saturation does not appear to be related to density, but rather to aggregate properties as indicated earlier. Lime has been used for a number of years as an antistrip agent; therefore, it is reasonable to expect that the use of limestone filler will reduce the water susceptibility of the sand mix.

Conclusions

15. Based on this limited laboratory study the following conclusions concerning field performance of sand-loess mixtures were made:

a. Loess filler improves the stability, tensile strength, and water susceptibility of sand mixes.

b. Sand mixes using limestone dust filler provided better stability, tensile strength, and resistance to water than sand mixes with loess filler.

c. Limestone filler added to the sand allowed for higher compaction densities than those obtained when loess filler was used, resulting in higher tensile strength and stability.

Recommendations

16. Based on the results of this study, loess filler improves the strength of sand mixes. Limestone dust produces mixes having properties better than the sand-loess mixes. If a limestone dust is available at a reasonable cost, it should be used. Loess can be used to improve the properties of sand mixes if limestone dust is not available or the cost is too great.

Table 1

Material Properties

Sand Gradation: Sieve Size	Sand Gradation: Percent Passing	Aggregate Specific Gravity		Asphalt Properties
3/8 in.	100	Limestone dust	2.62	Specific gravity, 1.032
No. 4	92	Loess	2.67	Penetration (0.1 mm), 69
No. 8	81	Sand	2.65	Viscosity at 140° F, 2,089 poises
No. 16	74			Viscosity at 275° F, 492 centistokes
No. 30	59			
No. 50	11			
No. 100	3			
No. 200	2.4			

Table 2

Mix Identification

Mix	Description
A	Aggregate - 100% sand; 9.6% AC-20 asphalt
B	Aggregate - 96% sand, 4% limestone dust; 8% AC-20 asphalt
C	Aggregate - 92% sand, 8% limestone dust; 6.6% AC-20 asphalt
D	Aggregate - 88% sand, 12% limestone dust; 5.5% AC-20 asphalt
E	Aggregate - 96% sand, 4% loess; 8% AC-20 asphalt
F	Aggregate - 92% sand, 8% loess; 6.6% AC-20 asphalt
G	Aggregate - 88% sand, 12% loess; 5.5% AC-20 asphalt

Table 3

Mix Properties

Mix Type	Density lb/cu ft	VMA %	Stability lb	Retained Stability After Static Immersion lb	Retained Stability After Static Immersion %	Retained Stability After Vacuum Saturation lb	Retained Stability After Vacuum Saturation %	Flow (0.01 in.)	Tensile Strength psi
A	135.7	25.7	216	220	102	13	6	12	47.0
B	137.3	23.3	273	300	110	88	32	14	54.2
C	140.7	20.3	534	541	102	207	39	13	69.4
D	142.8	18.1	833	756	91	313	38	11	80.6
E	135.4	24.4	250	240	96	53	21	14	53.4
F	135.3	24.3	360	283	79	88	24	11	58.2
G	135.3	22.5	514	420	82	92	18	10	61.8

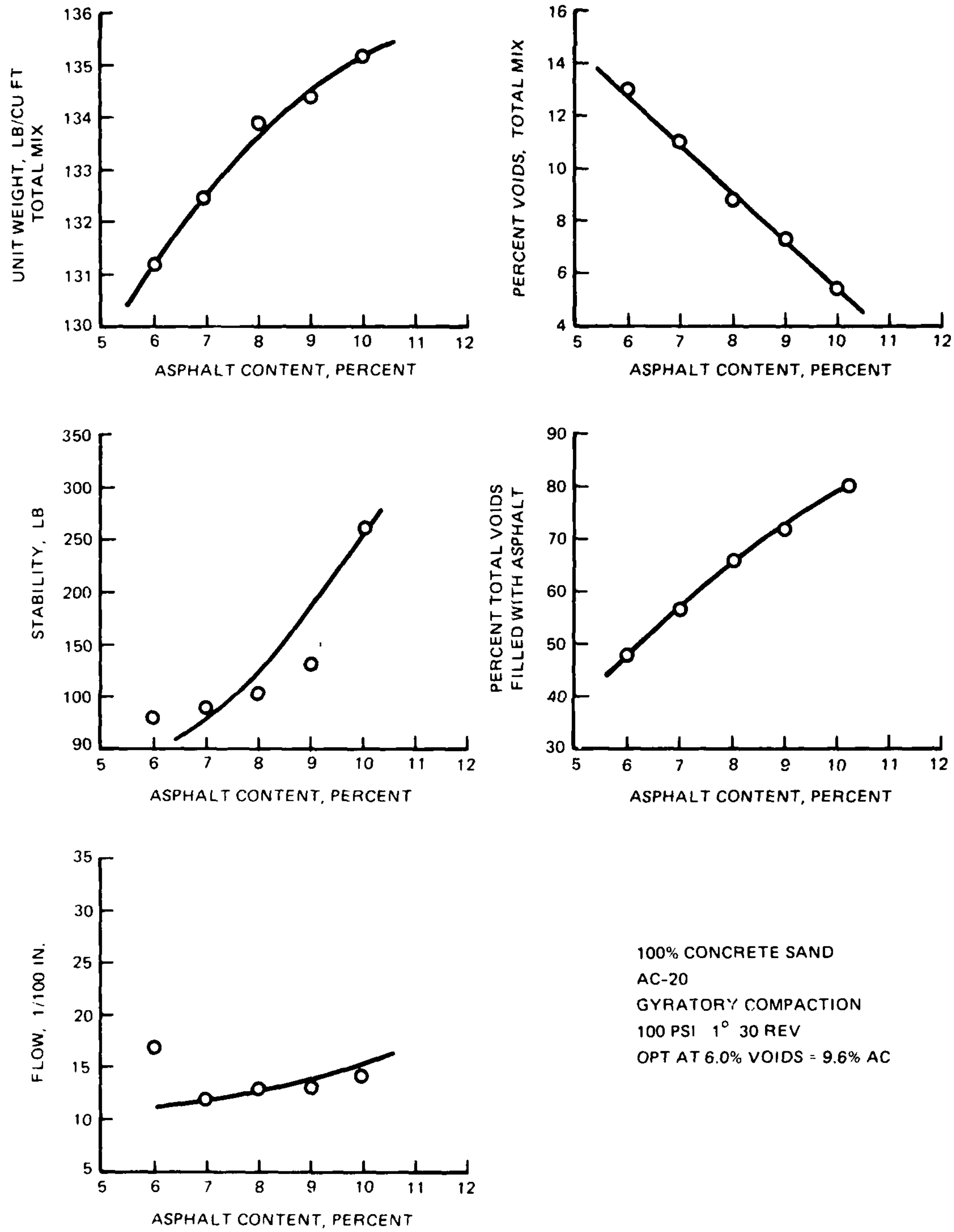


Figure 1. Mix design for 100 percent sand

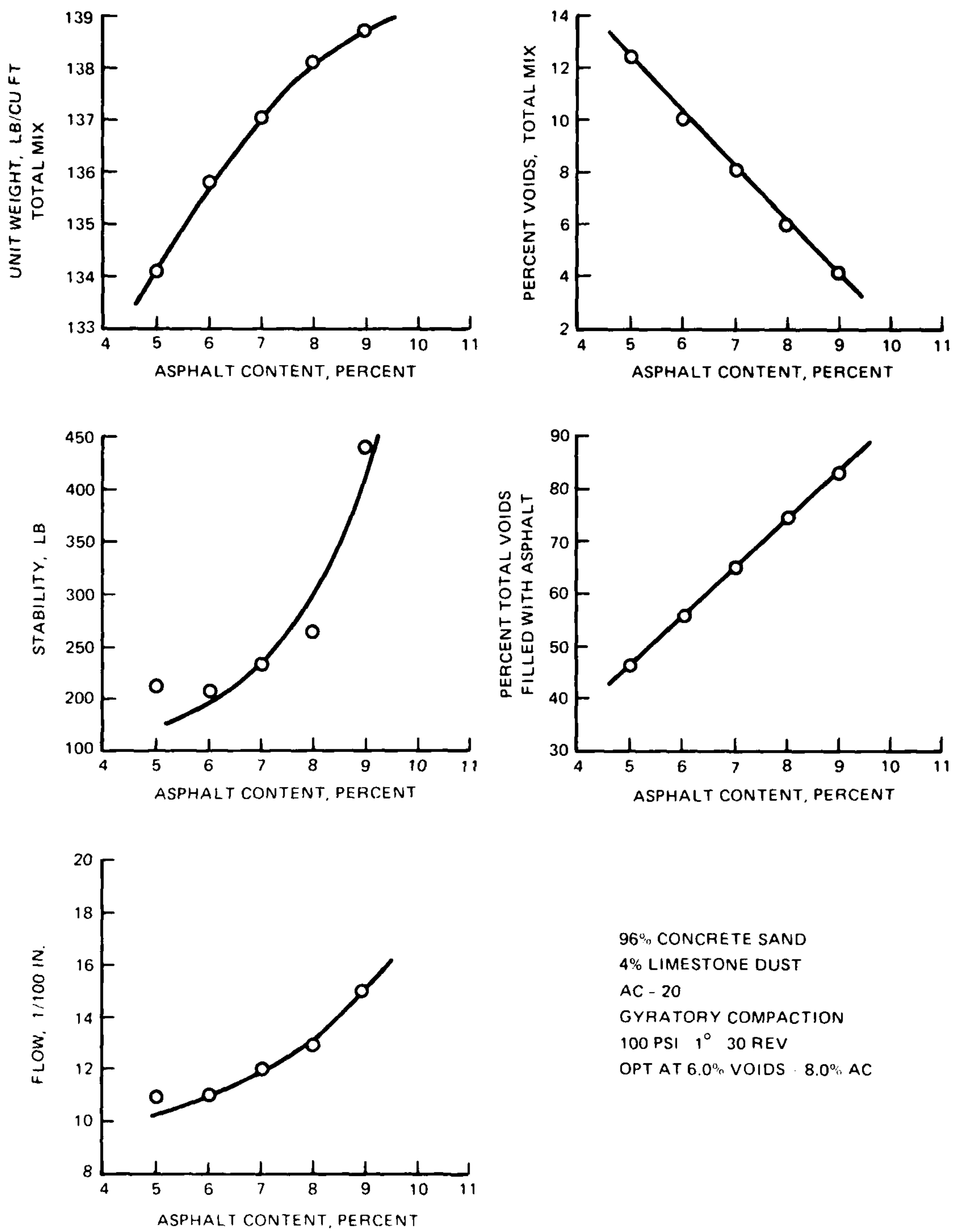


Figure 2. Mix design for sand containing
4 percent limestone dust

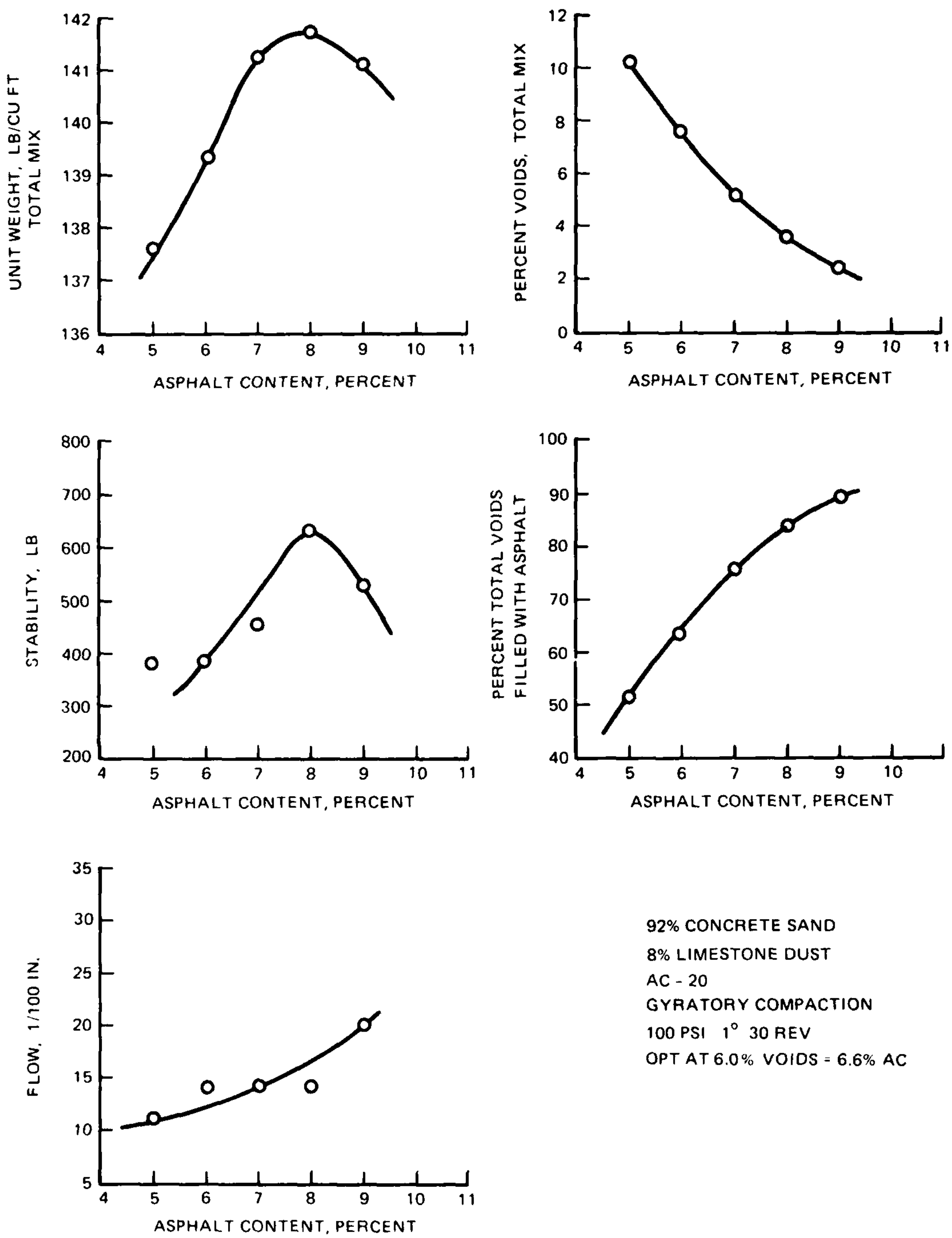


Figure 3. Mix design for sand containing
8 percent limestone dust

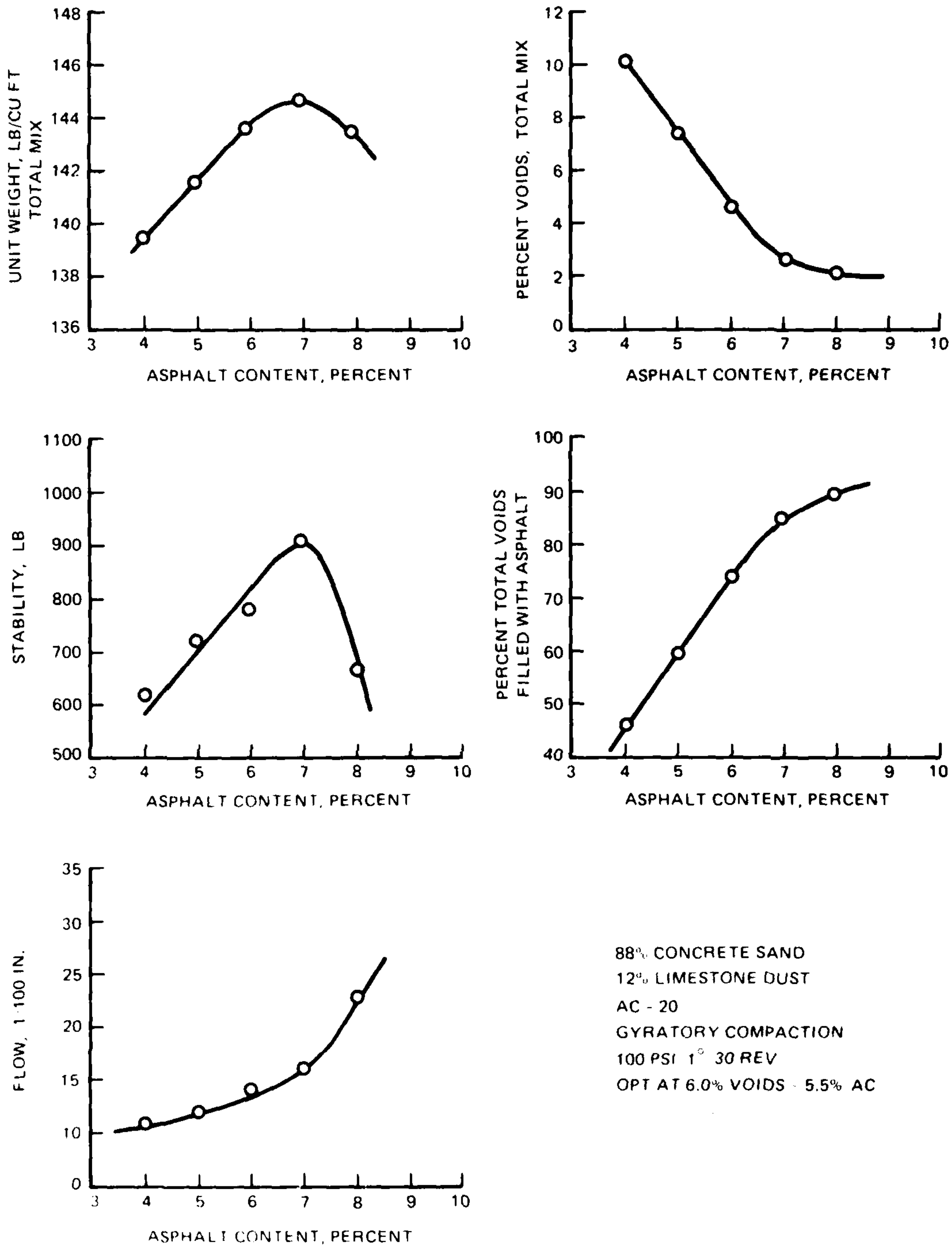


Figure 4. Mix design for sand containing 12 percent limestone dust

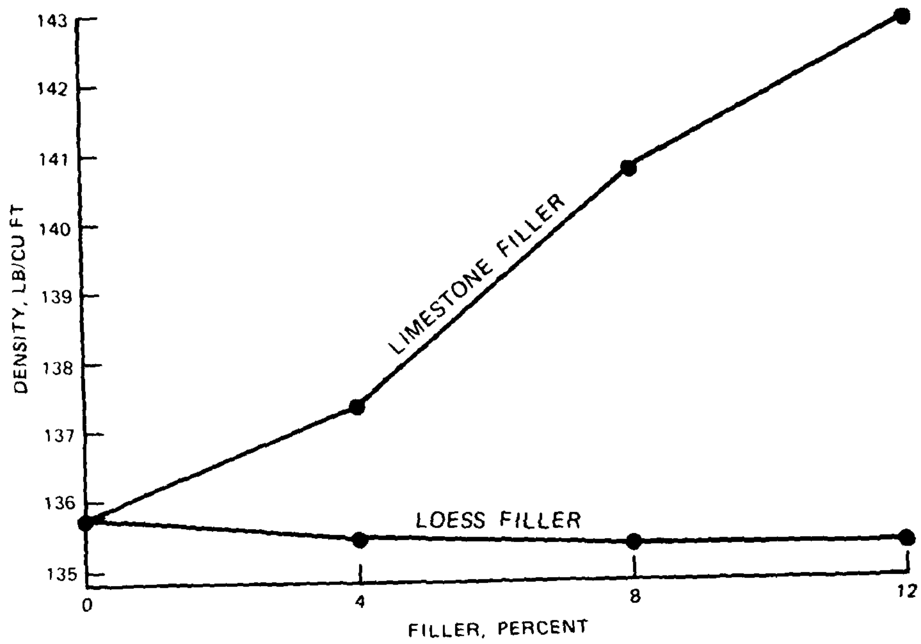


Figure 5. Filler content versus density

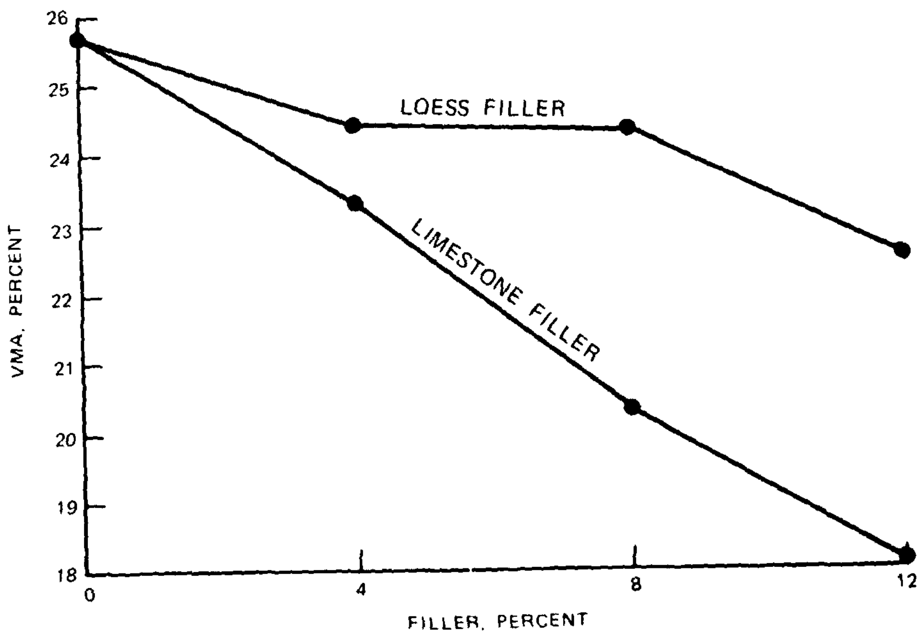


Figure 6. Filler content versus VMA

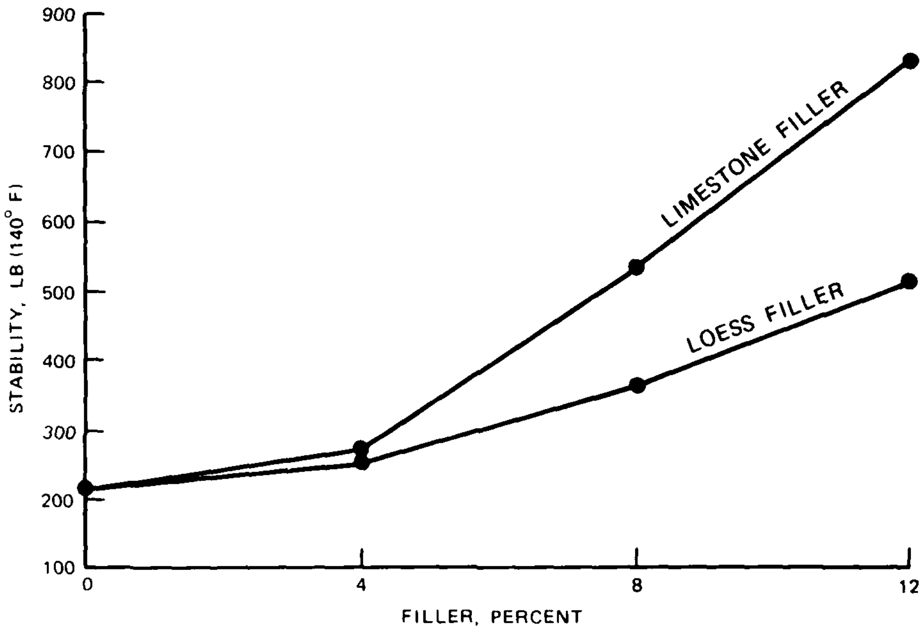


Figure 7. Filler content versus stability

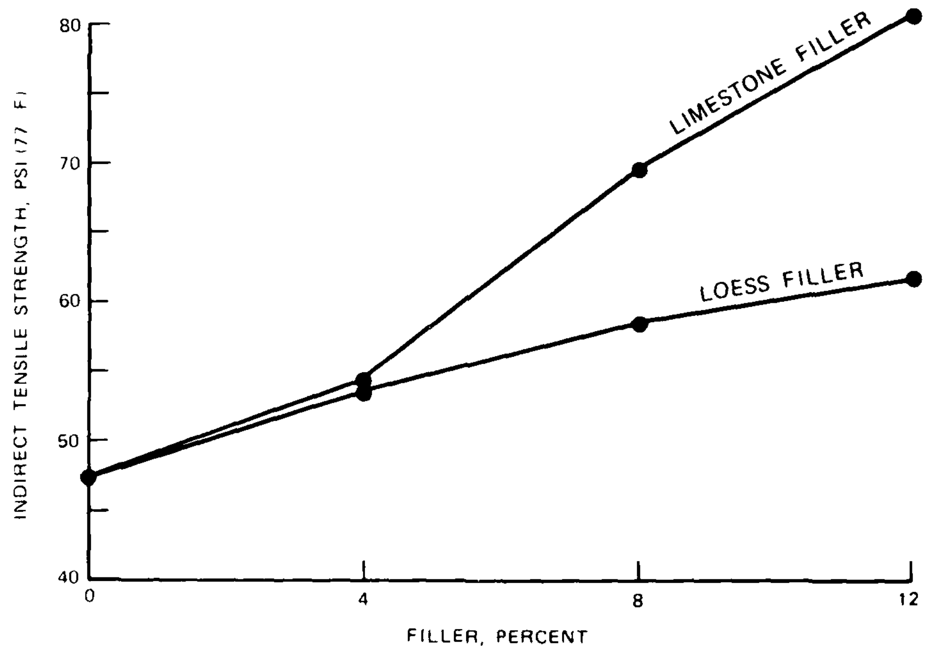


Figure 8. Filler content versus indirect tensile strength

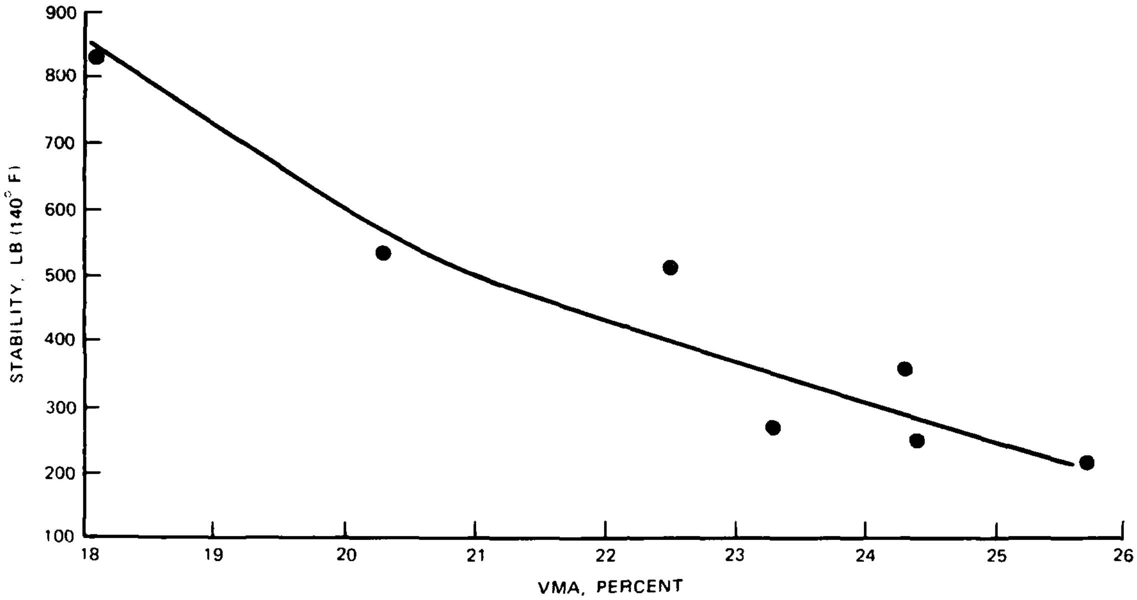
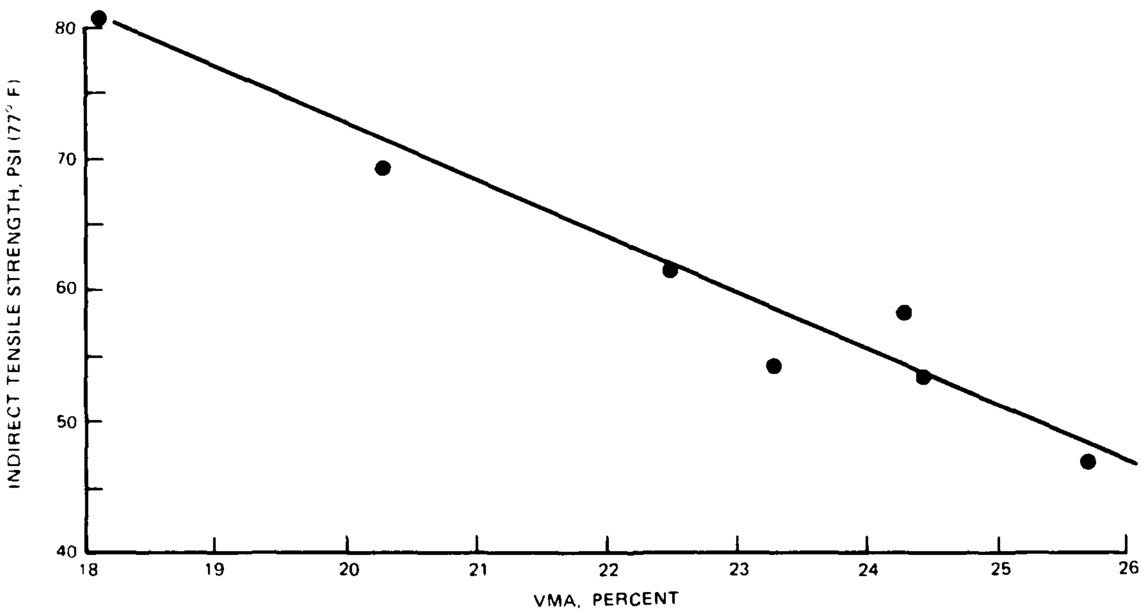


Figure 9. VMA versus stability



Figı 10. VMA versus indirect tensile strength

END

FILMED

3-86

DTIC