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THE COMPARATIVE VALUE OF SILICA DUST AND PORTLAND CEMENT AS AN ASPHALT FILLER

A THESIS SUBMITTED TO THE FACULTY OF

MICHIGAN STATE COLLEGE OF AGRICULTURE AND APPLIED SCIENCE

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Bachelor of Science - June 1929.

THESIS

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ACKNOWLEDGMENTS

In submitting this thesis to the faculty of Michigan State College, I wish to thank Mr. E. A. Finney for his excellent advice and scientific direction, which has helped me to complete this analysis. I also wish to express my gratitude to the City of Lansing, who so kindly donated the experimental materials and directed my course of work. Surely, no better combination could be wished for, than that of a theoritical expert like Mr. Finney, and a department like the Engineering Department of the City of Lansing, who are encountering present day problems.

PURPOSE OF THESIS

The purpose of this thesis is to determine which of the two fillers, Portland Cement or Silica Dust, is the best to use in making a sheet asphalt, and what mix produces the best results.

GENERAL

Sheet asphalt is of American origin, first devised as a substitute for the finely pulverized European rock asphalt. The early sheet asphalt surfaces were composed of sand and asphalt, with or without the addition of filler, the constituents being being mixed well above the melting point of asphalt.

Early experiences resulted in both successes and failures, and after many exhaustive investigations it was found that three things were necessary for a successful sheet asphalt wearing surface mixture, namely:

1. A sand or sands of good quality and proper gradation of sizes .

"Passing	Percent by Weight
200 mesh sieve	0 to 5
100 " "	10 to 25
80 " "	6 to 20
50 " "	5 to 40
40 " "	5 to 30
30 " "	5 to 25
20 " "	4 to 15
10 " "	3 to 15
Retained on 10	0 to 2 " (1)

2, A filler of extreme fineness.

"Filler - 65 to 70% shall pass 200 mesh sieve.
All shall pass 50 mesh sieve." (2)

(1) and (2) - Specifications of The Asphalt Association, New York City.

3. An asphaltic cement of proper consistency, possessing strong and permanent binding power.

Filler may be defined as the inpalpably fine material flour, which is incorporated in sheet asphalt surface mixture to increase its strength, toughness, density and water-proofness. Portland cement and silica dust are the materials chiefly used as the source of filler.

MATERIALS USED

The materials used for this analysis are the same as those used by the city of Lansing in their work.

SAND

Sieve Analysis

Retained on	#10	sieve	7.0%
Passing	#10	"	6.6%
"	#20	"	7.4%
"	#30	"	3.8%
"	#40	"	15.0%
"	#50	"	34.1%
"	#80	"	10.6%
"	#100	"	11.4%
"	#200	"	4.1%
			100.0%

SILICA DUST

Sieve Analysis

Retained on	#50	sieve	.65%
Passing	#50	"	2.17%
"	#80	"	24.78%
"	#200	"	72.40%
			100.00%

PORTLAND CEMENT

Sieve Analysis

Retained on	#50	sieve	.5%
Passing	#50	"	1.7%
"	#80	"	26.2%
"	#200	"	71.6%
			100.0%

BITUMEN

Specific gravity	1.05
Solubility in C S_2	99%
Ductility	90cm
Pentration 100 gram weight - 5 sec.	54 m.m.
Softening Point	60.5°C

PROCEDURE

This analysis is based on the standard test for shear as perscribed by the Asphalt Association, New York City.

Forty-eight different mixes, varying as shown on data sheets - pages 10-11 - were used in the making of the test briquetts. These briquetts were made according to standard specifications and compressed to 3000# per square inch. After standing twenty-four hours the briquetts were tested for shear and these results were plotted as shown on pages 12 - 15. The conclusions were based on these graphs.

PREPARATION OF BRIQUETTS

The sand, bitumen and filler were all heated to 350°F in separate containers, and then thoroughly mixed, using the varying percentages of the different constituents. The asphalt was then placed in the testing apparatus with a solid plate in place of the plate containing the knife edged hole as shown on page 17. The required compression was obtained as illustrated on page 16.

EXPLANATION OF CURVES

The curves are all of a somewhat similar nature. That is, with sand as a base, a constand percent of asphalt cement, and a varying amount of filler; the strength increases, as the amount of filler is increased up to a certain amount and then gradually decreases. In the case of the twelve percent asphalt cement the Silica Dust curve tends to have a more constant value than the Portland Cement curve, showing that by using the Silica Dust as a filler one would expect to get better results if there was a little variation in the mix.

CONCLUSIONS

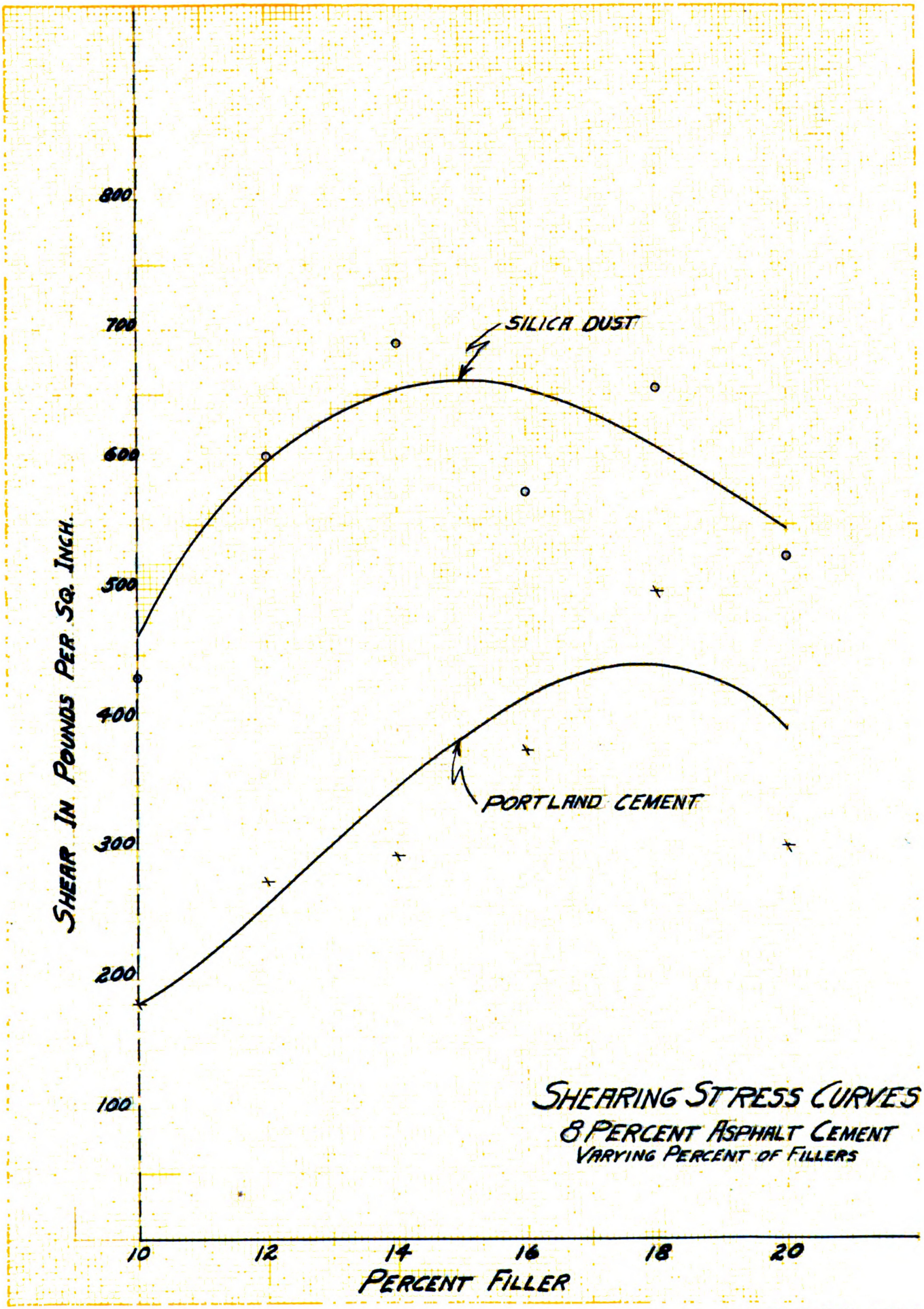
It can be clearly seen from the graphs on pages 12 to 15 that the Silica Dust filler is the best for all mixes. The best mix is that of the ten percent asphalt cement, sixteen percent filler and seventy-four percent sand, whether Silica Dust or Portland Cement is used.

DATA

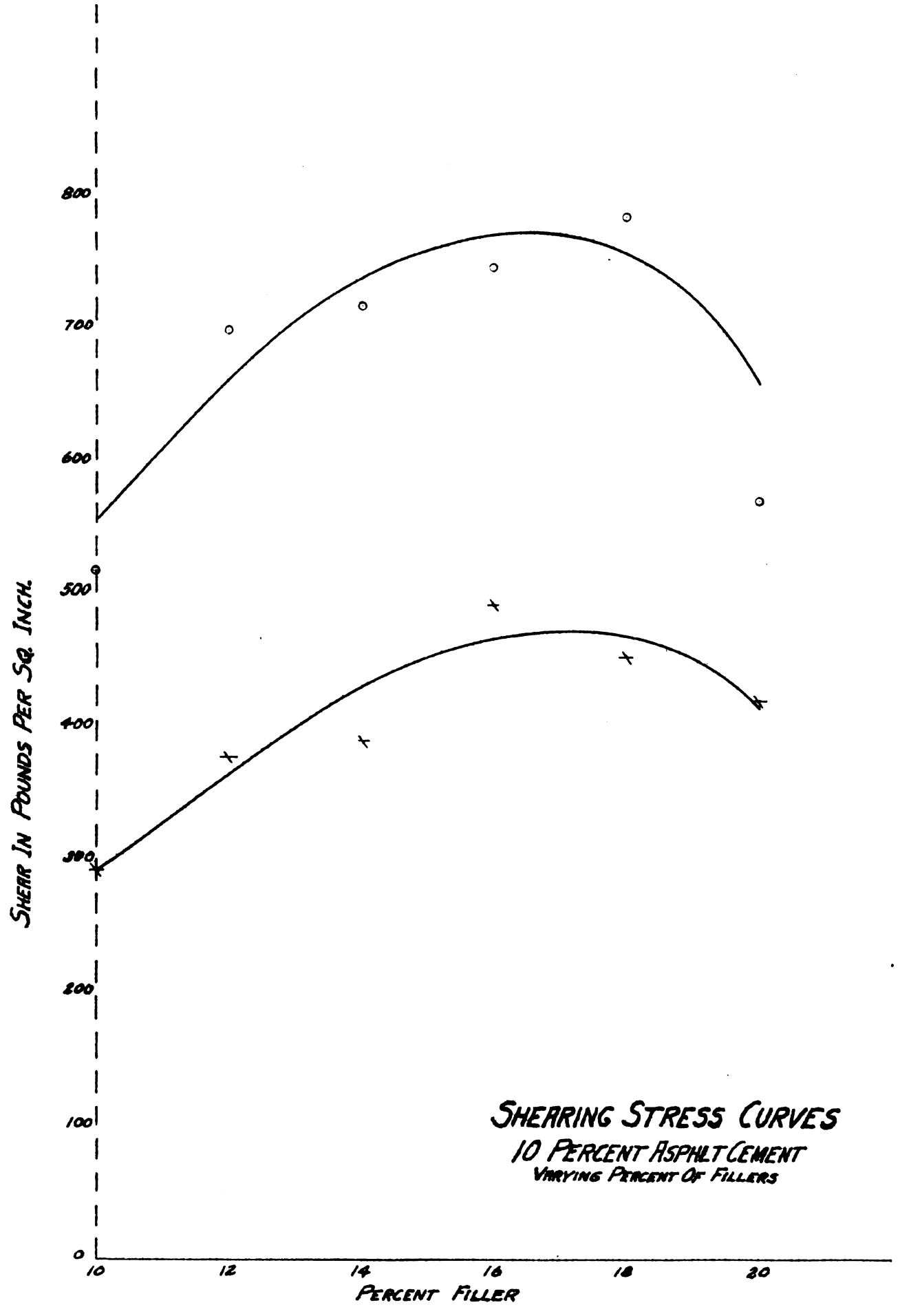
SILICA DUST FILLER			
Mix	Depth in inches	Pressure #	Shear #/sq.in.
8-10-82	2.000 2.000	4815 4360	432
8-12-80	2.187 1.937	5975 5670	602
8-14-78	1.875 1.875	6230 5940	690
8-16-76	2.062 1.813	5415 5115	570
8-18-74	2.125 1.937	6015 5900	655
8-20-72	1.875 2.000	5760 4200	525
10-10-80	1.813 2.000	5610 4675	520
10-12-78	1.875 1.813	6345 5820	701
10-14-76	1.937 1.625	6000 5070	720
10-16-74	1.937 1.875	7670 5775	749
10-18-72	1.875 1.875	7200 6070	727
10-20-70	2.000 2.000	5920 6035	573
12-10-78	2.000 1.937	5515 4710	518
12-12-76	2.250 1.625	4675 4660	526
12-14-74	1.875 1.813	4960 4900	569
12-16-72	1.937 1.813	5090 4820	562
12-18-70	1.813 2.125	4485 4920	505
12-20-68	1.813 2.125	4365 4540	493
14-10-76	1.750 1.813	1500 1575	184
14-12-76	1.750 1.750	1830 2375	224
14-14-72	1.750 1.875	2300 1950	256
14-16-70	2.000 1.687	3830 3050	372
14-18-68	1.750 1.687	2300 3000	329
14-20-66	1.687 1.875	2375 2910	319

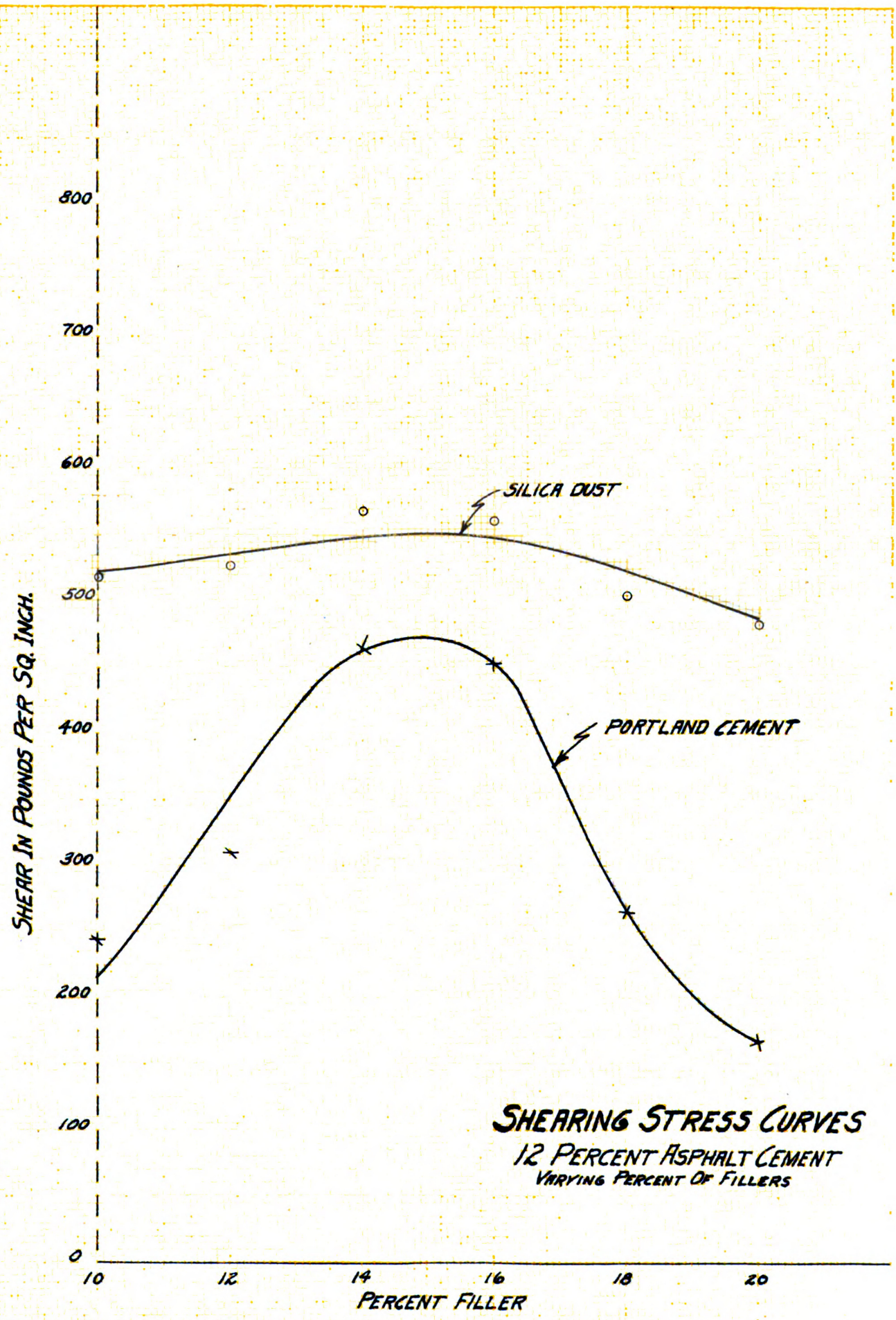
DATA

PORTLAND CEMENT FILLER			
Mix	Depth in inches	Pressure #	Shear #/sq.in.
8-10-82	2.125 2.187	1800 1895	182
8-12-80	1.937 2.000	2540 2550	275
8-14-78	2.000 2.000	3235 3005	295
8-16-76	2.000 1.937	3490 3755	370
8-18-74	2.062 2.062	5400 4350	498
8-20-72	2.000 2.062	3430 2720	301
10-10-80	2.187 1.937	3020 2580	294
10-12-78	2.125 1.937	3820 3425	379
10-14-76	2.125 2.000	3895 4195	392
10-16-74	1.937 2.125	4725 5160	495
10-18-72	2.000 2.062	4955 4310	455
10-20-70	2.375 1.875	4955 3535	422
12-10-78	2.062 1.875	2460 2060	244
12-12-76	1.937 2.000	3400 2540	310
12-14-74	1.937 1.815	4845 5530	466
12-16-72	1.937 2.000	3810 4015	403
12-18-70	1.813 2.062	2100 2765	265
12-20-68	1.688 2.125	1270 1535	167
14-10-76	2.000 1.875	1310 995	118
14-12-74	1.875 2.000	1060 1305	122
14-14-72	2.062 1.813	1400 1410	154
14-16-70	1.813 1.875	1315 1365	154
14-18-68	2.125 1.875	1380 1535	157
14-20-66	2.000 1.813	1960 1795	197



SHEARING STRESS CURVES
8 PERCENT ASPHALT CEMENT
VARYING PERCENT OF FILLERS


SHEAR IN POUNDS PER SQ. INCH.
800
700
600
500
400
300
200
100
0
10
12
14
16
18
20
PERCENT FILLER
SHEARING STRESS CURVES
10 PERCENT ASPHALT CEMENT
VARYING PERCENT OF FILLERS



SHEARING STRESS CURVES

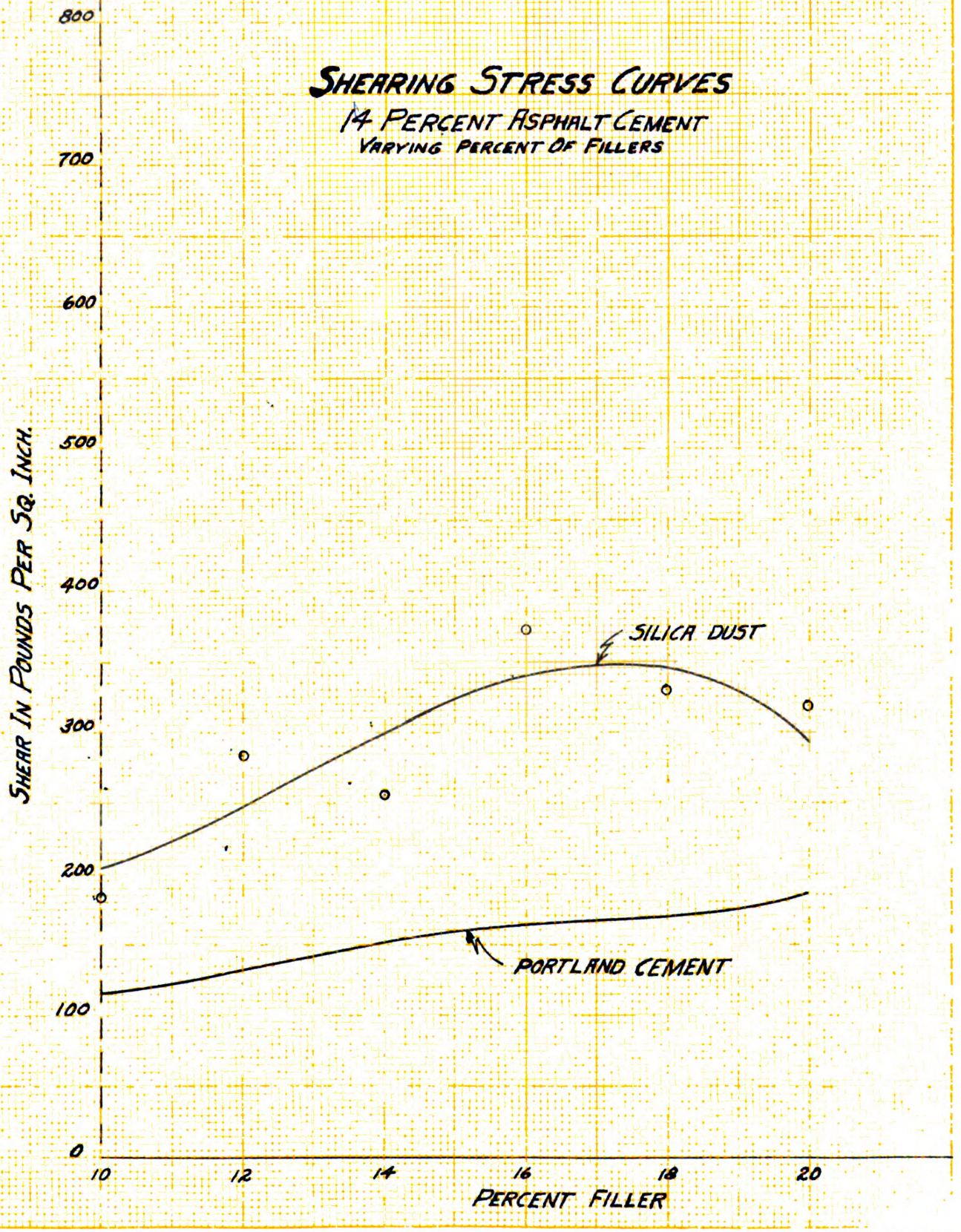
12 PERCENT ASPHALT CEMENT

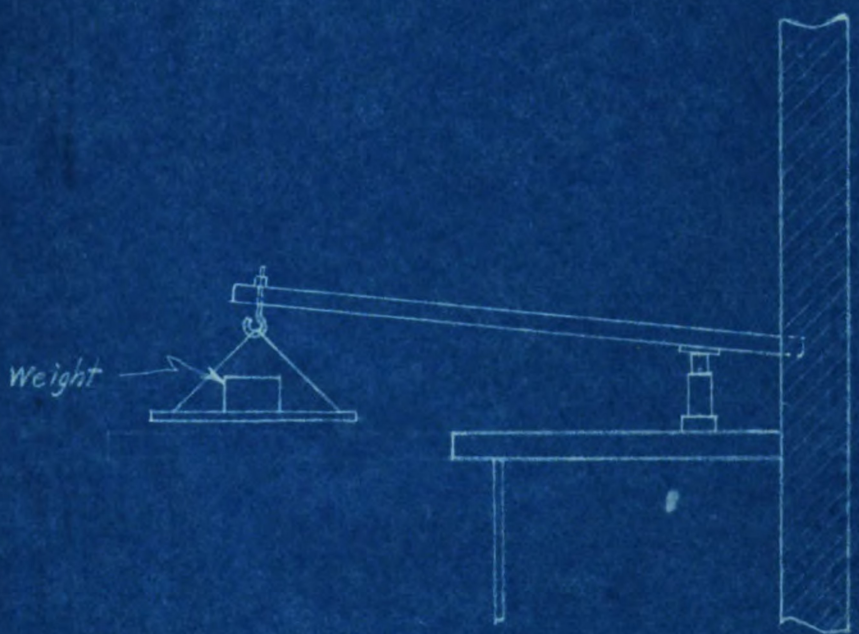
VARYING PERCENT OF FILLERS

SHEARING STRESS CURVES

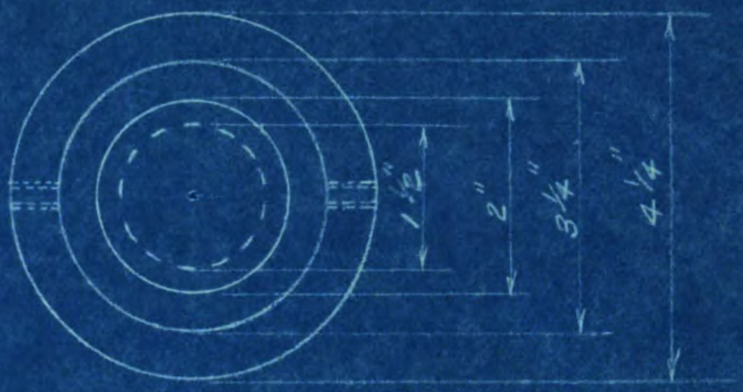
14 PERCENT ASPHALT CEMENT

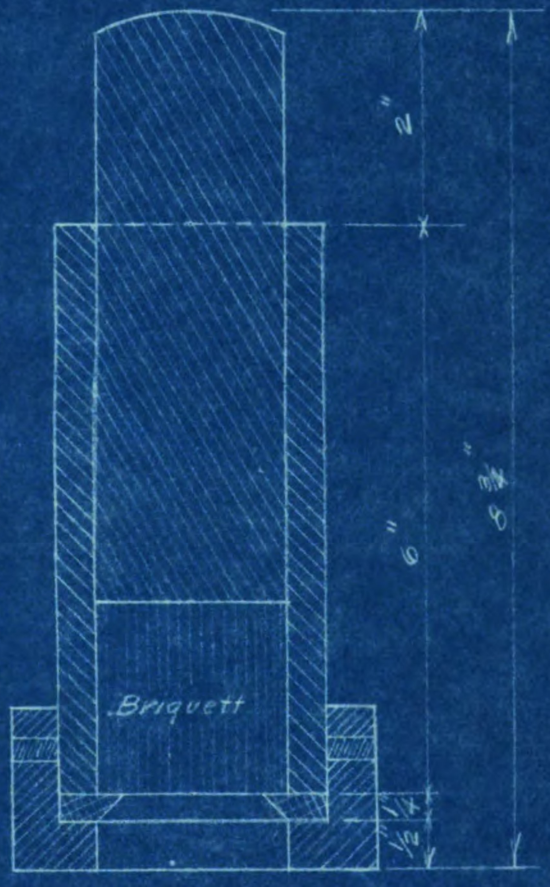
VARYING PERCENT OF FILLERS





METHOD OF OBTAINING REQUIRED COMPRESSION IN MAKING OF BRIQUETTS





ASSEMBLY VIEW — HALF SECTION
Scale 1/2" = 1"

STANDARD SHEAR TESTING EQUIPMENT