SCHURECHT

The Relation between Fineness of Grain of Shale & Crushing Strength of the Burned Product

Ceramics

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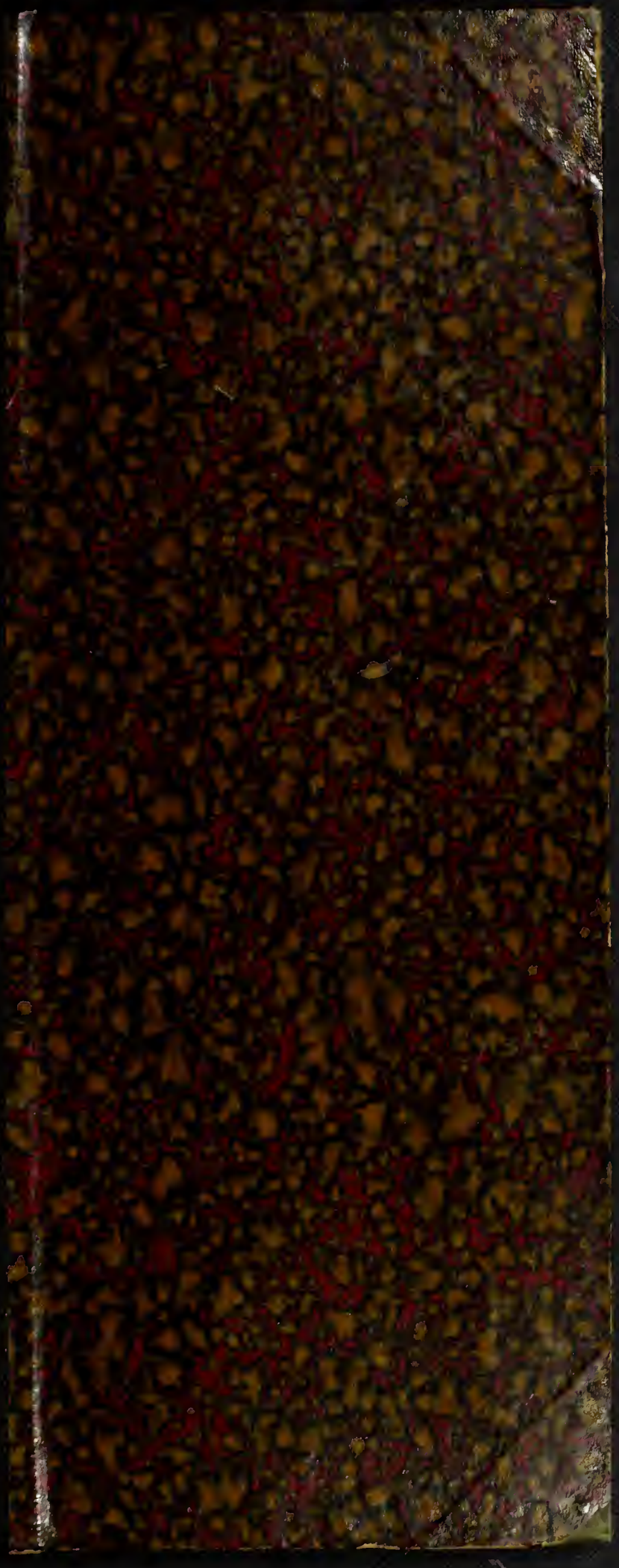

THE RELATION BETWEEN FINENESS OF GRAIN OF SHALE AND CRUSHING STRENGTH OF THE BURNED PRODUCT

BY

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THESIS

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IN

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Harry George Schurecht

ENTITLED The Relation Between Fineness of Grain of Shale and Crushing Strength of The Burned Product

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF Bachelor of Science in Ceramics

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The Relation between the Fineness of Grain of a Shale and the Crushing Strength of the Burned Product

I, Introduction

There has been considerable discussion among brick manufacturers as to the effect of the fineness to which shale is ground upon the crushing strength of the brick. Some manufacturers claim that fine grinding causes brittleness while others maintain that it causes toughness and imparts to a brick a greater crushing strength. Worcester[1] says that an increase in size of grain of a shale will cause an increase in the burning shrinkage of the brick. Brown

[1] The effect of Fine Grinding in the Manufacture of Bedford Shale by the dry and plastic process. By W. G. Worcester, T. A. C. S., Vol. 5, p. 295.

says that brick made from a certain number of clays had a maximum crushing strength[1] when their absorption was about three per cent. The purpose of this work is to determine the relation between the fineness to which a shale is ground and the resultant crushing strength of the burned product. No previous work has been done exactly along this line in so far as the writer could determine.

II, Execution of Work

Material Used. The material used was a Paving Brick Shale obtained through the kindness of the Barr Brick Company of Streator, Illinois. This shale is rather resistant to slaking action in water and hence the coarser particles were not disintegrated appreciably when the samples were tempered with water for moulding the trial pieces.

[1] Vol. 14, T. A. C. S.

The shale which was received in large lumps was reduced in a jaw crusher and separated into six different degrees of fineness by screening. These different sizes are :-

Mixture Table

Series	1 Below 60	2 40-60	3 20-40	4 16-20	5 8-16	6 4-8
I	100	0	0	0	0	0
II	30	70	0	0	0	0
III	30	0	70	0	0	0
IV	30	0	0	70	0	0
V	30	0	0	0	70	0
VI	30	0	0	0	0	70

1. Portion passing 60 M Screen,

2. Portion passing 40 M Screen and remaining on 60. M.

3. Portion passing 20 M Screen and remaining on 40 M.

4. Portion passing 16 M Screen and remaining on 20 M.

5. Portion passing 8 M Screen and remaining on 16 M.

6. Portion passing 4 M Screen and re-

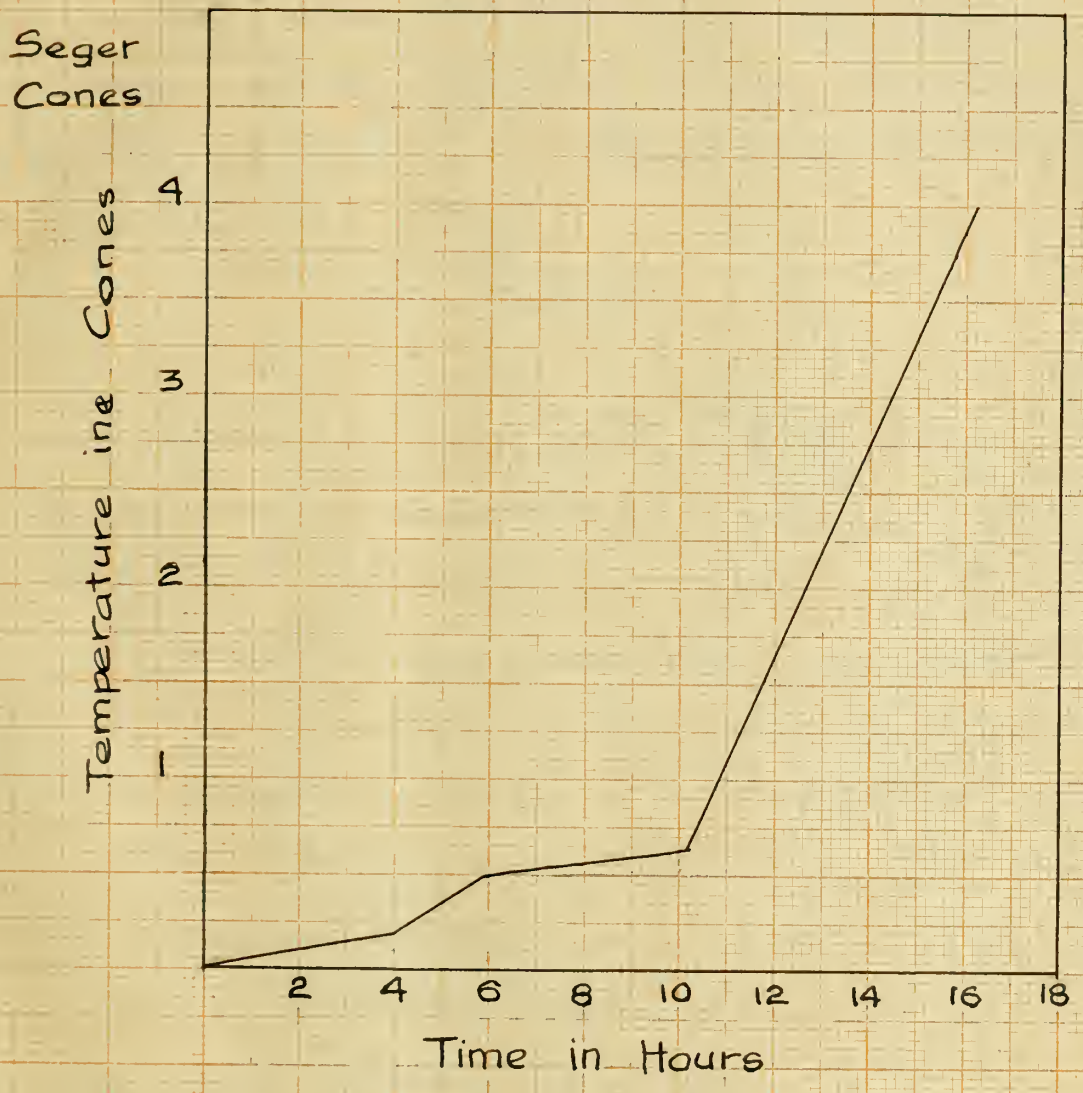
maining on 8M.

In making up the trials from the coarse materials, it is necessary to employ a bonding material in order to hold the coarser grains together. The fine material passing the 60 M. Screen was used for this purpose. One set of trials (I) was made from the bond material alone. In all others, trials were made from the materials coarser than 60 M; 30% of the bond was added in each case and is therefore a constant factor in trials II-VI

The mixtures were pugged by hand to a stiff mud consistancy. Six cylinders about 7.3 cms. in diameter and 7.3 cms. high were cut from each mixture and repressed in a hand power machine. They were allowed to dry for six days in air after which they were burned to Seger cone 4 in an oil fired kiln.

Six tensile strength briquets were also made of each mixture

Time Temperature Burning Curve



and were tested in the air dry condition on a Fairbanks Tensile Strength machine.

The crushing strength briquets were capped at each end with plaster of paris to insure an even pressure on the top and bottom and crushed on a Riehle machine in the Experimental Engineering laboratory.

III, Results

Tensile Tests. Series I contained the finest grained material and showed the highest tensile strength. The tensile strength gradually decreased with an increase in size of grains. This corresponds to Orton's[1] statement that the tensile strength of a clay and sand mixture increases up to a certain point with a decrease in size of the sand grains.

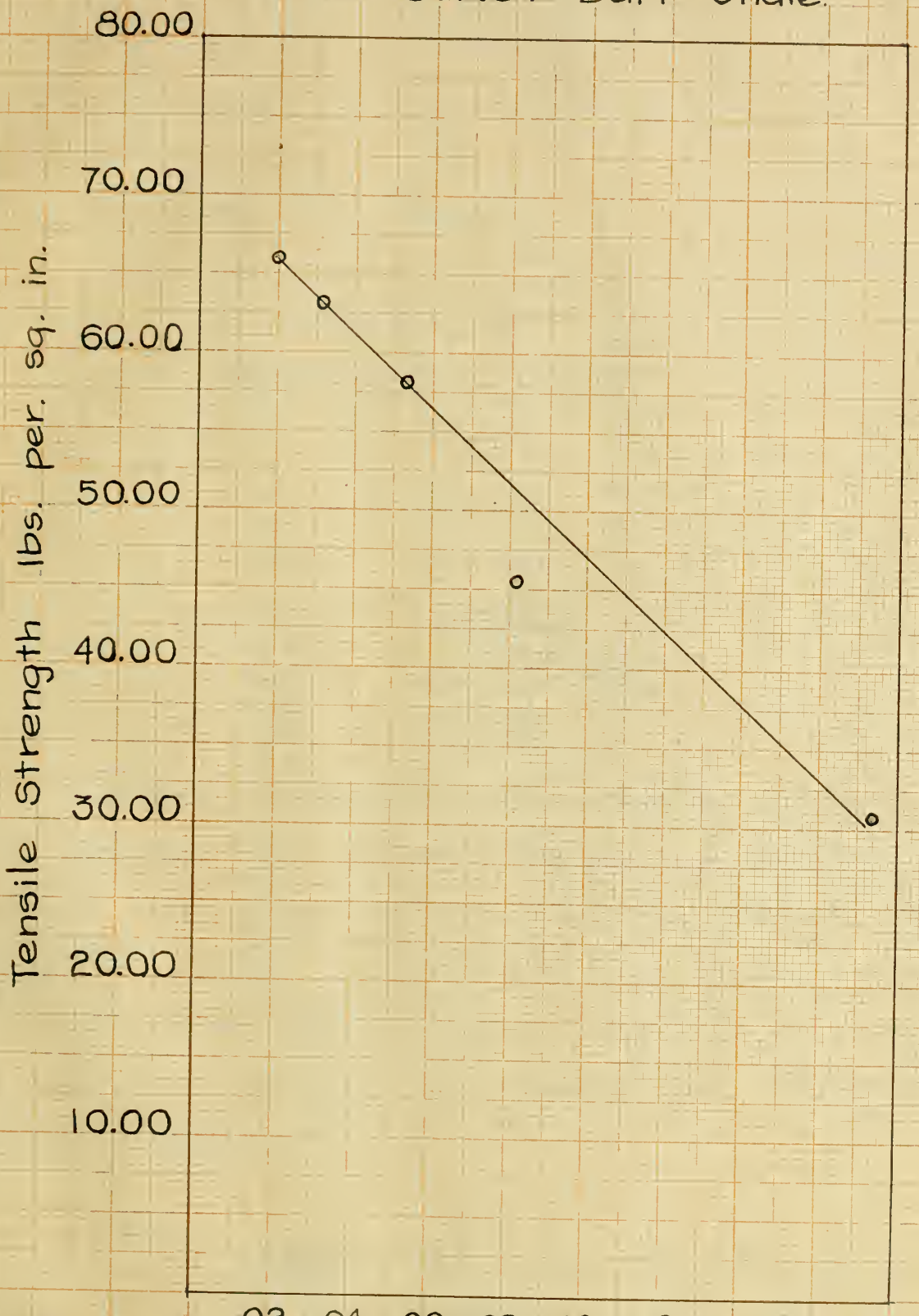
[1] Further Notes on Tensile Strength of clay mixtures. By Edward Orton Jr., E. M., T. A. C. S., page 198 Vol. 3.

Tensile Strength per square inch of Air Dried Briquets.

Series I-VI						
Briq.	No. I	No. II	No. III	No. IV	No. V	No. VI
a	78	61	58	55	44	26
b	84	61	50	50	56	30
c	65	102	75	60	50	34
d	70	54	57	58	40	27
e	73	60	80	65	43	25
f	68	62	59	65	45	35
Average	73	67	63.	59	46	30

The column headed Brig. and lettered a, b, c, + etc. represents the six trial pieces which were made of each mixture. For instance column No. II represents the tensile strengths of the six trial pieces which contained 30 parts of bonding material and 70 parts of coarse material which went through 40 M. screen and remained on 60 M.

Tensile Strength & Fineness of Grain Curve. Barr Shale.



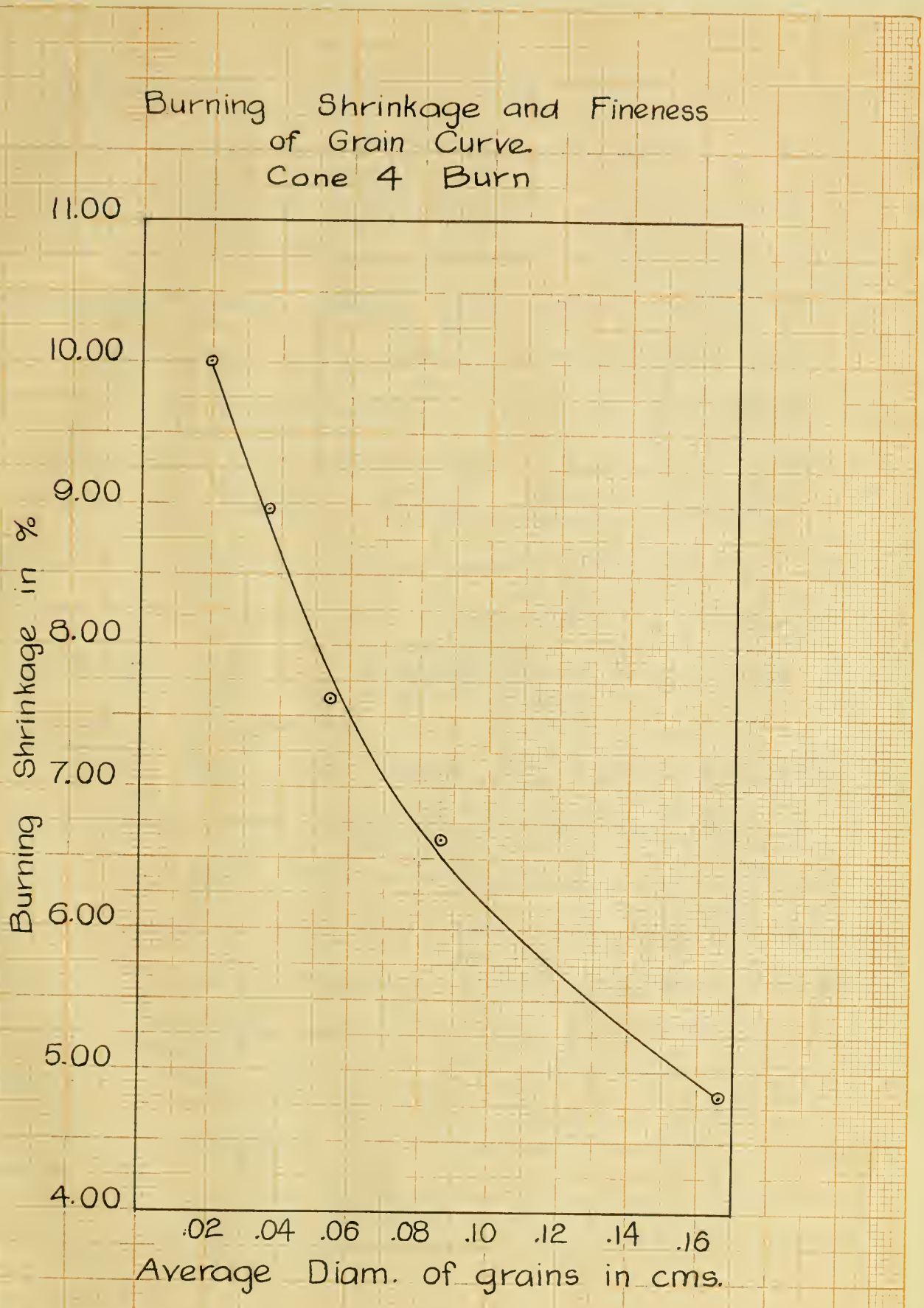
These results indicate that the bonding power of the air dry shale is decreased with an increase in size of grains.

Burning Shrinkage.

Series I-VI	
Series	Burning Shrink.
I	11.00%
II	10.10%
III	8.95%
IV	7.56%
V	6.52%
VI	4.80%

These results showed a decrease in burning shrinkage with an increase in size of grains of shale. This agrees with Worcesters' conclusions who concluded that an increase in size of grain causes a decrease in burning shrinkage.

'The effect of Fine Grinding in the Manufacture of Bedford Shale. By W. G. Worcester, T. A. C. S. Vol. 5, Page 295.

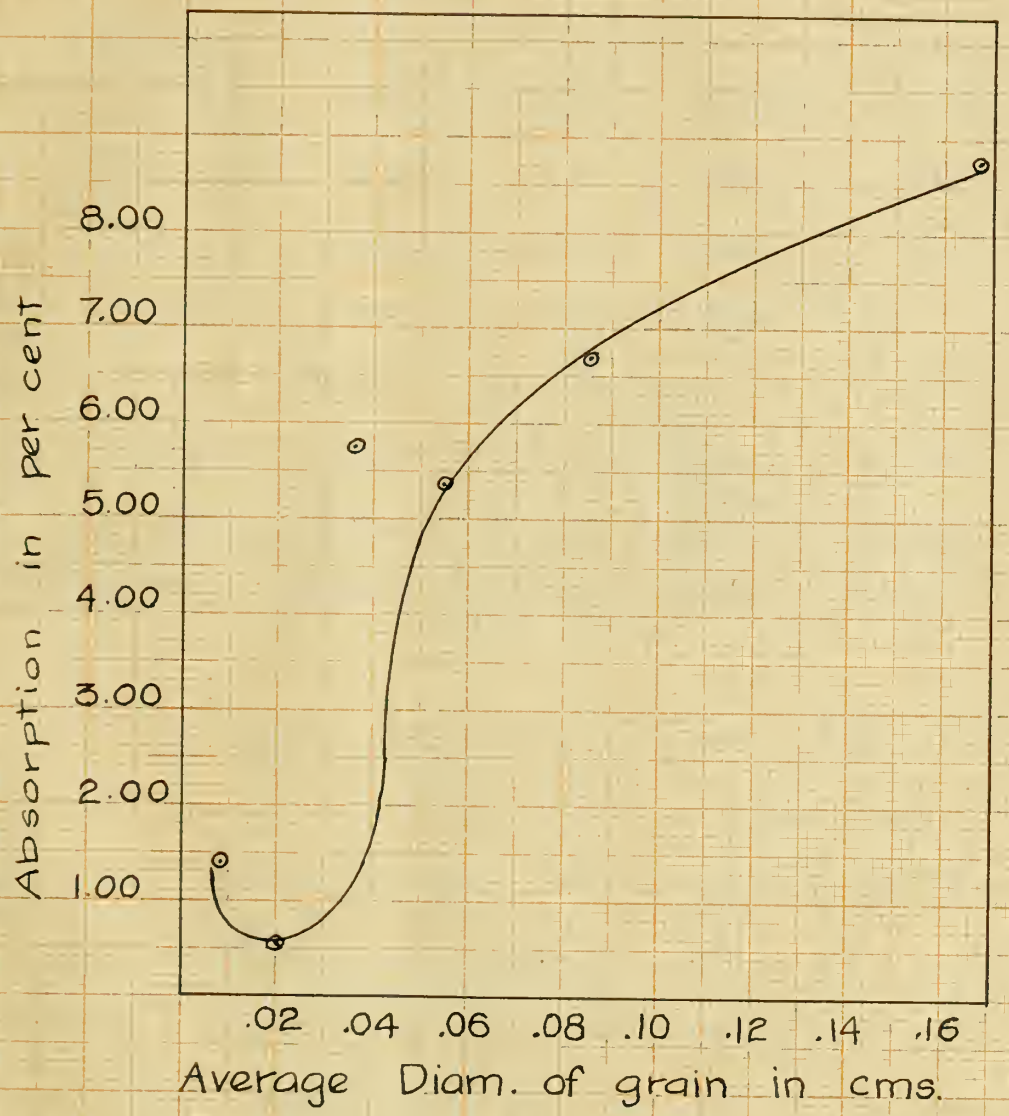

Burning Shrinkage and Fineness of Grain Curve
Cone 4 Burn
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
Burning Shrinkage in %
.02
.04
.06
.08
.10
.12
.14
.16
Average Diam. of grains in cms.

Absorption Tests. The per cent absorption gradually decreased with an increase in fineness of grain up to a certain point when it again increased in the per cent absorption. The change to an increased per cent in absorption was probally due to vesicular structure of the brick.

Crushing Tests. The cylindrical blocks which were all burned to cone 4 showed a marked increase in vitrification with an increase in fineness of grain.

The results showed that the crushing strength of a shale increases with an increase in fineness of grain up to a certain point when it decreases. All pieces were burned to the same temperature and for the same length of time but the degree of vitrification was much less in the coarse grained trial pieces than in the fine grained ones.

Absorption and Fineness of Grain Curve



Crushing Strength in lbs.
per. sq. in.

Series I-VI						
Briq.	No.I	No.II	No.III	No.IV	No.V	No.VI
a	8,250	7,250	7,420	10,300	6,850	4,570
b	9,675	14,850	13,100	7,300	7,400	4,850
c	9,400	7,700	6,710 X	7,630	7,710	5,180
d	8,100	9,800	10,320	9,450	7,300	5,2160
e	8,750	4,550 X	12,200	7,300	4,650	5,660
f	13,300	9,900	6,580	8,470	5,800	4,950
Average	9,577	9,958	9,938	8,560	6,619	5,094

X (These trial pieces were cracked and hence were not used in figuring the average strengths of briquets.

In these series I, II, III, etc. the Roman numerals again indicate the different degrees of fineness of grain while a, b, c, + etc represent the six samples of each mixture.

Relation between fineness of Grain & Crushing Strength of Shale.

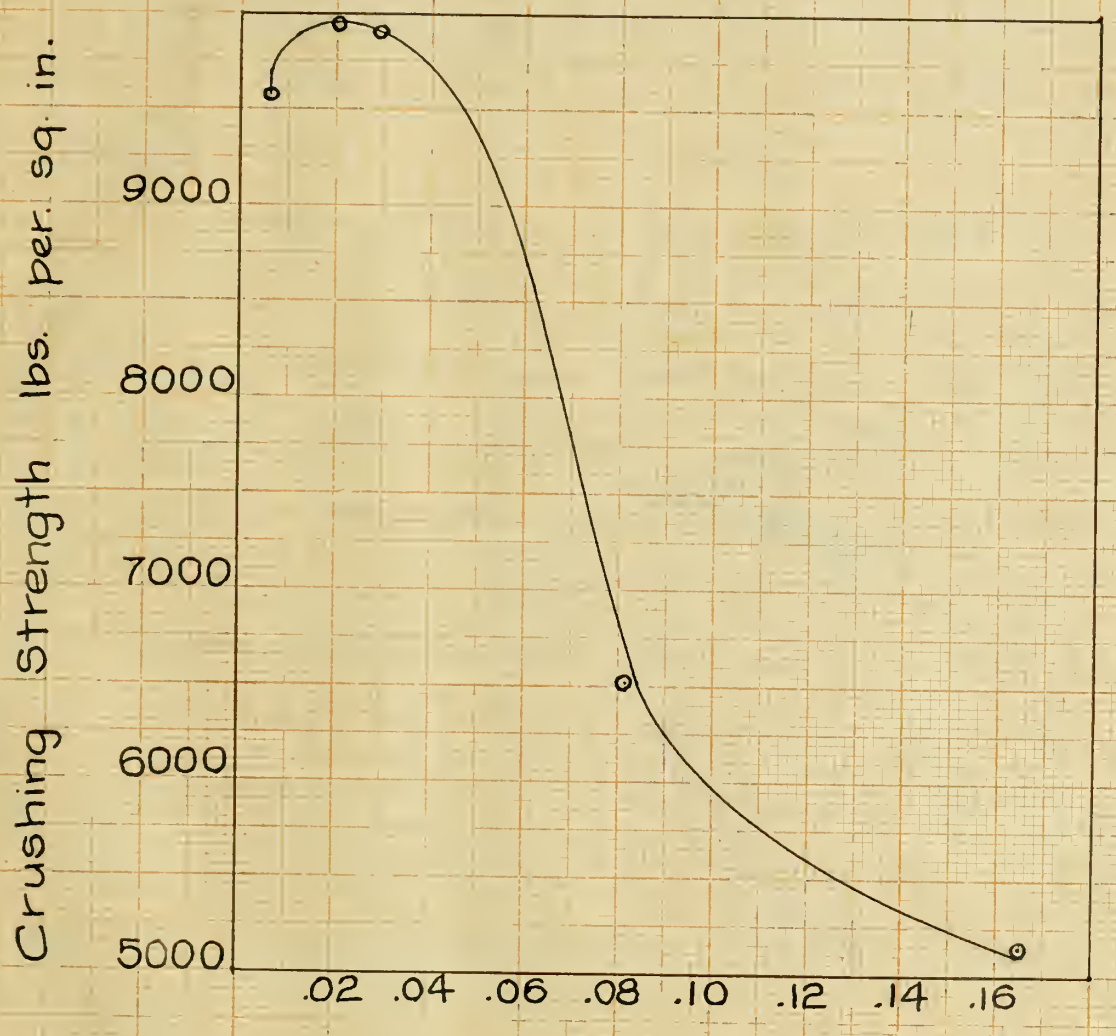


Fig. II

IV, Conclusions

Tensile Strength. The tensile strength of clay is increased with fine grinding.

Burning Shrinkage. An increase in fineness of grain causes an increase in the burning shrinkage of a shale.

Absorption Tests. The crushing strength of this shale increased with a decrease in size of grains and the absorption at the same time decreased up to a certain point when it again increased.

Crushing Strength. An increase in fineness of grain of a shale causes an increase in crushing strength of the burned product up to a certain point when it decreased the crushing strength.

To produce a brick having a maximum crushing strength with a minimum amount of time and fuel, material having a fineness between 20-40 mesh should be used.