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A study and analysis of pumice-concrete building blocks

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BLOCKS

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A STUDY AND ANALYSIS OF PUMICE-CONCRETE BUILDING BLOCKS

A Thesis

Presented to

the Faculty of the Department of Civil Engineering

University of New Mexico

In Partial Fulfillment

of the Requirements for the Degree

Master of Science in Civil Engineering

by

George Leon Server

May 1947

This thesis, directed and approved by the candidate's committee, has been accepted by the Graduate Committee of the University of New Mexico in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

France V. Scholes
DEAN

May 24, 1947
DATE

Thesis committee

W. C. Wagner
CHAIRMAN

E. Perry Steen

R. D. Ford

This thesis, [illegible] and approved by the candidate's committee, has been accepted by the Graduate Committee of the University [illegible] in partial fulfillment of the requirements for the degree

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Thesis committee

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CHAPTER I

INTRODUCTION

The increasing use of concrete building blocks employing lightweight volcanic aggregates has presented many problems. Questions are constantly arising regarding locations of suitable lightweight aggregates, properties of the various materials, properties of blocks with different proportions of cement, and methods of manufacturing.

Since there are numerous lightweight aggregates supposedly suitable for building blocks, the writer has confined his study to a volcanic material known as pumice. This study was made with the expectation of developing a satisfactory method for designing concrete building blocks using the local deposits of pumice as the aggregate. An analysis has been made of the various blocks manufactured in this state in order to get a comparison between the white and brown pumices, to determine the effect of adobe and various other admixtures on the compressive strength, the methods of manufacturing, and the effect of proper curing.

The term lightweight aggregate implies material which may be substituted for the usual rock, sand, and gravel commonly used as the major part of concrete, but being distin-

[illegible]

[illegible]

The investigation of concrete building blocks [illegible] using lightweight aggregate presents [illegible] many problems. Questions are continually arising concerning the kinds of suitable lightweight aggregates, properties of the various materials, properties of blocks with different proportions of cement, and methods of manufacture.

There is not much recorded literature [illegible] concerning proposed methods for building blocks, [illegible] the writer has confined his study to a [illegible]. [illegible] was made with the [illegible] of developing a satisfactory method for [illegible] concrete [illegible] blocks and [illegible] deposits of pumice in the [illegible]. [illegible] have been made of [illegible] which were [illegible] in order to get a correlation between the [illegible], to determine the effect of [illegible] on the compressive strength, the methods of manufacturing, and the effect of [illegible].

The [illegible] lightweight [illegible] material which may be substituted for the [illegible] sand, and gravel commonly used as the major part of concrete, [illegible]

guished by its lightness in weight.

The art of making and using concrete is old and well developed. Research and experience have nearly determined the qualities necessary in its constituents, and time has tested theories and applications. Elaborate specifications and tests have been devised and generally adopted governing all phases of concrete work, from selection of material through engineering design down to mixing and pouring.

A new material entering such an old art should be able to conform to the already established framework. It should meet the specifications for physical structure; it should produce a product meeting the usual tests; and it should be in the same price bracket. It is hardly sufficient for a new material merely to meet competition, but in order to overcome conservatism, it should have higher qualities and/or should be cheaper. Such conditions are hard to meet, for a difference in one physical quality is invariably accompanied by others. If, because of such differences, such material does not conform to established procedures, its introduction as being suited for building products is correspondingly more difficult.

The introduction of lightweight aggregates has presented the type problem outlined above. Their lightness in weight is caused by physical structures so different that similarity

[illegible] by the [illegible]

[illegible]

developed, [illegible] and [illegible]

qualities [illegible]

theories [illegible]

[illegible]

concrete [illegible]

[illegible]

[illegible]

to [illegible]

meet the specifications [illegible]

duce a product [illegible]

same price [illegible]

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The [illegible]

ed the [illegible]

is caused by [illegible]

to ordinary aggregates of rock and gravel is only superficial. Frequently certain lightweight aggregates will not meet standard specifications and tests. Engineering design must be altered so that such lightweight concrete produced by such design will furnish the strength required. Mixes must be changed to meet the pecularities of these materials, and many mixes must be handled and placed with special precautions.

In spite of all this, the use of these materials has grown steadily for the past two decades and is growing even faster today. Lightweight aggregates have been subjected to much criticism, and sometimes even ridicule -- probably because enthusiastic advocates occasionally step ahead of research and experience. The proof that lightweight building blocks have arrived and have taken their place in the construction industry is incontestable. The rapidly growing number of large buildings, which, while largely built of lightweight blocks, are still too massive to be brushed off by words or conservative theories.

CHAPTER II

HISTORICAL DEVELOPMENT OF PUMICE AS A LIGHTWEIGHT BUILDING MATERIAL

Pumice as a lightweight aggregate for concrete building purposes is a comparatively new material to this country, yet it was used in buildings many years ago. Descriptions of ancient work contain references as to the use of spalls of tuff and pumice in concrete masonry.

During the renowned Roman building period in the first centuries B.C. and A.D., fragments of pumice three to six inches in size were used as aggregate to reduce dead weight in the construction of many of the great domes, such as that of the Pantheon, and of the immense vaults of the public baths in Rome. Little is known of its use in Europe from that time until shortly after the middle of the last century when pumice concrete was introduced in the Nette and Brohl Valleys in Germany. This pumice aggregate was obtained from local deposits, and the concrete proved so satisfactory that its use for lightweight construction spread through other European countries.

Doctor Paul Reiter, Anthropology Department, University of New Mexico wrote the following article on the early use of pumice as a building material in New Mexico:

In New Mexico the earliest use of pumice in masonry construction is believed to have occured close to 1200 A.D. on the eastern slope of the Jemez Mountains, between the Chama River and the Rio Salado, which are tributaries of the Rio Grande River. Several hundred ruins are known in this area, all dating approximately from 1250 A.D. to approximately 1500 A.D. The ruins consist of paralled tiers of contiguous house rooms. The villages contain subterranean kivas, which are also constructed of pumice masonry.

House rooms are formed of walls made from blocks or slabs of pumice which may average sixteen inches long, eight to ten inches wide, and five inches thick. Joints of one course are overlapped by succeeding courses. Doors with pumice blocks for lintels were common. Sporatic use of pumice blocks occurred after 1500 A.D., but the use was not as extensive.

The first large-scale use of pumice for concrete aggregate in this country was begun in 1935 near Napa, California, at the north end of San Francisco Bay.

The building boom that started as soon as World War II ended caused demands for all building materials. Many new products started coming on the market and pumice-block plants cropped out all over the country.

CHAPTER III

PHYSICAL PROPERTIES OF PUMICE

The lightweight volcanic material known as pumice is a natural silicic glass which was produced by volcanism in the form of a molten froth. This froth, upon cooling rapidly, trapped tiny gas bubbles that caused it to remain extremely porous and minutely vesicular in structure. Pumice is white to light gray or light tan in color. The dead-air cells in the pumice give it excellent insulating properties against heat, cold, and sound. The glassy composition makes it practically fire-proof, its fusing point being 2,450 degrees Fahrenheit.

Pumice is composed of silky fibers and is very porous. These fibers separate larger pores or holes, which in turn are separated or continuous to varying degrees. Some pumices will float on water for several days with no apparent settling, while others rapidly absorb water and sink. Where pumice is deposited on the ground, the deposits consist of particles of all sizes from volcanic ash to large boulders; but where dropped in water it reaches its final resting place as a sedimentary deposit with the consequent sizing and classification of water action.

While most pumices make good lightweight aggregates,

water-laid deposits are a better source than airborne deposits. The airborne deposits contain an excess of dust which is undesirable, while the water-laid deposits are well graded.

The following is an article from a bulletin published by the Department of Scientific and Industrial Research, London, England:

> Pumice, the only natural lightweight aggregate in common use in England, is of volcanic origin. Most molten lavas contain, dissolved in them, appreciable amounts of gases which, when released during solidification, produce a porous and honeycombed structure in the mass. Lavas which have solidified rapidly without release of gases form dense, glassy solids, while those which have been in some degree distended by the escape of gases form scoria. Pumice represents the extreme stage of this distension and is formed from a lava so swollen by escaping gases as to form a kind of solidified froth. It consists of a glassy mass honeycombed with cavities, and sometimes contains a certain amount of crystallized matter. In color, pumice varies from white to yellow or even brown.
>
> Pumice is found in many countries, but that used in Great Britain has usually been obtained from the German deposits occurring in the neighborhood of Coblenz on the Rhine. These deposits consist of bands of pumice, several feet thick, separated by thin layers of other materials. Raw pumice as quarried contains a certain proportion of volcanic dust, shale, and other extraneous matter. 12

Figures one and two are photographs of pumice. Figure one shows the difference in color, letter A indicates the white pumice and letter B the brown. Figure two has been magnified ten times the original size, and the porosity and structure of the pumice can be seen easily.

water-laid deposit [illegible] de-

posits. The [illegible]

in calcination, while [illegible]

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by the Department of [illegible],

London, England:

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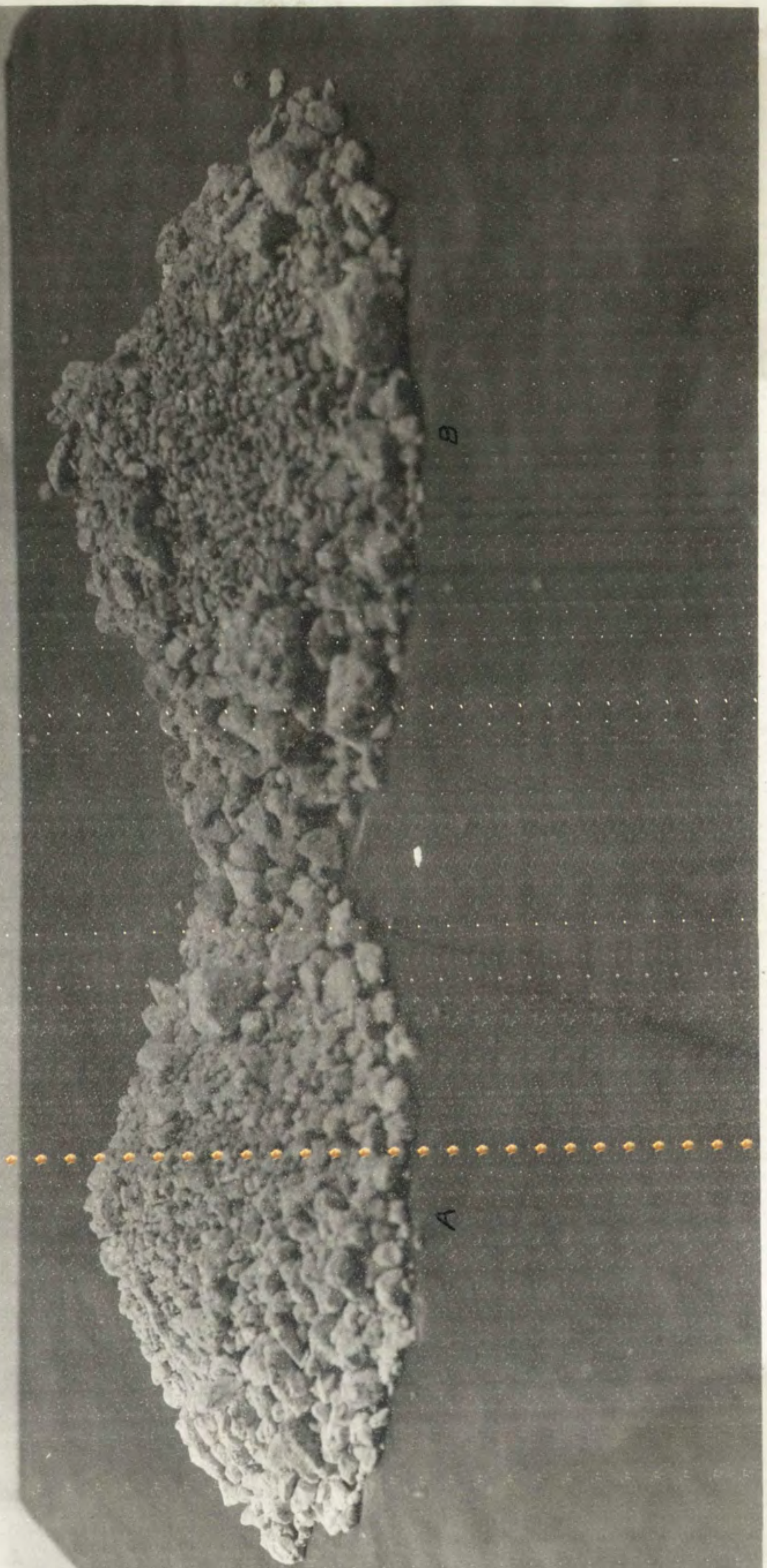
B
A

Fig. 1

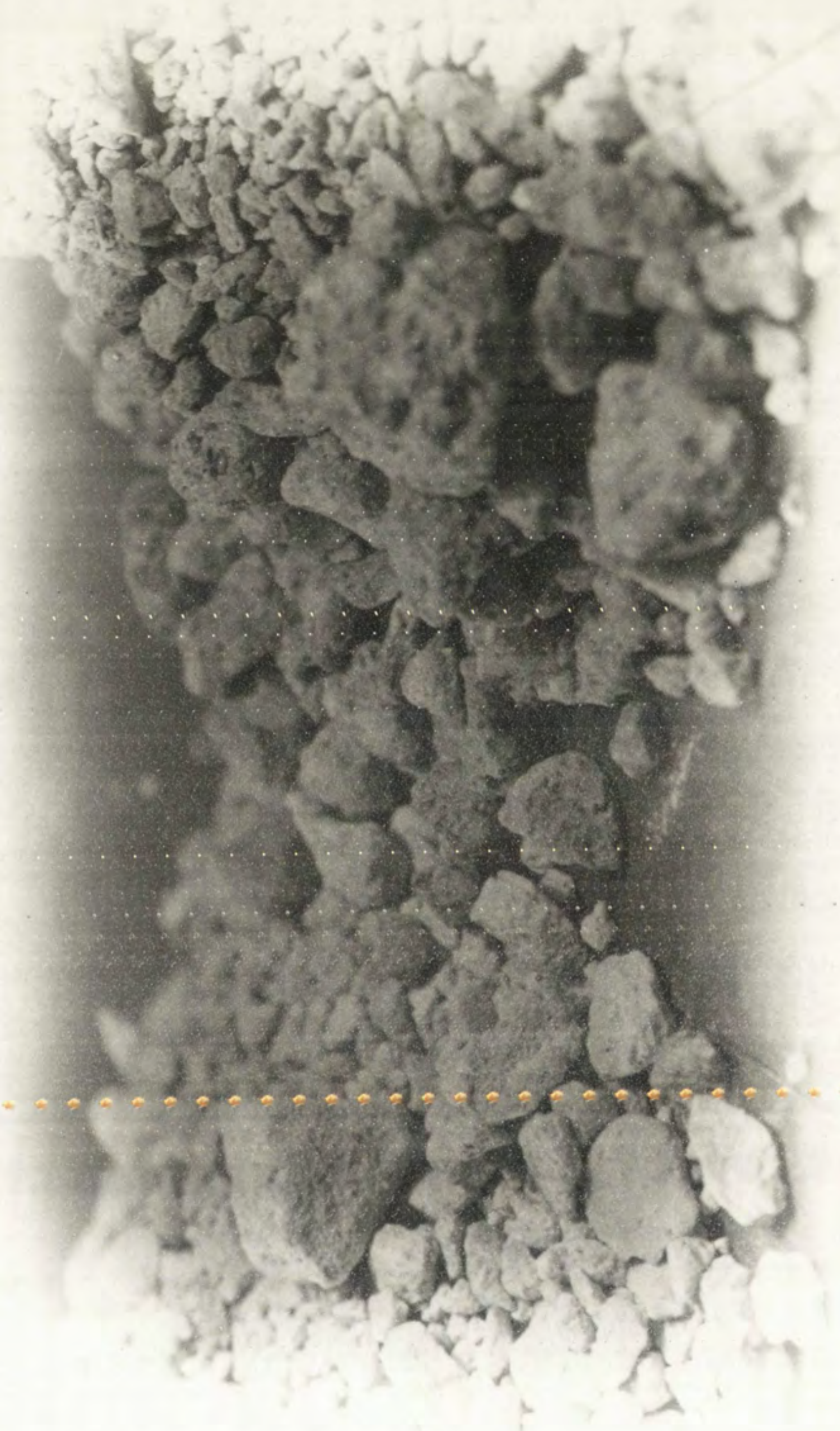

Fig. 2

CHAPTER IV

TESTS ON PHYSICAL PROPERTIES OF PUMICE

The majority of brown pumice used for concrete aggregate in New Mexico comes from the Jemez Mountains, near Jemez Springs, New Mexico, and the white pumice comes from pits near Cochiti, New Mexico.

According to Doctor Vincent Kelly, Geologist, University of New Mexico, both pumices have been transported some distance, the brown pumice being transported the further. This conclusion was based on the smoothness of the particles of pumice.

Many samples of both colors of pumice were gathered and subjected to various tests on the physical properties of aggregates. All tests performed were in accordance with the specifications of the American Society for Testing Materials.

I. SCREEN ANALYSIS

The grading of an aggregate is perhaps its most important property; therefore, a large number of samples of both white and brown pumice were analyzed. The pumice had to be in a dry condition in order to separate the dust from the other material, so all samples were dried to a bone-dry state before

CHAPTER IV

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According to Doctor Stuart Northrop, Geologist, University of New Mexico, both pumices have been transported from distances, the brown pumice being transported the farther. This conclusion was based on the smoothness of the particles of pumice.

Four samples of both colors of pumice were collected and subjected to various tests on the physical properties of aggregates. All tests performed were in accordance with the specifications of the American Society for Testing Materials.

I. SCREEN ANALYSIS

The grading of an aggregate is perhaps its most important property; therefore, a large number of samples of both white and brown pumice were analyzed. The pumice had to be in a dry condition in order to separate the minus material, so all samples were dried to a constant weight before

being analyzed.

The pit-run pumice was found to contain from twenty to forty per cent coarse material. Coarse material will be that retained om the number four sieve. A very small per cent of the coarse material was found to be three-fourths of an inch or larger. Most of the particles passed the one-half-inch sieve.

The fine material passing the number four sieve was found to be deficient of particles that would be retained on the number fifty and number one-hundred sieves. Also, occasionally, an excess of dust was found.

Because of the deficiency in fine material, it was necessary to add sand to the pumice to obtain a dense and well-graded aggregate. This would not be necessary if a screening plant were available. The pumice could be screened and then proportioned so the deficiency of fines could be supplemented.

Table I gives the average results of the screen analysis performed on several samples of both kinds of pumice.

Table II gives the grading requirements for lightweight aggregates according to the American Society for Testing Materials. As can be seen readily from a comparison of the two tables, neither the white nor the brown pumice met the grading requirements.

being analyzed.

The pit-run gravel was found to contain from twenty to forty per cent coarse material. [illegible] material [illegible] retained on the number four sieve. A very small per cent of the coarse material was found to be three-fourths of an inch or larger. Most of the particles passed the one-half-inch sieve.

The fine material passing the number four sieve was found to be deficient [illegible] would be retained on the number fifty and number one hundred sieves, [illegible] an excess of [illegible] found.

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Table I gives the average results of the sieve analyses performed on several samples of both kinds of gravel.

Table II gives the specification requirements for aggregates according to the American Society for Testing Materials. As can be seen readily from a comparison of the two tables, neither the sands nor the gravel meet the grading requirements.

TABLE I

GRADING OF BROWN AND WHITE PUMICE

Size Designation	Percentages Passing Sieves Having Square Openings								
	1 in.	3/4 in.	1/2 in.	3/8 in.	No. 4 (4760 Micron)	No. 8 (2380 Micron)	No. 16 (1190 Micron)	No. 50 (297 Micron)	No. 100 (149 Micron)
Brown Pumice Fine Aggregate No. 4 to Dust	....	....	....	....	100.0	62.5	27.0	9.0	7.0
White Pumice Fine Aggregate No. 4 to Dust	....	....	....	....	100.0	71.0	40.0	14.0	11.0
Brown Pumice Coarse Aggregate 3/4 in. to No. 4	100.0	97.0	92.0	76.5	12.0	6.0	....	....	....
White Pumice Coarse Aggregate 3/4 in. to No. 4	100.0	99.0	95.0	85.0	8.0	3.0	....	....	....

TABLE II

GRADING REQUIREMENTS FOR LIGHTWEIGHT AGGREGATES

Size Designation	Percentages Passing Sieves Having Square Openings								
	1 in.	3/4 in.	1/2 in.	3/8 in.	No. 4 (4760 Micron)	No. 8 (2380 Micron)	No. 16 (1190 Micron)	No. 50 (297 Micron)	No. 100 (149 Micron)
Fine Aggregate									
1/4 in. to Dust	....	....	....	100	95-100	....	45-80	10-30	5-15
3/8 in. to Dust	....	....	100	95-100	55-80	....	....	10-25	5-15
Coarse Aggregate									
1/2 in. to No. 4	....	100	90-100	40-75	0-15	0-5	....	....	....
1/2 in. to No. 8	....	....	100	85-100	0-20	0-5	....	....	....
3/4 in. to No. 4	100	90-100	....	20-55	0-10	0-5	....	....	....

II. ORGANIC IMPURITIES

The organic impurities test is an approximate determination of the presence of injurious organic compounds in natural aggregates which are to be used in concrete or cement mortar.

The fines of both the brown and white pumices were subjected to this test. A twelve-ounce bottle was filled to four and one-half ounces with the fine pumice and then filled to seven ounces with a three per cent solution of sodium hydroxide. The color of the resulting solution, after standing twenty-four hours, was the indicator of the presence of organic matter. The results of the test indicated that the brown pumice contained some organic matter but not enough to restrict its use in any extent. The white pumice contained even less organic matter.

The dust was then separated from the fines, and the test, as described above, was performed on the remaining material. The resulting solution was clearer than the results of the other test. By performing this experiment, it was proved that the small amount of organic matter was contained in the dust, indicating that the pumice itself was free from injurious organic compounds.

The principal value of this test is to furnish a warning that further tests may be necessary.

[illegible] SUMMARY AND [illegible]

The present [illegible] has [illegible] determination of the percentages of [illegible] organic compounds in natural [illegible] which may [illegible] be used [illegible] ment matter.

The [illegible] of [illegible] and [illegible] have been subjected to this test. A [illegible] and one-half [illegible] the [illegible] seven ounces with [illegible] The color of the resulting solutions, [illegible] twenty-four hours, [illegible] of the [illegible] of organic matter. The results of the [illegible] indicated [illegible] some organic matter [illegible] to any extent. The [illegible]

The [illegible] test, [illegible] material. The [illegible] the other tests. [illegible] that the small amount of [illegible] dust, indicating that [illegible] ous organic compounds.

The principal value of [illegible] ing that further tests may be necessary.

III. UNIT WEIGHT

The unit weight of an aggregate is the weight of a cubic foot of the aggregate and is found by weighing a known volume of the material. A one-half cubic-foot container was used in this test. The unit weights were found for the coarse, fine, and pit-run material in a bone-dry condition. The unit weight can be found either in a loose or compacted state; the former was used for this test.

Table III gives a comparison of the unit weights of the coarse, fine, and pit-run material of the two pumices.

TABLE III	White Pumice Unit Weight	Brown Pumice Unit Weight
Pit-Run Material	32.4#	38.0#
Coarse Material	26.9#	30.5#
Fine Material	39.0#	39.2#

IV. ABSORPTION

Samples of coarse, fine, and pit-run material of both pumices were dried to a constant weight, and a sample of known weight was taken. The sample was then soaked in water for twenty-four hours. This material was then removed from the water, and the surface water dried with a cloth. The saturated surface-dried sample was then weighed and the per cent absorption was calculated from the following formula:

Per Cent Absorption = (Saturated Surface-Dried Weight - Dry Weight x 100)/Dry Weight

Table IV gives a comparison of the per cent absorption of the coarse, fine, and pit-run material of the two pumices.

TABLE IV	White Pumice % Absorption	Brown Pumice % Absorption
Pit-Run Material	46.0	36.0
Coarse Material	43.0	39.8
Fine Material	48.0	34.3

CHAPTER V

METHODS OF MANUFACTURING PUMICE CONCRETE BLOCKS

The procedure of most producers of pumice blocks is essentially the same, varying only in accuracy of proportionment. The equipment is similar, yet varies from home-made rigs to quite expensive plants. The vibration type of machine is the least expensive and is used almost exclusively in New Mexico. Block molds are of various sizes and shapes, ranging from $3\frac{1}{2}$" x 6" x 12" to 8" x 8" x 16".

Pumice is introduced into the mixer, and water is added in order to saturate the pumice. After the pumice has been mixed with the water for a few minutes, the sand and cement are added, plus any admixtures. As this is mixing, additional water is added until the mix becomes plastic. Then, it is introduced into a hopper above the mold. The concrete is scraped into the mold and vibrated, the excess being scraped off the top of the mold. The vibrating lasts but a few seconds; then the mold is revolved through one-hundred eighty degrees and the blocks are pressed out of the mold on wooden pallets. The blocks are stacked in small piles and allowed to set approximately twenty-four hours, then removed from the pallets and put in stock piles for curing. Most manufacturers

APPENDIX F

[illegible]

The process of manufacture of [illegible] is essentially the same, varying only in [illegible] of [illegible]ments. The equipment is [illegible] rigs to quite expensive plants. [illegible] is the [illegible] Mexico. Block molds are of various sizes and shapes, ranging from [illegible].

Pumice is introduced into the mixer, and [illegible] is added in order to [illegible] the product. After the [illegible] has been mixed with the [illegible], the [illegible] ment are [illegible] tional water is added until the [illegible] is introduced [illegible] the mold. The [illegible] scraped into the mold and [illegible] off the top of the mold. The [illegible] onds; then the mold is [illegible] one-hundred [illegible] degrees and the blocks are [illegible] out of the mold on wooden pallets. The [illegible] and allowed to set approximately twenty-four hours, [illegible] from the pallets and put in stock piles for curing. Most manufacturers

try to have their blocks meet compressive-strength specifications in seven to ten days.

The methods of measuring the ingredients of the blocks is usually the fallacy of this system. The aggregate is usually proportioned with shovels and the water is added until the mixer operator thinks the desired plasticity has been reached. The materials should be proportioned with more accuracy in most cases.

The cement is sometimes measured with a shovel. Since cement "fluffs up", all concrete designs are based on the weight of cement, not the volume. Therefore, a chance for error in cement content exists if this method of measurement is used.

The varying amounts of water used gives varying water-cement ratios, and the water-cement ratio is the basis of all concrete design. This above all should be kept constant for all mixes, thus demanding a more precise means of measuring.

The speed of the vibrator has a great effect on the blocks produced. If the speed of vibration is increased, the resulting block is more dense and vice versa. If the mix is too wet, due to vibration, the cement will segregate and weaken the strength of the block. Therefore, designs that produce excellent blocks in one machine may fail in another.

try to have them in the best condition [illegible] [illegible]tions in seven to ten days.

The [illegible] of [illegible] the [illegible] is usually the [illegible] of [illegible]. The aggregate is [illegible]ally proportioned with [illegible] and the [illegible] the mixer operator [illegible] reached. The [illegible] [illegible]racy in most cases.

The cement is [illegible] cement [illegible] weight of cement, [illegible] ror in cement [illegible] used.

The varying amounts of water [illegible] cement ratios, [illegible] concrete design. [illegible] all mixes, thus [illegible]

The speed of the vibrator [illegible] blocks produced. If the speed of [illegible] is increased, the resulting block is more dense [illegible] too wet, due to vibration, the cement will [illegible] on the strength of the block. [illegible] duce excellent blocks in the [illegible]

Methods used by a small per cent of block producers has hurt the pumice-block industry, but fortunately many of these types of plants have gone out of business, since they have been unable to meet the competition offered by more efficient and conscientious block producers. Unfortunately they have left their mark on the pumice-block industry.

Figures three and four show several sizes and various shapes of the finished blocks.

Figures five and six show one of the better block-producing plants in Albuquerque, New Mexico.

In Figure five, the mold operator is scraping the concrete into the mold and vibrating it. Blocks shown in the foreground have recently been molded and are allowed to set twenty-four hours before they are stacked for curing. The wooden pallets used to hold the wet blocks are stacked beside the building.

Figure six shows the blocks being pressed from the mold.

Figure seven shows pumice blocks being used on one of the larger construction jobs in Albuquerque, New Mexico.

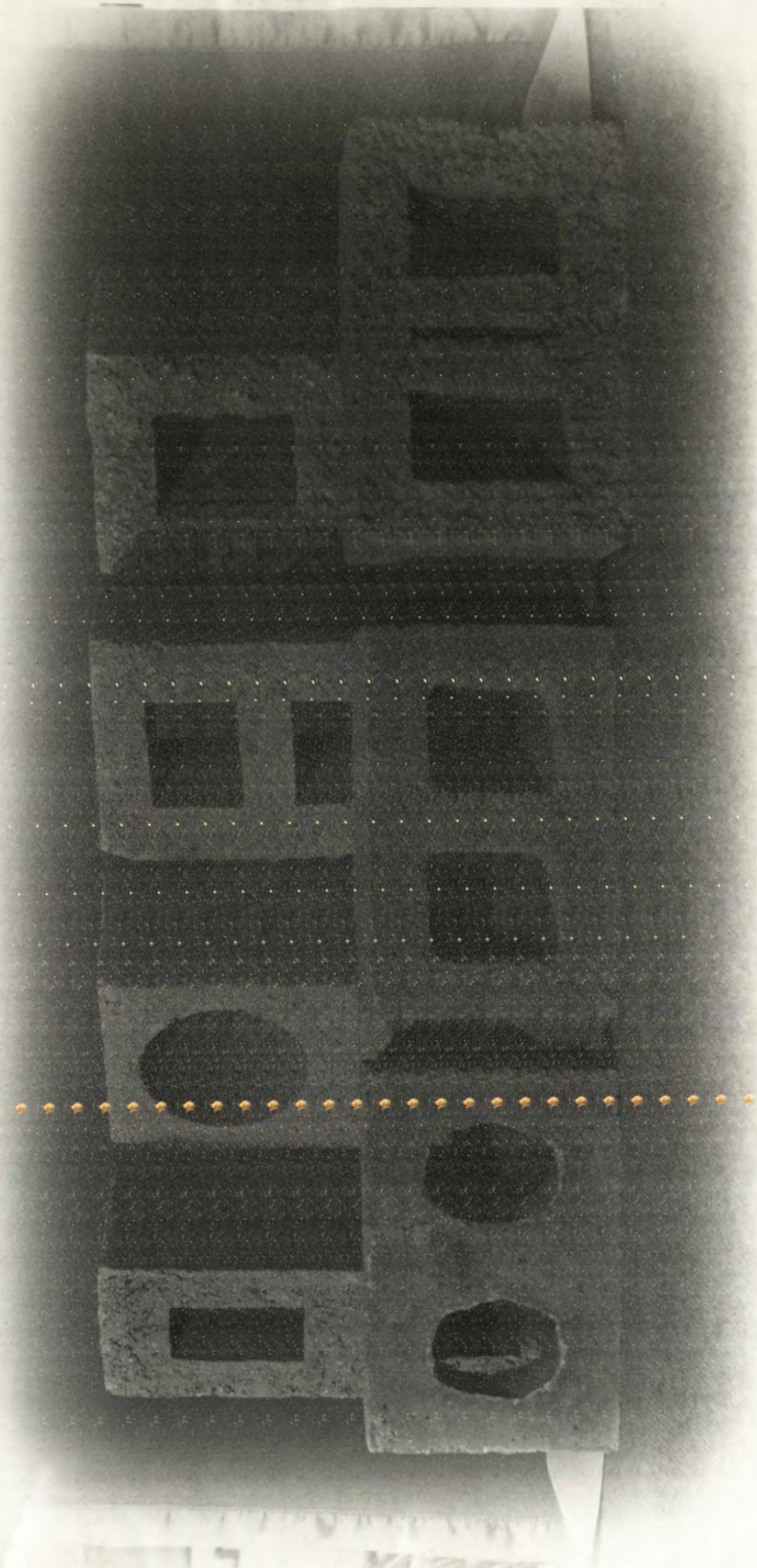


Fig. 5

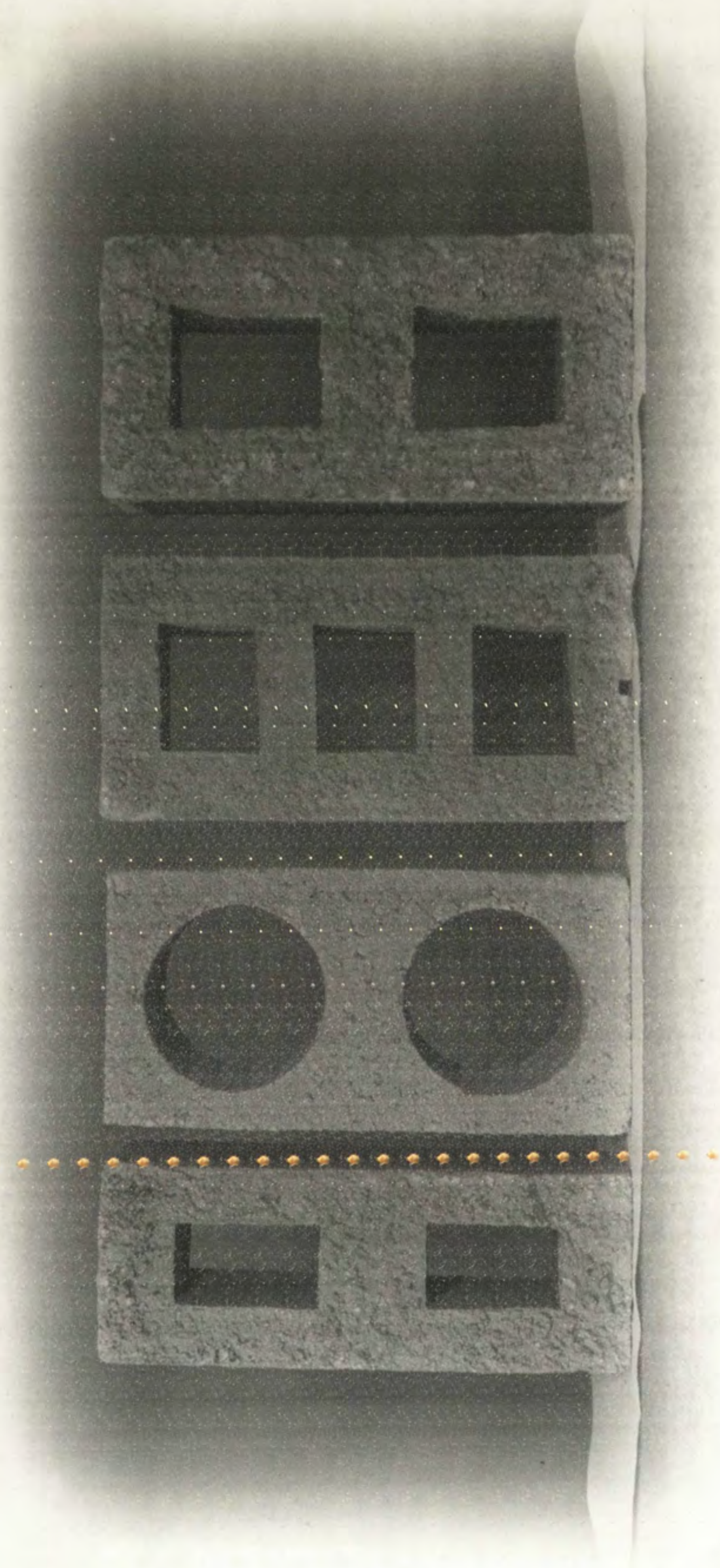


Fig. 4

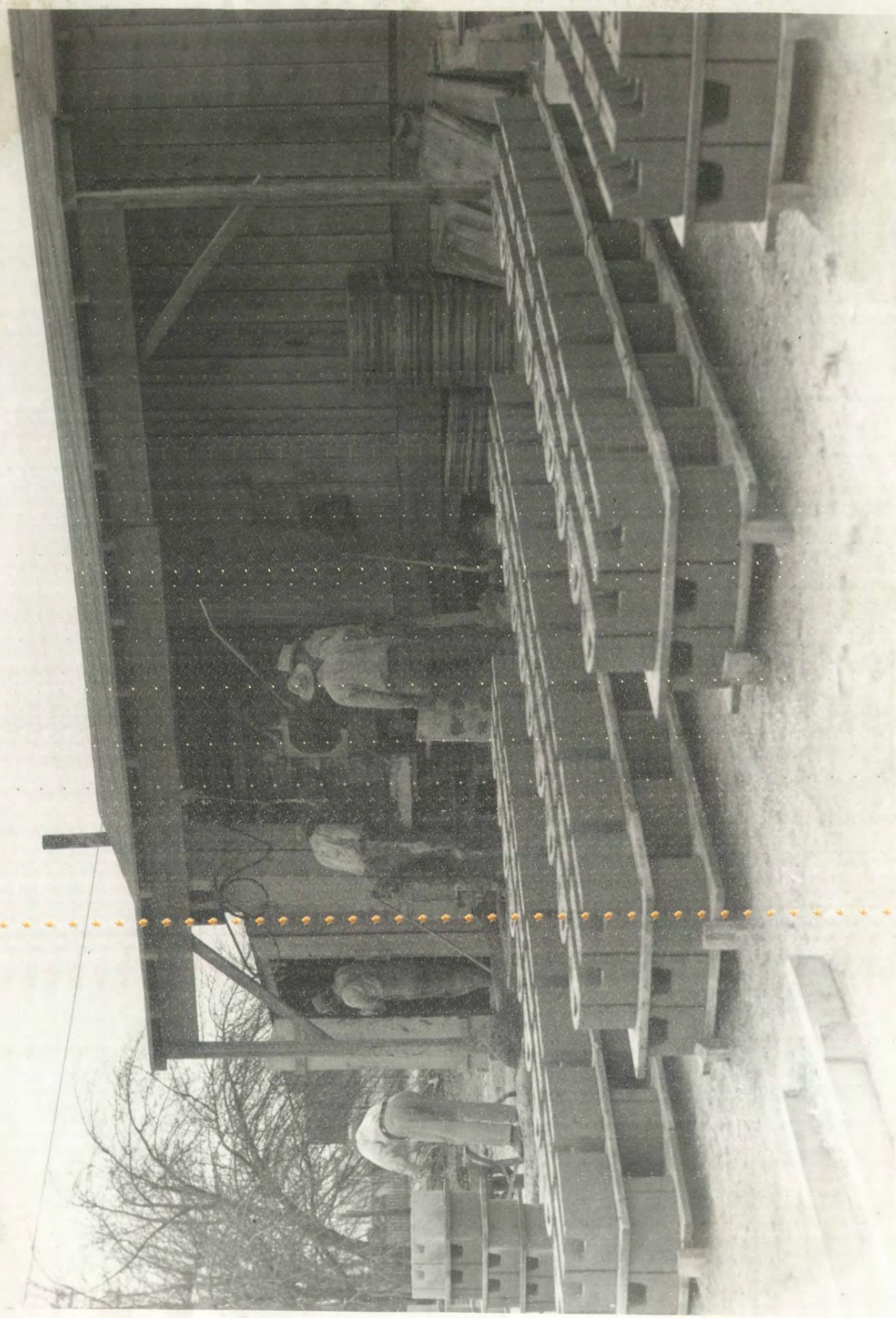


Fig. 5

Fig. 6

EZERASE BOND

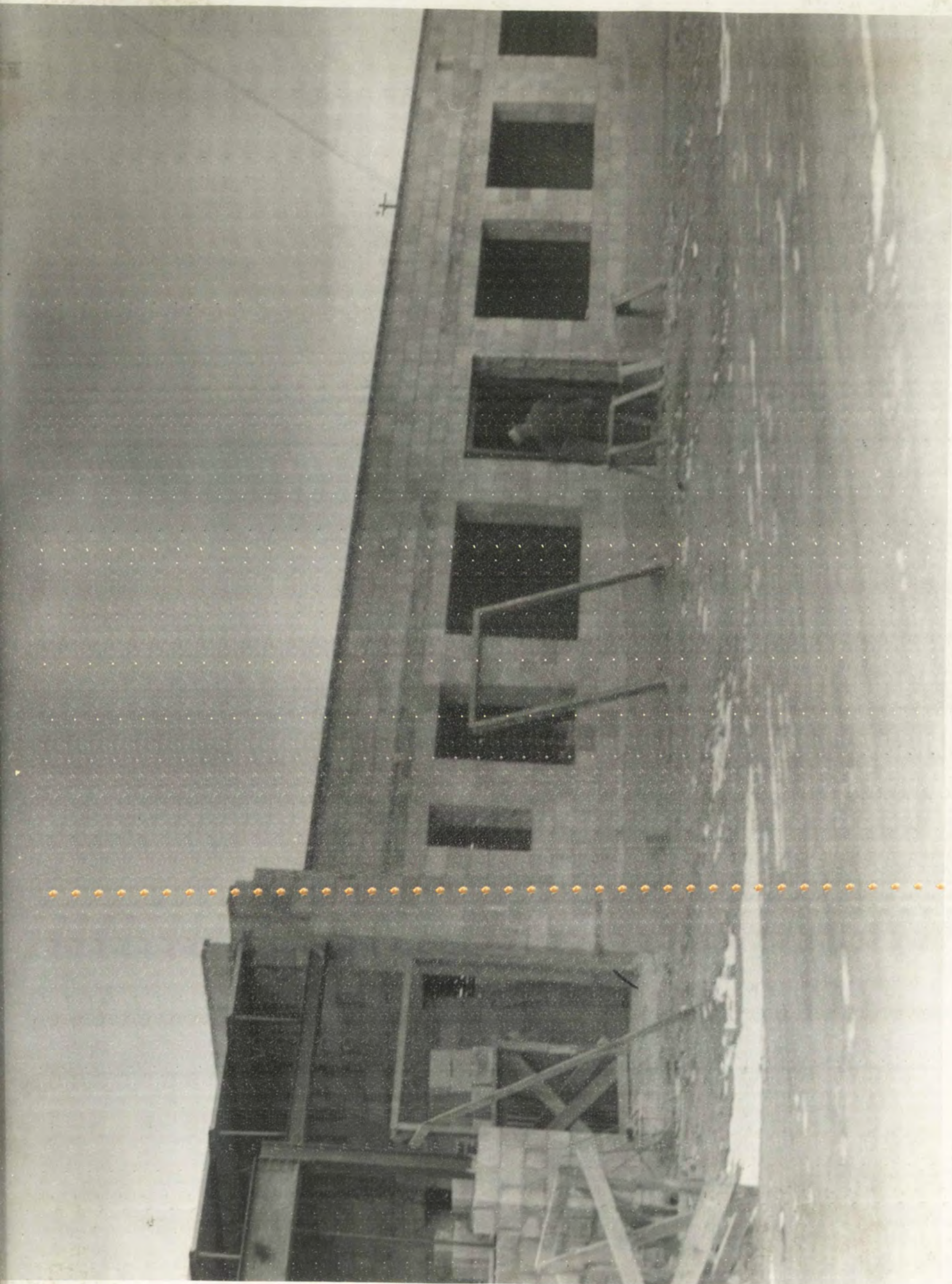


Fig. 7

CHAPTER VI

COLLECTION AND CURING OF SAMPLES

I. SAMPLING

At the time this research was begun there were about forty block plants in Albuquerque, New Mexico alone. Samples were obtained from most of these plants and from others throughout the state. Most of the owners of the plants were cooperative and willing to provide samples of their regular mixes.

The determination of the exact mixes used was the greatest problem encountered because, as previously explained, proportioning of the materials was not accurate in some cases. Several mixes were checked to see whether they were relatively consistent. The weight of each material going into the mix was obtained, and uniform samples of the materials were taken to the laboratory for further analysis. By knowing the weight of each material in the mix, and since by laboratory analysis the unit weights of the respective materials were found, it was possible to convert the mix used to a one-sack batch, by volume. By a one-sack batch by volume is meant the number of cubic feet of aggregate per sack of cement. The results of the mixes are shown on the data sheets (Figure

Eight) on this basis.

It was impossible to determine the amount of water used because the mixing water was poured in the mixer in every conceivable way. Some mixers had water gages but they were frequently inaccurate. In most cases the water was introduced into the mixer by buckets or garden hoses.

The blocks molded from the mixes that had been checked were marked so they could be picked up the next day. Seventeen blocks were taken from each mix and given a symbol for future identification. After the blocks were in the laboratory, a uniform block was selected from each group and measurements were taken. All other blocks in each respective group were assumed to have the same dimensions. This was not an exact method by any means, but time did not permit measuring every block, since over one-thousand blocks were tested in this work.

II. CURING

The blocks were tested for compressive strengths at the ages of three, seven, and twenty-eight days. In order to determine the effect of proper curing, six blocks from each group were placed in a moist room at seventy degrees Fahrenheit -- ideal curing conditions. The remaining eleven blocks

were stacked out-of-doors in order to duplicate the curing conditions at the plants. For the first few days the blocks were wet down, and then allowed to dry out. This work was carried out during the summer and early fall; therefore, there was no danger of the blocks freezing. If the danger of freezing had existed, provisions would have been made to keep the blocks warm until the cement had time to set up and develop the majority of its strength. Calcium Chloride was used as an admixture during the winter months because it helped to dry out the blocks, thereby reducing the danger of freezing.

were stocked out-of-doors in order to duplicate the curing conditions at the plants. For the first few days the blocks were wet down, and then allowed to dry out. This work was carried out during the summer and early fall; therefore, there was no danger of the blocks freezing. If the danger of freezing had existed, provisions could have been made to keep the blocks warm until the cement had time to set and to develop the majority of its strength. Calcium chloride was used as an admixture during the winter months because it helped to dry out the blocks, thereby reducing the danger of freezing.

CHAPTER VII

TESTING OF SAMPLES

I. COMPRESSIVE TEST

The American Society for Testing Materials compressive-strength specifications requires that the block withstand a pressure, in compression, of seven hundred pounds per square inch over the gross area, if the minimum face shell thickness is more than one and one-quarter inches. The face shell thickness, being less than this value and more than three-quarters of an inch, requires the block to withstand a pressure, in compression, of one thousand pounds per square inch. All the blocks tested in this work had a minimum face shell thickness of more than one and one-quarter inches.

Four blocks from each sample were broken in compression at the ages of three, seven, and twenty-eight days. Two of the four blocks were cured in the moist room, and the remaining two were cured in the open.

Before the blocks were broken they were weighed, and the two bearing surfaces capped with a thin paste of plaster of paris. The cap, or coating, of plaster of paris insured an even distribution of the compressive load introduced on the block. The blocks were crushed on a Riehle, two hundred

thousand pound hand-operated machine.

The unit compressive stress over the gross area was calculated from the load, P, indicated on the compression machine, and the gross area of the block. The following formula was used:

Unit Stress, p.s.i. = P/A

When P = total load

And A = gross area of block

The net area of each block was calculated from measurements taken of a uniform block from each group, and the unit stress over the net area was found from the same formula-- A in this case being the net area. The American Society for Testing Materials gives no specifications for the compressive strength over the net area.

Results of the compressive tests are recorded as average values on the data sheets (Figure Eight), and the average twenty-eight day stresses are tabulated in Tables V through XI.

II. TEST FOR ABSORPTION, MOISTURE CONTENT, NET VOLUME, AND UNIT WEIGHT

As soon as the blocks of a certain mix had met the compressive strength requirements, the tests for absorption,

thousand pound hand-operated machine.

The unit compressive stress over the gross area was calculated from the load, P, indicated on the compression machine, and the gross area of the block. The following formula was used:

Unit Stress, p.s.i. = P/A

When P = total load

And A = gross area of block

The net area of each block was calculated from measurements taken of a uniform block from each group, and the unit stress over the net area was found from the same formula—A in this case being the net area. The American Society for Testing Materials gives as specifications for the compressive strength over the net area.

Results of the compressive tests are presented as average values on the data sheets (Figure [illegible]), and the average twenty-eight day strengths are tabulated in Tables [illegible] and XI.

II. TEST FOR ABSORPTION, MOISTURE CONTENT, NET VOLUME, AND UNIT WEIGHT

As soon as the blocks of a certain mix had met the compressive strength requirements, the tests for absorption,

moisture content, net volume, and unit weight were performed. Although these are four different values, the testing procedure is the same for all four results and can be performed as one test. The results are obtained by the application of different formulae to the results.

The remaining five blocks of the seventeen were used for these tests. These blocks were cured in the open. The blocks were weighed (recorded as sampled weight) and then placed in an oven for drying. After the units had dried to a constant weight, they were weighed (recorded as dry weight) and then completely submerged in water for twenty-four hours. They were then removed one at a time, and weighed suspended while immersed in water (recorded as suspended weight immersed), allowed to drain for sixty seconds and weighed wet (recorded as wet weight). This gave four recorded weights: sampled weight, dry weight, suspended weight immersed, and wet weight. These values were averaged for the five blocks.

1. ABSORPTION

The absorption is the number of pounds of water absorbed by a cubic foot of concrete, and is calculated by the following formula:

(Wet Weight - Dry Weight) 62.4/Wet Weight - Suspended Weight Immersed

The American Society for Testing Materials standard specifications give the maximum water absorption as fifteen pounds per cubic foot of concrete for the average of five blocks. The average absorption of each sample is given on the data sheets (Figure Eight) and is tabulated in Table XII.

2. MOISTURE CONTENT

The moisture content, at the time the blocks met compressive-strength requirements, is expressed as a percentage of the total absorption. The following formula being used to calculate the per cent moisture in a unit:

(Sampled Weight - Dry Weight) x 100/(Wet Weight - Dry Weight) = per cent moisture

The American Society for Testing Materials specifications for maximum moisture content is forty per cent. This means that the block should contain not more than forty per cent moisture when used in construction. The average moisture content of each unit is given on the data sheets (Figure Eight) and is tabulated in Table XII.

3. NET VOLUME

The net volume is found from the formula from the American Society for Testing Materials Standards:

The American Society for Testing Materials Standard Speci-fications give the maximum water absorption as [illegible] pounds per cubic foot of concrete for the average of five blocks. The average absorption of each sample is given in the data sheets (Figure Eight) and is tabulated in Table [illegible].

2. MOISTURE CONTENT

The moisture content, at the time the blocks met compressive-strength requirements, is expressed as a percentage of the total absorption. The following formula is used to calculate the per cent moisture in a unit:

$$\frac{(\text{Sampled weight} - \text{Dry weight}) \times 100}{\text{Soaked weight} - \text{Dry weight}} = \text{per cent moisture}$$

The American Society for Testing Materials specifications for maximum moisture content is forty per cent. This means that the block should contain not more than forty per cent moisture of that absorbed in the absorption test. The average moisture content of each unit is given on the data sheets (Figure Eight) and is tabulated in Table [illegible].

3. NET VOLUME

The net volume is found from the formula from the American Society for Testing Materials Standards:

Dry Weight / Weight per Cubic Foot

These results are more or less a check on the calculation, for each mold should produce a block with a constant net volume unless the block has been excessively chipped, or undue slumping has occurred on some units because of excessive water. The average net volume of each sample has been recorded on the data sheets (Figure Eight) and has been tabulated in Table XIII.

4. UNIT WEIGHT

The unit weight of the blocks was found by using the following formula from the American Society for Testing Materials Standards:

(Dry Weight x 62.4)/(Wet Weight - Suspended Weight Immersed) = Unit Weight

No specifications for unit weight of lightweight concrete blocks is given by the American Society for Testing Materials, but these data were included because the writer had hoped to find a direct relationship between the unit weight and the compressive strength.

The unit weight of each sample is contained in Tables V through XI.

III. FREEZE-THAW TEST

Sections of blocks containing adobe, sand, and pumice and sections of blocks containing sand and pumice were subjected to alternate cycles of freezing and thawing. This test was performed in order to determine the deleterious effect of adobe, if any, but it was not used extensively because of the lack of suitable equipment.

The American Society for Testing Materials specifications require that the specimens be subjected to fifty-one cycles of alternate freezing and thawing unless they have lost three per cent of their original dry weight, or visual observation notes disintegration.

The recordings of the weights and losses in weight are shown in Table XIV.

IV. EXPLANATION OF FIGURE EIGHT

Figure eight contains a data sheet for each sample included in this discussion. The mix is given by volume per sack of cement and any admixtures used are shown. The average size of the unit, average gross area, average net area, average net volume, and a diagram are shown.

The average compressive stresses are shown for both

III. FREEZE-THAW TEST

Sections of blocks containing adobe, soil, and cement and sections of blocks containing sand and cement were subjected to alternate cycles of freezing and thawing. This test was performed in order to determine the deleterious effect of adobe, if any, but it was not used extensively, because of the lack of suitable equipment.

The American Society for Testing Materials specifications require that the specimens be subjected to fifty-[illegible] cycles of alternate freezing and thawing unless they have lost three per cent of their original dry weight, or visual observation notes disintegration.

The recordings of the weights and losses in weight are shown in Table XIV.

IV. EVALUATION OF TEST DATA

Figure eight contains a data sheet for each sample included in this discussion. The mix is given by volume per sack of cement and any admixtures used are shown. The average size of the unit, average gross area, average net area, average net volume, and a diagram are shown.

The average compressive stresses are shown for each

moist-cured and dry-cured samples at the age broken. The total average compressive load, P, and the average weight of the blocks are tabulated.

The screen analysis of both the sand and pumice used in the mix is tabulated and the average absorption and average moisture content of the blocks are shown.

SAMPLE NO. 1

MIX:

4.60 CU. FT. PUMICE PER SACK OF CEMENT

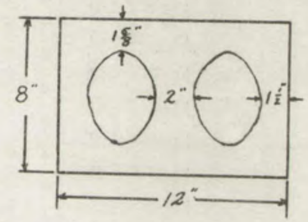
3.61 CU. FT. SAND PER SACK OF CEMENT

ADMIXTURES Pozzolith 14½ oz./sack cement

SIZE OF TILE 3½ x 8 x 12   GROSS AREA 96 sq. in.

NET AREA 70.7 sq. in.   NET VOLUME .1385 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	14.50	86,500	900	1,224	MOIST
3	12.75	77,500	807	1,095	DRY
7	14.15	111,500	1,156	1,570	MOIST
7	13.50	109,500	1,140	1,551	DRY
28	14.40	129,500	1,350	1,835	MOIST
28	13.15	123,000	1,281	1,740	DRY

AVERAGE MOISTURE CONTENT 52.60%   AVERAGE ABSORPTION 14.32#/cu.ft.

SCREEN ANALYSIS OF PUMICE

35.3% COURSE   64.7 % FINE

Sieve	% RETAINED
1"	0.00
3/4"	2.17
1/2"	7.70
3/8"	21.75
#4	92.50
#8	100.00

Sieve	% RETAINED
#4	0.0
#8	54.0
#16	86.0
#50	92.0
#100	92.5
PAN	100.0

SCREEN ANALYSIS OF SAND

Sieve	% RETAINED
#4	17.0
#8	30.0
#16	39.0
#50	84.0
#100	96.0
PAN	100.0

Fig. 8

SAMPLE NO. 2

MIX: 13.31 CU.FT. PUMICE PER SACK OF CEMENT

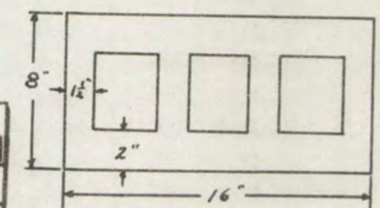
3.144 CU.FT. SAND PER SACK OF CEMENT

ADMIXTURES 1.83 cu.ft. of Adobe/ sack cement

SIZE OF TILE 8 x 8 x 16   GROSS AREA 128 sq. in.

NET AREA 82.75 sq. in.   NET VOLUME .3788 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	34.30	82,000	640	991	MOIST
3	33.30	34,500	270	414	DRY
7	35.25	104,500	816	1,263	MOIST
7	32.85	88,500	692	1,070	DRY
28	36.75	118,000	922	1,427	MOIST
28	30.85	105,500	825	1,277	DRY

AVERAGE MOISTURE CONTENT 49.34%   AVERAGE ABSORPTION 14.11 #/cu.ft.

SCREEN ANALYSIS OF PUMICE

16.12 % COURSE   83.88 % FINE

Sieve	% RETAINED	Sieve	% RETAINED
1"	0.00	#4	0.0
3/4"	3.34	#8	16.0
1/2"	13.35	#16	44.0
3/8"	40.00	#50	82.0
#4	100.00	#100	87.0
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

Sieve	% RETAINED
#4	2.0
#8	14.0
#16	23.0
#50	80.0
#100	95.0
PAN	100.0

Fig. 8

SAMPLE NO. 3

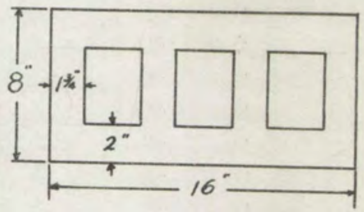
MIX:
6.0 CU. FT. PUMICE PER SACK OF CEMENT
2.5 CU. FT. SAND PER SACK OF CEMENT

ADMIXTURES

SIZE OF TILE 8 x 8 x 16 GROSS AREA 128 sq. in.

NET AREA 91.22 sq. in. NET VOLUME .377 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	36.05	73,000	570	800	MOIST
3	37.40	97,500	761	1,070	DRY
7	34.80	75,500	586	823	MOIST
7	37.40	132,500	1,035	1,451	DRY
28	37.75	126,500	984	1,382	MOIST
28	35.05	174,000	1,360	1,908	DRY

AVERAGE MOISTURE CONTENT 71.50%

AVERAGE ABSORPTION 15.04#/cu. ft.

SCREEN ANALYSIS OF PUMICE

30.4 % COURSE 69.6 % FINE

	% RETAINED
1"	0.00
3/4"	1.80
1/2"	7.25
3/8"	23.80
#4	100.00
#8	100.00

	% RETAINED
#4	0.0
#8	34.0
#16	74.0
#50	98.0
#100	99.0
PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	2.0
#8	14.0
#16	23.0
#50	80.0
#100	95.0
PAN	100.0

Fig. 8

SAMPLE NO. 4

MIX: 6.50 CU.FT. PUMICE PER SACK OF CEMENT

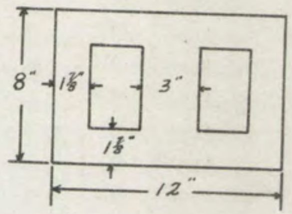
1.62 CU.FT. SAND PER SACK OF CEMENT

ADMIXTURES Adobe .8 cu. ft./sack cement

SIZE OF TILE 5 x 8 x 12 GROSS AREA 96 sq. in.

NET AREA 72.84 sq. in. NET VOLUME .1976 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	19.00	63,500	662	873	MOIST
3	18.25	69,000	719	948	DRY
7	20.15	85,000	886	1,170	MOIST
7	17.35	80,000	834	1,100	DRY
28	20.45	114,500	1,192	1,573	MOIST
28	17.00	112,000	1,168	1,540	DRY

AVERAGE MOISTURE CONTENT 49.0%

AVERAGE ABSORPTION 13.75#/cu. ft.

SCREEN ANALYSIS OF PUMICE

28.7 % COURSE 71.3 % FINE

	% RETAINED		% RETAINED
1"	0.00	#4	0.0
3/4"	3.45	#8	21.0
1/2"	13.80	#16	48.0
3/8"	32.80	#50	82.0
#4	100.00	#100	87.0
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	2.0
#8	15.0
#16	22.0
#50	78.0
#100	94.0
PAN	100.0

Fig. 8

SAMPLE NO. 5

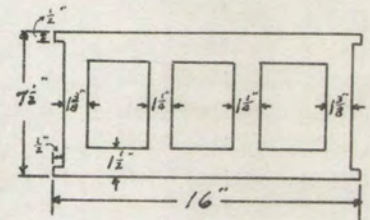
MIX:
4.85 CU.FT. PUMICE PER SACK OF CEMENT
1.41 CU.FT. SAND PER SACK OF CEMENT

ADMIXTURES ______

SIZE OF TILE 8 x 7½ x 16 GROSS AREA 120 sq. in.

NET AREA 70.84 sq. in. NET VOLUME .338 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	28.50	50,000	416	580	MOIST
3	27.35	61,000	508	850	DRY
7	30.10	53,500	446	755	MOIST
7	26.05	66,000	550	932	DRY
28	30.80	75,500	629	1,067	MOIST
28	25.20	73,000	609	1,031	DRY

AVERAGE MOISTURE CONTENT 17.9% AVERAGE ABSORPTION 14.6#/cu. ft.

SCREEN ANALYSIS OF PUMICE

32.6 % COURSE 67.4 % FINE

% RETAINED

1"	0.00
3/4"	1.77
1/2"	8.87
3/8"	31.85
#4	100.00
#8	100.00

#4	0.0
#8	28.0
#16	56.0
#50	86.0
#100	90.0
PAN	100.0

SCREEN ANALYSIS OF SAND

% RETAINED

#4	2.0
#8	9.0
#16	18.0
#50	76.0
#100	94.0
PAN	100.0

Fig. 8

SAMPLE NO. 6

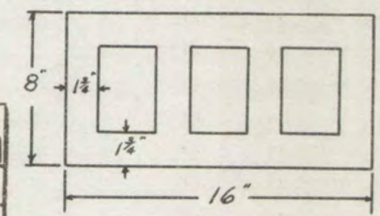
MIX: 5.33 CU.FT. PUMICE PER SACK OF CEMENT   ADMIXTURES Adobe .614 cu. ft./sack cement

2.36 CU.FT. SAND PER SACK OF CEMENT

SIZE OF TILE 5 x 8 x 16   GROSS AREA 128 sq. in.

NET AREA 88.4 sq. in.   NET VOLUME .270 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	26.95	82,500	645	934	MOIST
3	23.75	76,500	597	865	DRY
7	26.75	100,500	785	1,138	MOIST
7	23.50	91,500	712	1,035	DRY
28	26.50	136,500	1,066	1,545	MOIST
28	23.35	143,000	1,114	1,619	DRY

AVERAGE MOISTURE CONTENT 52.68%   AVERAGE ABSORPTION 14.22#/cu. ft.

SCREEN ANALYSIS OF PUMICE

16.2 % COURSE   83.8 % FINE

	% RETAINED		
1"	0.00	#4	0.0
3/4"	3.30	#8	16.0
1/2"	13.40	#16	44.0
3/8"	40.00	#50	82.0
#4	100.00	#100	87.0
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	12.0
#8	14.0
#16	26.0
#50	83.0
#100	97.0
PAN	100.0

Fig. 8

SAMPLE NO. 7

MIX:

5.33 CU. FT. PUMICE PER SACK OF CEMENT

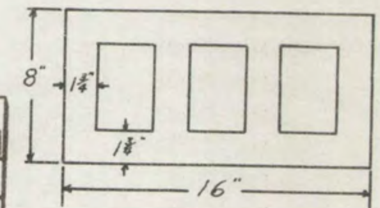
2.36 CU. FT. SAND PER SACK OF CEMENT

ADMIXTURES Adobe .7675 cu. ft./sack cement

SIZE OF TILE 5 x 8 x 16 GROSS AREA 128 sq. in.

NET AREA 88.4 sq. in. NET VOLUME .270 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	27.85	95,000	742	1,035	MOIST
3	23.80	81,500	652	923	DRY
7	27.95	123,000	960	1,392	MOIST
7	24.00	102,000	778	1,153	DRY
28	27.90	152,000	1,191	1,720	MOIST
28	24.65	158,500	1,239	1,792	DRY

AVERAGE MOISTURE CONTENT 49.0%

AVERAGE ABSORPTION 14.88#/cu. ft.

SCREEN ANALYSIS OF PUMICE

16.2% COURSE 83.8 % FINE

% RETAINED

1"	0.00
3/4"	3.30
1/2"	13.40
3/8"	40.00
# 4	100.00
# 8	100.00

# 4	0.0
# 8	16.0
# 16	44.0
# 50	82.0
# 100	87.0
PAN	100.0

SCREEN ANALYSIS OF SAND

% RETAINED

# 4	12.0
# 8	14.0
# 16	26.0
# 50	83.0
# 100	97.0
PAN	100.0

Fig. 8

SAMPLE NO. 8

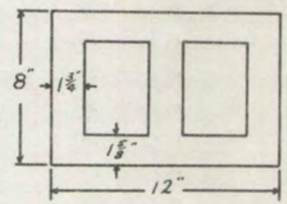
MIX: 5.33 CU.FT. PUMICE PER SACK OF CEMENT — ADMIXTURES Adobe .7675 cu. ft./sack cement

2.36 CU.FT. SAND PER SACK OF CEMENT

SIZE OF TILE 5 x 8 x 12 — GROSS AREA 96 sq. in.

NET AREA 66.65 sq. in. — NET VOLUME .193 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	19.10	74,000	770	1,110	MOIST
3	17.80	77,500	807	1,161	DRY
7	20.00	97,500	1,015	1,462	MOIST
7	17.60	95,000	990	1,424	DRY
28	20.30	136,500	1,422	2,025	MOIST
28	17.40	110,000	1,145	1,650	DRY

AVERAGE MOISTURE CONTENT 40.94% — AVERAGE ABSORPTION 14.3#/cu. ft.

SCREEN ANALYSIS OF PUMICE

16.2 % COURSE — 83.8 % FINE

Screen	% RETAINED
1"	0.00
3/4"	3.30
1/2"	13.40
3/8"	40.00
#4	100.00
#8	100.00

Screen	% RETAINED
#4	0.0
#8	16.0
#16	44.0
#50	82.0
#100	87.0
PAN	100.0

SCREEN ANALYSIS OF SAND

Screen	% RETAINED
#4	12.0
#8	14.0
#16	26.0
#50	83.0
#100	97.0
PAN	100.0

Fig. 8

SAMPLE NO. 9

MIX: 6.55 CU.FT. PUMICE PER SACK OF CEMENT

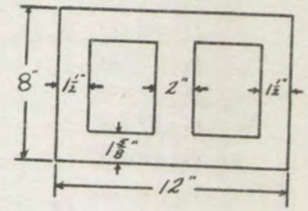
2.54 CU.FT. SAND PER SACK OF CEMENT

ADMIXTURES Adobe .4 cu. ft./sack cement

SIZE OF TILE 6 x 8 x 12 GROSS AREA 96 sq. in.

NET AREA 63.45 sq. in. NET VOLUME .214 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	21.75	42,000	439	662	MOIST
3	20.25	51,000	632	717	DRY
7	22.10	69,500	724	1,047	MOIST
7	19.50	63,500	662	956	DRY
28	22.45	95,500	1,042	1,571	MOIST
28	19.30	67,500	703	1,059	DRY

AVERAGE MOISTURE CONTENT 33.9%

AVERAGE ABSORPTION 14.32#/cu. ft.

SCREEN ANALYSIS OF PUMICE

16.2 % COURSE

	% RETAINED
1"	0.00
3/4"	3.30
1/2"	13.40
3/8"	40.00
#4	100.00
#8	100.00

83.8 % FINE

	% RETAINED
#4	0.0
#8	16.0
#16	44.0
#50	82.0
#100	87.0
PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	2.0
#16	8.0
#50	72.0
#100	91.0
PAN	100.0

Fig. 8

SAMPLE NO. 10

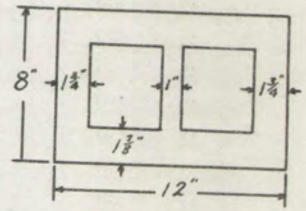
MIX: 4.84 CU. FT. PUMICE PER SACK OF CEMENT — ADMIXTURES Adobe .415 cu. ft./sack cement

1.65 CU. FT. SAND PER SACK OF CEMENT

SIZE OF TILE 5 x 8 x 12 — GROSS AREA 96 sq. in.

NET AREA 64.14 sq. in. — NET VOLUME .189 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	20.40	90,500	945	1,411	MOIST
3	18.20	90,500	945	1,411	DRY
7	20.60	107,000	1,114	1,669	MOIST
7	18.25	106,500	1,109	1,660	DRY
28	20.60	139,500	1,453	2,177	MOIST
28	17.60	140,000	1,458	2,182	DRY

AVERAGE MOISTURE CONTENT 63.6% — AVERAGE ABSORPTION 14.43#/cu. ft.

SCREEN ANALYSIS OF PUMICE

20.5 % COURSE — 79.5 % FINE

Sieve	% RETAINED
1"	0.00
3/4"	0.00
1/2"	2.70
3/8"	24.05
#4	94.60
#8	100.00

Sieve	% RETAINED
#4	0.5
#8	34.0
#16	64.0
#50	88.0
#100	90.0
PAN	100.0

SCREEN ANALYSIS OF SAND

Sieve	% RETAINED
#4	1.0
#8	2.0
#16	10.0
#50	64.0
#100	92.0
PAN	100.0

Fig. 8

SAMPLE NO. 11

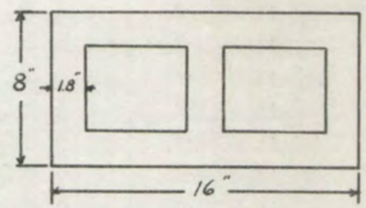
MIX: 5.95 CU. FT. PUMICE PER SACK OF CEMENT ADMIXTURES Adobe .751 cu. ft./sack cement

1.06 CU. FT. SAND PER SACK OF CEMENT

SIZE OF TILE 6 x 8 x 16 GROSS AREA 128 sq. in.

NET AREA 81.78 sq. in. NET VOLUME .270 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	25.30	132,500	1,035	1,620	MOIST
3	24.70	130,000	1,015	1,590	DRY
7	24.50	135,000	1,063	1,651	MOIST
7	22.50	139,500	1,085	1,700	DRY
28	25.80	179,500	1,401	2,098	MOIST
28	23.85	188,000	1,469	2,300	DRY

AVERAGE MOISTURE CONTENT 43.63% AVERAGE ABSORPTION 13.02#/Cu. ft.

SCREEN ANALYSIS OF PUMICE

31.6 % COURSE 68.4 % FINE

% RETAINED

1"	0.00	#4	1.0
3/4"	0.00	#8	44.0
1/2"	0.55	#16	79.0
3/8"	25.00	#50	93.0
#4	98.60	#100	94.0
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

% RETAINED

#4	0.0
#8	4.0
#16	11.0
#50	74.0
#100	92.0
PAN	100.0

Fig. 8

SAMPLE NO. 12

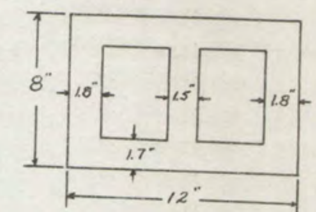
MIX:
5.95 CU.FT. PUMICE PER SACK OF CEMENT
1.06 CU.FT. SAND PER SACK OF CEMENT

ADMIXTURES Adobe .751 cu. ft./sack cement

SIZE OF TILE 5 x 8 x 12 GROSS AREA 96 sq. in.

NET AREA 61.73 sq. in. NET VOLUME .172 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	16.35	107,000	1,119	1,733	MOIST
3	14.55	82,500	860	1,337	DRY
7	15.85	107,500	1,120	1,741	MOIST
7	14.45	120,000	1,250	1,944	DRY
28	16.25	139,000	1,433	2,250	MOIST
28	14.20	125,500	1,308	2,034	DRY

AVERAGE MOISTURE CONTENT 37.6%

AVERAGE ABSORPTION 12.65#/cu. ft.

SCREEN ANALYSIS OF PUMICE

31.6 % COURSE 68.4% FINE

% RETAINED

1"	0.00
3/4"	0.00
1/2"	0.55
3/8"	25.00
#4	98.60
#8	100.00

#4	1.0
#8	44.0
#16	79.0
#50	93.0
#100	94.0
PAN	100.0

SCREEN ANALYSIS OF SAND

% RETAINED

#4	0.0
#8	4.0
#16	11.0
#50	74.0
#100	92.0
PAN	100.0

Fig. 8

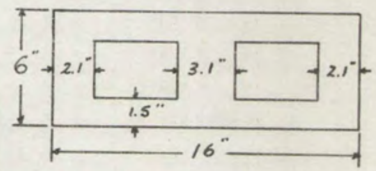
SAMPLE NO. 13

MIX:
5.95 CU.FT. PUMICE PER SACK OF CEMENT — ADMIXTURES Adobe .751 cu. ft./sack cement
1.06 CU.FT. SAND PER SACK OF CEMENT

SIZE OF TILE 6 x 6 x 16 — GROSS AREA 96 sq. in.

NET AREA 72.05 sq. in. — NET VOLUME .244 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	20.95	99,000	1,030	1,373	MOIST
3	21.10	114,500	1,194	1,589	DRY
7	21.30	137,000	1,429	1,900	MOIST
7	20.50	147,000	1,531	2,020	DRY
28	21.75	162,500	1,694	2,255	MOIST
28	20.00	173,500	1,806	2,405	DRY

AVERAGE MOISTURE CONTENT 56.55% — AVERAGE ABSORPTION 14.25#/cu. ft.

SCREEN ANALYSIS OF PUMICE

31.6 % COURSE — 68.4 % FINE

	% RETAINED
1"	0.00
3/4"	0.00
1/2"	0.55
3/8"	25.00
#4	98.60
#8	100.00

#4	1.0
#8	44.0
#16	79.0
#50	93.0
#100	94.0
PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	4.0
#16	11.0
#50	74.0
#100	92.0
PAN	100.0

Fig. 8

SAMPLE NO. 14

MIX: 5.38 CU. FT. PUMICE PER SACK OF CEMENT

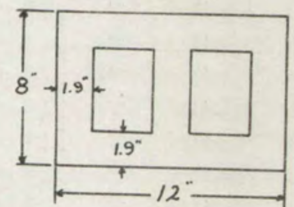
2.64 CU. FT. SAND PER SACK OF CEMENT

ADMIXTURES ______

SIZE OF TILE 4½ x 8 x 12 GROSS AREA 96 sq. in.

NET AREA 69.15 sq. in. NET VOLUME .166 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	18.65	75,000	781	1,083	MOIST
3	15.85	69,500	724	1,003	DRY
7	18.05	91,500	953	1,323	MOIST
7	15.70	101,500	1,057	1,467	DRY
28	18.05	124,500	1,297	1,800	MOIST
28	15.30	118,500	1,234	1,711	DRY

AVERAGE MOISTURE CONTENT 22.0%

AVERAGE ABSORPTION 15.31#/cu. ft.

SCREEN ANALYSIS OF PUMICE

37.0 % COURSE 63.0 % FINE

	% RETAINED
1"	0.00
3/4"	4.60
1/2"	12.40
3/8"	30.80
#4	92.30
#8	100.00

#4	0.0
#8	24.0
#16	66.0
#50	88.0
#100	92.0
PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	2.0
#16	12.0
#50	68.0
#100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 15

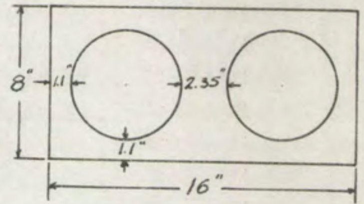
MIX: 11.00 CU.FT. PUMICE PER SACK OF CEMENT — ADMIXTURES Brick cement .474 cu. ft./ sack cement

5.84 CU.FT. SAND PER SACK OF CEMENT

SIZE OF TILE 6 x 8 x 16 GROSS AREA 128 sq. in.

NET AREA 75.1 sq. in. NET VOLUME .276 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	28.35	61,000	476	812	MOIST
3	26.10	65,000	508	865	DRY
7	29.30	86,000	672	1,145	MOIST
7	24.55	82,000	640	1,091	DRY
28	29.40	124,000	968	1,651	MOIST
28	24.40	104,000	812	1,383	DRY

AVERAGE MOISTURE CONTENT 21.6% AVERAGE ABSORPTION 13.7#/cu. ft.

SCREEN ANALYSIS OF PUMICE

27.3 % COURSE 72.7% FINE

% RETAINED

1"	0.00
3/4"	0.00
1/2"	2.70
3/8"	24.05
#4	94.60
#8	100.00

#4	0.5
#8	34.0
#16	64.0
#50	88.0
#100	90.0
PAN	100.0

SCREEN ANALYSIS OF SAND

% RETAINED

#4	0.0
#8	2.0
#16	7.0
#50	63.0
#100	89.0
PAN	100.0

Fig. 8

SAMPLE NO. 16

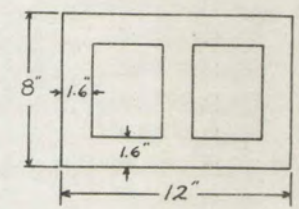
MIX: 5.84 CU.FT. PUMICE PER SACK OF CEMENT — ADMIXTURES Adobe .734 cu. ft./sack

1.99 CU.FT. SAND PER SACK OF CEMENT — cement

SIZE OF TILE 5 x 8 x 12 GROSS AREA 96 sq. in.

NET AREA 55.7 sq. in. NET VOLUME .1835 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	19.05	75,500	787	1,355	MOIST
3	17.25	75,000	781	1,346	DRY
7	19.20	90,500	942	1,624	MOIST
7	16.65	80,500	839	1,445	DRY
28	19.70	99,500	1,036	1,788	MOIST
28	16.30	98,500	1,034	1,768	DRY

AVERAGE MOISTURE CONTENT 33.07% AVERAGE ABSORPTION 13.19#/cu. ft.

SCREEN ANALYSIS OF PUMICE

37.0 % COURSE 63.0 % FINE

	% RETAINED
1"	0.00
3/4"	4.60
1/2"	12.40
3/8"	30.80
#4	92.30
#8	100.00

#4	0.0
#8	24.0
#16	66.0
#50	88.0
#100	92.0
PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	16.0
#8	24.0
#16	30.0
#50	78.0
#100	95.0
PAN	100.0

Fig. 8

SAMPLE NO. 17

MIX: 7.86 CU. FT. PUMICE PER SACK OF CEMENT

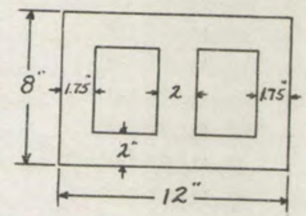
2.62 CU. FT. SAND PER SACK OF CEMENT

ADMIXTURES ______

SIZE OF TILE $5\frac{1}{2}$ x 8 x 12 GROSS AREA 96 sq. in.

NET AREA 70.0 sq. in. NET VOLUME .213 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	20.05	45,000	464	643	MOIST
3	20.25	46,500	488	665	DRY
7	21.55	68,000	713	972	MOIST
7	19.20	85,000	885	1,213	DRY
28	20.90	83,500	870	1,192	MOIST
28	17.15	90,500	943	1,292	DRY

AVERAGE MOISTURE CONTENT 46.56%

AVERAGE ABSORPTION 15.27#/cu. ft.

SCREEN ANALYSIS OF PUMICE

35.3% COURSE 64.7 % FINE

	% RETAINED
1"	0.00
3/4"	2.17
1/2"	7.70
3/8"	21.75
#4	92.50
#8	100.00

	% RETAINED
#4	0.0
#8	54.0
#16	86.0
#50	92.0
#100	92.5
PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 18

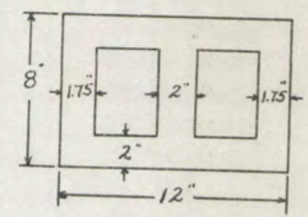
MIX: 9.0 CU.FT. PUMICE PER SACK OF CEMENT ADMIXTURES Pozzolith .9#/sack cement

3.0 CU.FT. SAND PER SACK OF CEMENT

SIZE OF TILE $5\frac{1}{2}$ x 8 x 12 GROSS AREA 96 sq. in.

NET AREA 70.0 sq. in. NET VOLUME .2175 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	20.25	56,000	583	800	MOIST
3	18.55	53,000	552	758	DRY
7	21.00	70,500	734	1,007	MOIST
7	17.10	79,000	823	1,129	DRY
28	21.10	99,000	1,031	1,416	MOIST
28	17.00	93,000	968	1,329	DRY

AVERAGE MOISTURE CONTENT 29.8% AVERAGE ABSORPTION 14.7#/cu. ft.

SCREEN ANALYSIS OF PUMICE

35.3 % COURSE 64.7 % FINE

% RETAINED

1"	0.00
3/4"	2.17
1/2"	7.70
3/8"	21.75
#4	92.50
#8	100.00

#4	0.0
#8	54.0
#16	86.0
#50	92.0
#100	92.5
PAN	100.0

SCREEN ANALYSIS OF SAND

% RETAINED

#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 19

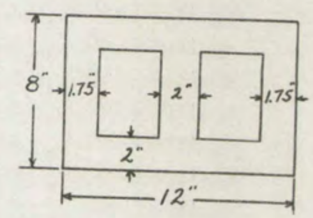
MIX: 12.10 CU.FT. PUMICE PER SACK OF CEMENT — ADMIXTURES Pozzolith .872#/sack cement

2.68 CU.FT. SAND PER SACK OF CEMENT

SIZE OF TILE $5\frac{1}{2}$ x 8 x 12 — GROSS AREA 96 sq. in.

NET AREA 70.0 sq. in. — NET VOLUME .2145 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	21.10	40,000	417	571	MOIST
3	18.55	39,500	411	564	DRY
7	20.00	50,000	520	715	MOIST
7	17.15	54,500	562	779	DRY
28	21.55	71,500	745	1,020	MOIST
28	16.55	69,000	719	986	DRY

AVERAGE MOISTURE CONTENT 23.4% — AVERAGE ABSORPTION 17.8#/cu. ft.

SCREEN ANALYSIS OF PUMICE

35.3 % COURSE — 64.7 % FINE

Course	% RETAINED
1"	0.00
3/4"	2.17
1/2"	7.70
3/8"	21.75
#4	92.50
#8	100.00

Fine	% RETAINED
#4	0.0
#8	54.0
#16	86.0
#50	92.0
#100	92.5
PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 20

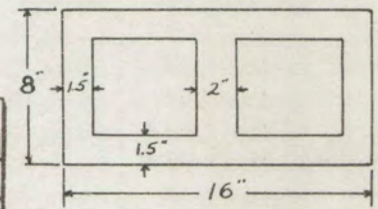
MIX:
10.00 CU.FT. PUMICE PER SACK OF CEMENT
3.33 CU.FT. SAND PER SACK OF CEMENT

ADMIXTURES ______

SIZE OF TILE 8 x 8 x 16 GROSS AREA 128 sq. in.

NET AREA 73.0 sq. in. NET VOLUME .312 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	24.30	62,000	484	849	MOIST
3	22.50	51,500	401	705	DRY
7	26.50	77,000	607	1,055	MOIST
7	23.65	70,500	550	966	DRY
28	26.15	84,000	656	1,150	MOIST
28	22.40	98,000	765	1,342	DRY

AVERAGE MOISTURE CONTENT 17.4%

AVERAGE ABSORPTION 14.2#/cu. ft.

SCREEN ANALYSIS OF PUMICE

35.3 % COURSE 64.7 % FINE

	% RETAINED
1"	0.00
3/4"	2.17
1/2"	7.70
3/8"	21.75
#4	92.50
#8	100.00

#4	0.0
#8	54.0
#16	86.0
#50	92.0
#100	92.5
PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 21

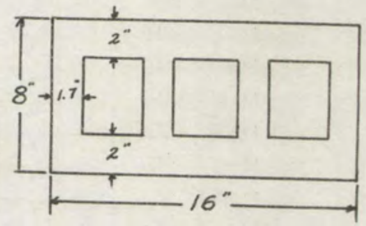
MIX: 4.960 CU.FT. PUMICE PER SACK OF CEMENT
1.965 CU.FT. SAND PER SACK OF CEMENT

ADMIXTURES ____

SIZE OF TILE 8 x 8 x 16 GROSS AREA 128 sq. in.

NET AREA 91.20 sq. in. NET VOLUME .3802 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	38.55	94,000	695	1,030	MOIST
3	35.50	88,500	672	970	DRY
7	37.75	117,000	913	1,282	MOIST
7	33.30	115,000	898	1,260	DRY
28	37.35	155,000	1,210	1,699	MOIST
28	33.20	150,500	1,174	1,650	DRY

AVERAGE MOISTURE CONTENT 26.8% AVERAGE ABSORPTION 14.6#/cu. ft.

SCREEN ANALYSIS OF PUMICE

30.4 % COURSE 69.6 % FINE

	% RETAINED		% RETAINED
1"	0.00	#4	0.0
3/4"	1.80	#8	34.0
1/2"	7.25	#16	74.0
3/8"	23.80	#50	98.0
#4	100.00	#100	99.0
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	3.0
#8	8.0
#16	15.0
#50	64.0
#100	93.0
PAN	100.0

Fig. 8

SAMPLE NO. 22

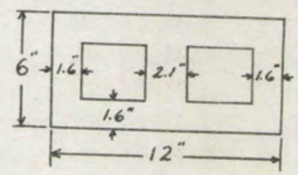
MIX: 7.30 CU.FT. PUMICE PER SACK OF CEMENT — ADMIXTURES Pozzolith .9#/sack cement

1.04 CU.FT. SAND PER SACK OF CEMENT

SIZE OF TILE 3½ x 6 x 12 — GROSS AREA 72 sq. in.

NET AREA 53.24 sq. in. — NET VOLUME .100 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	10.60	51,000	707	958	MOIST
3	9.75	43,500	675	817	DRY
7	10.80	67,000	931	1,259	MOIST
7	9.10	70,500	980	1,323	DRY
28	10.70	86,000	1,195	1,617	MOIST
28	8.75	79,000	1,097	1,483	DRY

AVERAGE MOISTURE CONTENT 32.15% — AVERAGE ABSORPTION 13.6#/cu. ft.

SCREEN ANALYSIS OF PUMICE

31.3 % COURSE — 68.7 % FINE

% RETAINED

Course	% Retained
1"	0.00
3/4"	0.00
1/2"	6.55
3/8"	21.30
#4	91.75
#8	100.00

Fine	% Retained
#4	0.0
#8	34.0
#16	68.0
#50	92.0
#100	95.0
PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 23

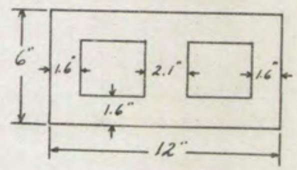
MIX: 10.94 CU.FT. PUMICE PER SACK OF CEMENT — ADMIXTURES Pozzolith .9#/sack cement

3.13 CU.FT. SAND PER SACK OF CEMENT

SIZE OF TILE $3\frac{1}{2}$ x 6 x 12 — GROSS AREA 72 sq. in.

NET AREA 53.24 sq. in. — NET VOLUME .100 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	9.95	26,500	369	498	MOIST
3	9.30	30,500	424	573	DRY
7	9.90	33,500	465	630	MOIST
7	8.25	38,500	535	723	DRY
28	9.90	61,000	848	1,147	MOIST
28	8.45	46,500	645	873	DRY

AVERAGE MOISTURE CONTENT 19.2%

AVERAGE ABSORPTION 14.6#/cu. ft.

SCREEN ANALYSIS OF PUMICE

31.3 % COURSE — 68.7 % FINE

	% RETAINED
1"	0.00
3/4"	0.00
1/2"	6.55
3/8"	21.30
#4	91.75
#8	100.00

#4	0.0
#8	34.0
#16	68.0
#50	92.0
#100	95.0
PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 24

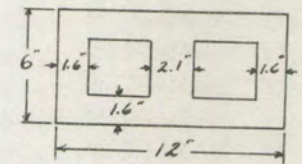
MIX: 8.53 CU.FT. PUMICE PER SACK OF CEMENT ADMIXTURES

3.13 CU.FT. SAND PER SACK OF CEMENT

SIZE OF TILE $3\frac{1}{2}$ x 6 x 12 GROSS AREA 72 sq. in.

NET AREA 53.24 sq. in. NET VOLUME .100 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	10.55	31,500	438	592	MOIST
3	10.10	35,000	485	658	DRY
7	10.55	43,500	603	817	MOIST
7	9.40	48,500	673	911	DRY
28	10.80	72,500	1,008	1,361	MOIST
28	8.65	70,500	972	1,323	DRY

AVERAGE MOISTURE CONTENT 26.6%

AVERAGE ABSORPTION 15.2#/cu. ft.

SCREEN ANALYSIS OF PUMICE

31.3 % COURSE 68.7 % FINE

	% RETAINED
1"	0.00
3/4"	0.00
1/2"	6.55
3/8"	21.30
#4	91.75
#8	100.00

#4	0.0
#8	34.0
#16	68.0
#50	92.0
#100	95.0
PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 25

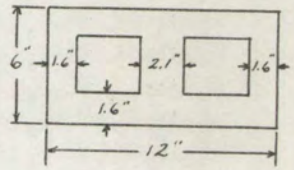
MIX:
8.53 CU. FT. PUMICE PER SACK OF CEMENT
3.13 CU. FT. SAND PER SACK OF CEMENT

ADMIXTURES ____

SIZE OF TILE $3\frac{1}{2}$ x 6 x 12 GROSS AREA 72 sq. in.

NET AREA 53.24 sq. in. NET VOLUME .100 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	10.30	35,500	492	667	MOIST
3	9.45	35,000	485	657	DRY
7	10.20	53,500	744	1,005	MOIST
7	8.40	41,500	575	780	DRY
28	10.35	79,500	1,104	1,492	MOIST
28	8.60	65,500	910	1,230	DRY

AVERAGE MOISTURE CONTENT 19.0% AVERAGE ABSORPTION 14.0#/cu. ft.

SCREEN ANALYSIS OF PUMICE

31.3 % COURSE 68.7 % FINE

	% RETAINED		
1"	0.00	# 4	0.0
3/4"	0.00	# 8	34.0
1/2"	6.55	# 16	68.0
3/8"	21.30	# 50	92.0
# 4	91.75	# 100	95.0
# 8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
# 4	0.0
# 8	3.0
# 16	9.0
# 50	63.0
# 100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 26

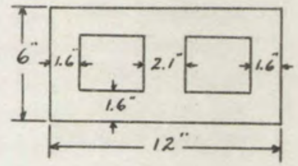
MIX:
8.53 CU. FT. PUMICE PER SACK OF CEMENT
3.13 CU. FT. SAND PER SACK OF CEMENT

ADMIXTURES Pozzolith .9#/sack cement

SIZE OF TILE $3\frac{1}{2}$ x 6 x 12 GROSS AREA 72 sq. in.

NET AREA 53.24 sq. in. NET VOLUME .100 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	11.50	47,000	652	884	MOIST
3	10.65	45,500	632	855	DRY
7	11.35	59,500	827	1,118	MOIST
7	10.00	63,000	874	1,183	DRY
28	11.40	109,000	1,515	2,047	MOIST
28	9.65	93,000	1,290	1,748	DRY

AVERAGE MOISTURE CONTENT 33.4%

AVERAGE ABSORPTION 14.6#/cu. ft.

SCREEN ANALYSIS OF PUMICE

31.3 % COURSE 68.7 % FINE

% RETAINED

1"	0.00	#4	0.0
3/4"	0.00	#8	34.0
1/2"	6.55	#16	68.0
3/8"	21.30	#50	92.0
#4	91.75	#100	95.0
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

% RETAINED

#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 27

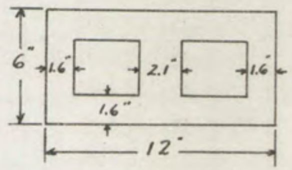
MIX:
10.94 CU.FT. PUMICE PER SACK OF CEMENT
3.13 CU.FT. SAND PER SACK OF CEMENT

ADMIXTURES ____

SIZE OF TILE $3\frac{1}{2}$ x 6 x 12 GROSS AREA 72 sq. in.

NET AREA 53.24 sq. in. NET VOLUME .098 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	10.35	25,000	348	470	MOIST
3	9.50	24,500	341	460	DRY
7	10.15	30,500	423	573	MOIST
7	8.70	34,500	477	648	DRY
28	10.40	57,000	791	1,070	MOIST
28	8.30	39,500	549	742	DRY

AVERAGE MOISTURE CONTENT 16.2%

AVERAGE ABSORPTION 16.9#/cu.ft.

SCREEN ANALYSIS OF PUMICE

31.3 % COURSE 68.7 % FINE

	% RETAINED		% RETAINED
1"	0.00	#4	0.0
3/4"	0.00	#8	34.0
1/2"	6.55	#16	68.0
3/8"	21.30	#50	92.0
#4	91.75	#100	95.0
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 28

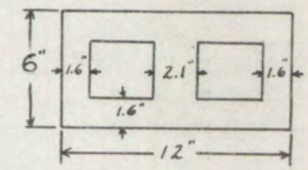
MIX:
10.94 CU.FT. PUMICE PER SACK OF CEMENT
3.13 CU.FT. SAND PER SACK OF CEMENT

ADMIXTURES ______

SIZE OF TILE 3½ x 6 x 12 GROSS AREA 72 sq. in.

NET AREA 53.24 sq. in. NET VOLUME .100 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	9.90	30,500	414	573	MOIST
3	9.20	35,500	492	666	DRY
7	9.80	37,000	513	695	MOIST
7	8.60	39,000	541	733	DRY
28	10.30	59,000	820	1,109	MOIST
28	8.20	41,000	570	770	DRY

AVERAGE MOISTURE CONTENT 14.8% AVERAGE ABSORPTION 15.7#/cu.ft.

SCREEN ANALYSIS OF PUMICE

31.3 % COURSE 68.7 % FINE

	% RETAINED
1"	0.00
3/4"	0.00
1/2"	6.55
3/8"	21.30
#4	91.75
#8	100.00

#4	0.0
#8	34.0
#16	68.0
#50	92.0
#100	95.0
PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 29

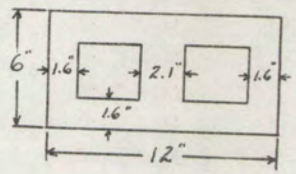
MIX: 7.30 CU. FT. PUMICE PER SACK OF CEMENT ADMIXTURES ____

3.13 CU. FT. SAND PER SACK OF CEMENT

SIZE OF TILE $3\frac{1}{2}$ x 6 x 12 GROSS AREA 72 sq. in.

NET AREA 53.24 sq. in. NET VOLUME .099 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	10.50	32,500	452	610	MOIST
3	9.80	33,500	465	630	DRY
7	10.70	48,500	674	910	MOIST
7	9.00	45,000	625	845	DRY
28	10.60	68,500	951	1,287	MOIST
28	8.85	60,500	840	1,237	DRY

AVERAGE MOISTURE CONTENT 16.2% AVERAGE ABSORPTION 14.8#/cu. ft.

SCREEN ANALYSIS OF PUMICE

31.3 % COURSE 68.7 % FINE

	% RETAINED
1"	0.00
3/4"	0.00
1/2"	6.55
3/8"	21.30
#4	91.75
#8	100.00

	% RETAINED
#4	0.0
#8	34.0
#16	68.0
#50	92.0
#100	95.0
PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 30

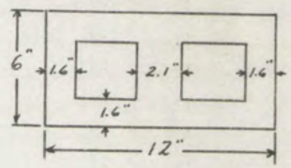
MIX: 7.30 CU.FT. PUMICE PER SACK OF CEMENT * ADMIXTURES Pozzolith .9#/sack cement

3.13 CU.FT. SAND PER SACK OF CEMENT*

SIZE OF TILE 3½ x 6 x 12 GROSS AREA 72 sq. in.

NET AREA 53.24 sq. in. NET VOLUME .100 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	10.10	74,000	1,030	1,390	MOIST
3	9.30	77,500	1,075	1,456	DRY
7	10.15	64,500	895	1,211	MOIST
7	9.00	95,000	1,320	1,783	DRY
28	10.20	97,000	1,345	1,821	MOIST
28	8.80	90,500	1,255	1,700	DRY

AVERAGE MOISTURE CONTENT 23.7% AVERAGE ABSORPTION 12.4#/cu. ft.

SCREEN ANALYSIS OF PUMICE

31.3 % COURSE 68.7 % FINE

Sieve	% RETAINED	Sieve	% RETAINED
1"	0.00	#4	0.0
3/4"	0.00	#8	34.0
1/2"	6.55	#16	68.0
3/8"	21.30	#50	92.0
#4	91.75	#100	95.0
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

Sieve	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

*High-early strength cement

Fig. 8

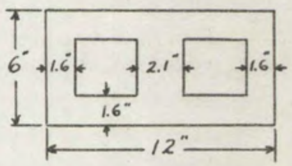
SAMPLE NO. 31

MIX:
7.30 CU.FT. PUMICE PER SACK OF CEMENT * ADMIXTURES
3.13 CU.FT. SAND PER SACK OF CEMENT *

SIZE OF TILE 3½ x 6 x 12 GROSS AREA 72 sq. in.

NET AREA 53.24 sq. in. NET VOLUME .100 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	10.70	56,500	785	1,061	MOIST
3	9.80	53,000	735	996	DRY
7	10.35	64,000	890	1,202	MOIST
7	9.05	69,000	958	1,297	DRY
28	10.55	75,500	1,049	1,419	MOIST
28	8.30	56,000	777	1,052	DRY

AVERAGE MOISTURE CONTENT 24.4%

AVERAGE ABSORPTION 14.7#/cu. ft.

SCREEN ANALYSIS OF PUMICE

31.3 % COURSE 68.7 % FINE

Screen	% RETAINED	Screen	% RETAINED
1"	0.00	#4	0.0
3/4"	0.00	#8	34.0
1/2"	6.55	#16	68.0
3/8"	21.30	#50	92.0
#4	91.75	#100	95.0
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

Screen	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

*High-early strength cement

Fig. 8

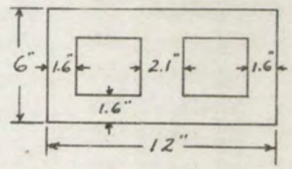
SAMPLE NO. 32

MIX:
8.53 CU.FT. PUMICE PER SACK OF CEMENT* ADMIXTURES ____
3.13 CU.FT. SAND PER SACK OF CEMENT* ____

SIZE OF TILE 3½ x 6 x 12 GROSS AREA 72 sq. in.

NET AREA 53.24 sq. in. NET VOLUME .099 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	10.25	47,500	658	892	MOIST
3	9.20	50,000	695	938	DRY
7	10.15	51,000	707	958	MOIST
7	9.00	56,000	778	1,025	DRY
28	10.20	68,000	944	1,278	MOIST
28	8.45	62,500	869	1,174	DRY

AVERAGE MOISTURE CONTENT 23.6% AVERAGE ABSORPTION 14.5#/cu. ft.

SCREEN ANALYSIS OF PUMICE

31.3 % COURSE 68.7 % FINE

	% RETAINED		
1"	0.00	#4	0.0
3/4"	0.00	#8	34.0
1/2"	6.55	#16	68.0
3/8"	21.30	#50	92.0
#4	91.75	#100	95.0
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

*High-early strength cement

Fig. 8

SAMPLE NO. 33

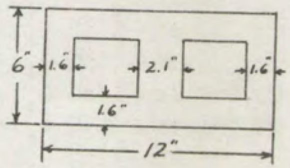
MIX: 8.53 CU.FT. PUMICE PER SACK OF CEMENT* ADMIXTURES Pozzolith .9#/sack cement

3.13 CU.FT. SAND PER SACK OF CEMENT*

SIZE OF TILE 3½ x 6 x 12 GROSS AREA 72 sq. in.

NET AREA 53.24 sq. in. NET VOLUME .100 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	10.40	52,000	723	977	MOIST
3	9.25	59,500	827	1,119	DRY
7	10.35	67,000	930	1,259	MOIST
7	9.10	84,000	1,166	1,579	DRY
28	10.70	79,000	1,097	1,484	MOIST
28	8.85	85,500	1,185	1,607	DRY

AVERAGE MOISTURE CONTENT 19.65%

AVERAGE ABSORPTION 13.3#/cu. ft.

SCREEN ANALYSIS OF PUMICE

31.3 % COURSE 68.7 % FINE

	% RETAINED		
1"	0.00	#4	0.0
3/4"	0.00	#8	34.0
1/2"	6.55	#16	68.0
3/8"	21.30	#50	92.0
#4	91.75	#100	95.0
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

*High-early strength cement

Fig. 8

SAMPLE NO. 34

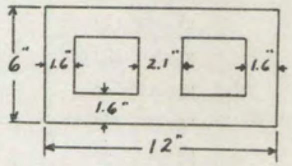
MIX: 10.94 CU. FT. PUMICE PER SACK OF CEMENT * ADMIXTURES ______

3.13 CU. FT. SAND PER SACK OF CEMENT *

SIZE OF TILE 3½ x 6 x 12 GROSS AREA 72 sq. in.

NET AREA 53.24 sq. in. NET VOLUME .1035 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	9.70	41,000	570	770	MOIST
3	8.85	41,000	570	770	DRY
7	9.60	45,500	633	855	MOIST
7	8.25	51,000	707	958	DRY
28	9.95	57,000	791	1,070	MOIST
28	8.10	55,500	770	1,042	DRY

AVERAGE MOISTURE CONTENT 18.6%

AVERAGE ABSORPTION 15.6#/cu. ft.

SCREEN ANALYSIS OF PUMICE

31.3 % COURSE 68.7 % FINE

	% RETAINED		% RETAINED
1"	0.00	#4	0.0
3/4"	0.00	#8	34.0
1/2"	6.55	#16	68.0
3/8"	21.30	#50	92.0
#4	91.75	#100	95.0
#8	100.00	PAN	100.00

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

*High-early strength cement

SAMPLE NO. 35

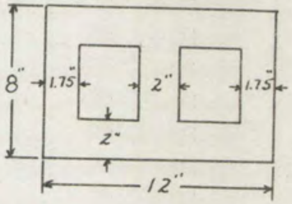
MIX:
8.0 CU.FT. PUMICE PER SACK OF CEMENT
2.5 CU.FT. SAND PER SACK OF CEMENT

ADMIXTURES ______

SIZE OF TILE 5½ x 8 x 12 GROSS AREA 96 sq. in.

NET AREA 70.0 sq. in. NET VOLUME .213 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	22.05	62,500	651	893	MOIST
3	19.60	59,500	625	850	DRY
7	21.70	78,500	827	1,121	MOIST
7	18.40	75,500	786	1,079	DRY
28	22.40	114,500	1,192	1,637	MOIST
28	18.00	114,000	1,189	1,629	DRY

AVERAGE MOISTURE CONTENT 21.4%

AVERAGE ABSORPTION 15.65#/cu. ft.

SCREEN ANALYSIS OF PUMICE

35.3 % COURSE 64.7 % FINE

	% RETAINED
1"	0.00
3/4"	2.17
1/2"	7.70
3/8"	21.75
#4	92.50
#8	100.00

	% RETAINED
#4	0.0
#8	54.0
#16	86.0
#50	92.0
#100	92.5
PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 36

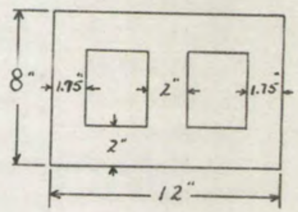
MIX: 8.0 CU. FT. PUMICE PER SACK OF CEMENT   ADMIXTURES ______

2.5 CU. FT. SAND PER SACK OF CEMENT

SIZE OF TILE 5½ x 8 x 12   GROSS AREA 96 sq. in.

NET AREA 70.0 sq. in.   NET VOLUME .212 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	21.50	62,500	651	893	MOIST
3	19.45	59,500	620	850	DRY
7	21.85	78,000	813	1,115	MOIST
7	19.70	94,000	978	1,342	DRY
28	22.20	96,000	980	1,371	MOIST
28	18.85	99,500	1,037	1,421	DRY

AVERAGE MOISTURE CONTENT 21.1%   AVERAGE ABSORPTION 16.16#/cu. ft.

SCREEN ANALYSIS OF PUMICE

35.3 % COURSE   64.7 % FINE

Screen	% RETAINED	Screen	% RETAINED
1"	0.00	#4	0.0
3/4"	2.17	#8	54.0
1/2"	7.70	#16	86.0
3/8"	21.75	#50	92.0
#4	92.50	#100	92.5
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

Screen	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

Fig. 8

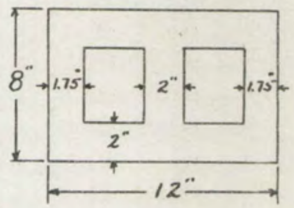
SAMPLE NO. 37

MIX:
8.0 CU.FT. PUMICE PER SACK OF CEMENT * ADMIXTURES
2.5 CU.FT. SAND PER SACK OF CEMENT *

SIZE OF TILE $5\frac{1}{2}$ x 8 x 12 GROSS AREA 96 sq. in.

NET AREA 70.0 sq. in. NET VOLUME .210 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	21.95	73,000	760	1,043	MOIST
3	19.75	78,000	812	1,114	DRY
7	22.20	88,500	922	1,263	MOIST
7	19.45	107,000	1,114	1,529	DRY
28	22.65	132,000	1,378	1,888	MOIST
28	19.10	138,500	1,445	1,980	DRY

AVERAGE MOISTURE CONTENT 68.71% AVERAGE ABSORPTION 15.26#/cu. ft.

SCREEN ANALYSIS OF PUMICE

35.3 % COURSE 64.7 % FINE

	% RETAINED		% RETAINED
1"	0.00	#4	0.0
3/4"	2.17	#8	54.0
1/2"	7.70	#16	86.0
3/8"	21.75	#50	92.0
#4	92.50	#100	92.5
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

*High-early strength cement

Fig. 8

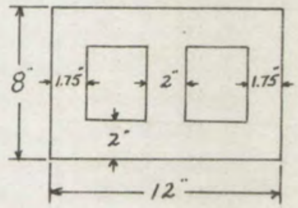
SAMPLE NO. 38

MIX:
8.0 CU.FT. PUMICE PER SACK OF CEMENT * ADMIXTURES
2.5 CU.FT. SAND PER SACK OF CEMENT *

SIZE OF TILE $5\frac{1}{2}$ x 8 x 12 GROSS AREA 96 sq. in.

NET AREA 70.0 sq. in. NET VOLUME .218 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	21.90	95,500	994	1,364	MOIST
3	20.50	98,000	1,020	1,400	DRY
7	22.30	110,500	1,152	1,580	MOIST
7	19.85	116,500	1,214	1,667	DRY
28	22.00	132,000	1,378	1,888	MOIST
28	19.50	155,500	1,620	2,220	DRY

AVERAGE MOISTURE CONTENT 70.74% AVERAGE ABSORPTION 13.4#/cu. ft.

SCREEN ANALYSIS OF PUMICE

35.3 % COURSE 64.7 % FINE

Sieve	% RETAINED	Sieve	% RETAINED
1"	0.00	#4	0.0
3/4"	2.17	#8	54.0
1/2"	7.70	#16	86.0
3/8"	21.75	#50	92.0
#4	92.50	#100	92.5
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

Sieve	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

*High-early strength cement

Fig. 8

SAMPLE NO. 39

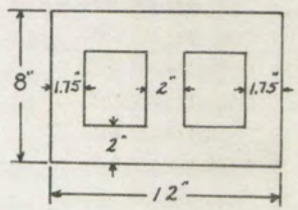
MIX: 12.00 CU.FT. PUMICE PER SACK OF CEMENT — ADMIXTURES Brick cement .5 cu. ft./ sack cement

3.75 CU.FT. SAND PER SACK OF CEMENT

SIZE OF TILE $5\frac{1}{2}$ x 8 x 12 GROSS AREA 96 sq. in.

NET AREA 70.0 sq. in. NET VOLUME .210 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	22.20	70,000	730	1,000	MOIST
3	20.30	74,500	775	1,053	DRY
7	21.45	80,500	839	1,150	MOIST
7	19.30	93,500	973	1,337	DRY
28	22.35	111,500	1,160	1,593	MOIST
28	19.00	131,500	1,370	1,879	DRY

AVERAGE MOISTURE CONTENT 83.44%

AVERAGE ABSORPTION 13.34#/cu. ft.

SCREEN ANALYSIS OF PUMICE

35.3 % COURSE 64.7 % FINE

Screen	% RETAINED	Screen	% RETAINED
1"	0.00	#4	0.0
3/4"	2.17	#8	54.0
1/2"	7.70	#16	86.0
3/8"	21.75	#50	92.0
#4	92.50	#100	92.5
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

Screen	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 40

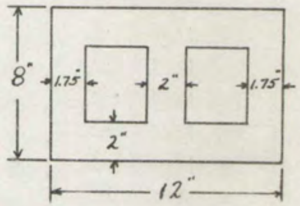
MIX: 9.0 CU.FT. PUMICE PER SACK OF CEMENT * ADMIXTURES ______

3.0 CU.FT. SAND PER SACK OF CEMENT * ______

SIZE OF TILE $5\frac{1}{2}$ x 8 x 12 GROSS AREA 96 sq. in.

NET AREA 70.0 sq. in. NET VOLUME .210 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	21.40	62,000	651	885	MOIST
3	19.70	75,000	781	1,071	DRY
7	21.65	83,500	870	1,193	MOIST
7	18.30	79,000	823	1,129	DRY
28	21.45	92,000	959	1,314	MOIST
28	18.00	103,500	1,078	1,479	DRY

AVERAGE MOISTURE CONTENT 66.03% AVERAGE ABSORPTION 14.94#/cu. ft.

SCREEN ANALYSIS OF PUMICE

35.3 % COURSE 64.7 % FINE

% RETAINED			
1"	0.00	# 4	0.0
3/4"	2.17	# 8	54.0
1/2"	7.70	# 16	86.0
3/8"	21.75	# 50	92.0
# 4	92.50	# 100	92.5
# 8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
# 4	0.0
# 8	3.0
# 16	9.0
# 50	63.0
# 100	90.0
PAN	100.0

*High-early strength cement

Fig. 8

SAMPLE NO. 41

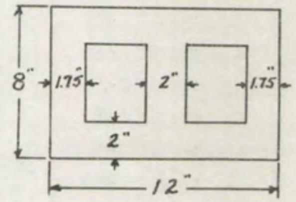
MIX:
12.0 CU.FT. PUMICE PER SACK OF CEMENT*
4.0 CU.FT. SAND PER SACK OF CEMENT*

ADMIXTURES Pozzolith .5#/sack cement

SIZE OF TILE 5½ x 8 x 12 GROSS AREA 96 sq. in.

NET AREA 70.0 sq. in. NET VOLUME .210 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	20.90	39,000	407	557	MOIST
3	19.40	47,000	489	671	DRY
7	21.10	39,000	407	557	MOIST
7	18.10	54,000	562	771	DRY
28	20.90	56,000	584	805	MOIST
28	17.80	74,500	775	1,064	DRY

AVERAGE MOISTURE CONTENT 15.5% AVERAGE ABSORPTION 17.13#/cu. ft.

SCREEN ANALYSIS OF PUMICE

35.3 % COURSE 64.7 % FINE

% RETAINED			
1"	0.00	#4	0.0
3/4"	2.17	#8	54.0
1/2"	7.70	#16	86.0
3/8"	21.75	#50	92.0
#4	92.50	#100	92.5
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

% RETAINED	
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

*High-early strength cement

Fig. 8

SAMPLE NO. 42

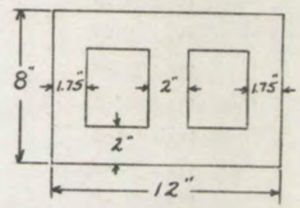
MIX: 12.00 CU.FT. PUMICE PER SACK OF CEMENT — ADMIXTURES Brick cement .5 cu. ft./ sack cement

3.75 CU.FT. SAND PER SACK OF CEMENT

SIZE OF TILE $5\frac{1}{2}$ x 8 x 12 GROSS AREA 96 sq. in.

NET AREA 70.0 sq. in. NET VOLUME .210 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	22.30	51,000	531	729	MOIST
3	19.80	54,000	562	771	DRY
7	22.20	73,000	761	1,042	MOIST
7	19.70	79,000	822	1,129	DRY
28	21.95	92,500	964	1,321	MOIST
28	19.40	105,500	1,098	1,509	DRY

AVERAGE MOISTURE CONTENT 23.52% — AVERAGE ABSORPTION 15.59#/cu. ft.

SCREEN ANALYSIS OF PUMICE

35.3 % COURSE — 64.7 % FINE

% RETAINED

Course	%	Fine	%
1"	0.00	#4	0.0
3/4"	2.17	#8	54.0
1/2"	7.70	#16	86.0
3/8"	21.75	#50	92.0
#4	92.50	#100	92.5
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 43

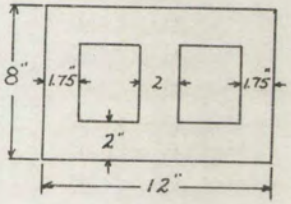
MIX: 8.0 CU.FT. PUMICE PER SACK OF CEMENT — ADMIXTURES Pozzolith .5#/sack cement

2.5 CU.FT. SAND PER SACK OF CEMENT

SIZE OF TILE $5\frac{1}{2}$ x 8 x 12 — GROSS AREA 96 sq. in.

NET AREA 70.0 sq. in. — NET VOLUME .210 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	21.65	69,000	719	986	MOIST
3	19.75	70,500	734	1,007	DRY
7	21.75	86,500	900	1,236	MOIST
7	19.50	94,500	985	1,351	DRY
28	22.05	101,500	1,050	1,451	MOIST
28	19.20	102,000	1,062	1,459	DRY

AVERAGE MOISTURE CONTENT 22.01%

AVERAGE ABSORPTION 14.99#/cu. ft.

SCREEN ANALYSIS OF PUMICE

35.3 % COURSE — 64.7 % FINE

Screen	% RETAINED	Screen	% RETAINED
1"	0.00	#4	0.0
3/4"	2.17	#8	54.0
1/2"	7.70	#16	86.0
3/8"	21.75	#50	92.0
#4	92.50	#100	92.5
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

Screen	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 44

MIX: 8.0 CU. FT. PUMICE PER SACK OF CEMENT

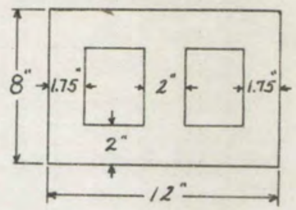
2.5 CU. FT. SAND PER SACK OF CEMENT

ADMIXTURES Adobe .5 cu. ft./sack cement

SIZE OF TILE $5\frac{1}{2}$ x 8 x 12 GROSS AREA 96 sq. in.

NET AREA 70.0 sq. in. NET VOLUME .210 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	22.30	62,000	651	886	MOIST
3	20.40	67,500	703	965	DRY
7	22.85	84,000	875	1,200	MOIST
7	19.95	87,500	911	1,250	DRY
28	22.65	112,000	1,168	1,600	MOIST
28	19.60	116,500	1,211	1,665	DRY

AVERAGE MOISTURE CONTENT 22.83%

AVERAGE ABSORPTION 15.03#/cu. ft.

SCREEN ANALYSIS OF PUMICE

35.3 % COURSE 64.7 % FINE

	% RETAINED		
1"	0.00	#4	0.0
3/4"	2.17	#8	54.0
1/2"	7.70	#16	86.0
3/8"	21.75	#50	92.0
#4	92.50	#100	92.5
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 45

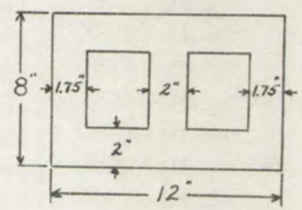
MIX: 9.0 CU.FT. PUMICE PER SACK OF CEMENT — ADMIXTURES Adobe .5 cu. ft./sack cement

3.0 CU.FT. SAND PER SACK OF CEMENT

SIZE OF TILE 5½ x 8 x 12 — GROSS AREA 96 sq. in.

NET AREA 70.0 sq. in. — NET VOLUME .210 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	22.65	60,500	631	865	MOIST
3	20.30	62,500	656	894	DRY
7	22.75	79,500	829	1,136	MOIST
7	19.95	84,000	875	1,200	DRY
28	22.65	112,500	1,172	1,608	MOIST
28	19.40	109,000	1,135	1,559	DRY

AVERAGE MOISTURE CONTENT 30.88% — AVERAGE ABSORPTION 15.79#/cu. ft.

SCREEN ANALYSIS OF PUMICE

35.3 % COURSE — 64.7 % FINE

	% RETAINED		
1"	0.00	#4	0.0
3/4"	2.17	#8	54.0
1/2"	7.70	#16	86.0
3/8"	21.75	#50	92.0
#4	92.50	#100	92.5
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

Fig. 8

SAMPLE NO. 46

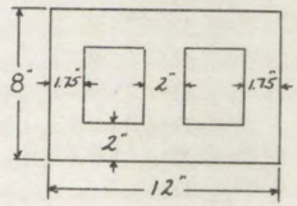
MIX: 14.00 CU.FT. PUMICE PER SACK OF CEMENT* ADMIXTURES Pozzolith .5#/sack cement

4.67 CU.FT. SAND PER SACK OF CEMENT* B.C. .33 cu. ft./sack cement

SIZE OF TILE 5½ x 8 x 12 GROSS AREA 96 sq. in.

NET AREA 70.0 sq. in. NET VOLUME .210 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	19.45	40,500	422	579	MOIST
3	16.65	33,500	349	479	DRY
7	19.45	47,000	490	671	MOIST
7	17.30	52,000	542	743	DRY
28	19.55	64,000	670	914	MOIST
28	17.00	60,500	630	865	DRY

AVERAGE MOISTURE CONTENT 15.00%

AVERAGE ABSORPTION 14.73#/cu. ft.

SCREEN ANALYSIS OF PUMICE

35.3 % COURSE 64.7 % FINE

	% RETAINED		
1"	0.00	#4	0.0
3/4"	2.17	#8	54.0
1/2"	7.70	#16	86.0
3/8"	21.75	#50	92.0
#4	92.50	#100	92.5
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

	% RETAINED
#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

*High-early strength cement

Fig. 8

SAMPLE NO. 47

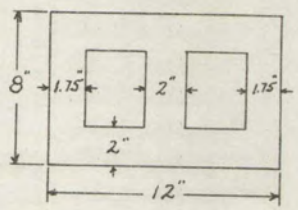
MIX: 9.0 CU.FT. PUMICE PER SACK OF CEMENT** ADMIXTURES

3.0 CU.FT. SAND PER SACK OF CEMENT**

SIZE OF TILE $5\frac{1}{2}$ x 8 x 12 GROSS AREA 96 sq. in.

NET AREA 70.0 sq. in. NET VOLUME .210 cu. ft.

DIAGRAM



AGE	WT.	LOAD P	PSI GROSS A.	PSI NET AREA	CURING CONDITION
3	21.00	26,500	276	378	MOIST
3	18.50	27,000	281	386	DRY
7	21.30	32,500	339	465	MOIST
7	18.30	38,000	396	543	DRY
28	21.80	49,500	516	708	MOIST
28	18.00	45,000	469	643	DRY

AVERAGE MOISTURE CONTENT 12.85% AVERAGE ABSORPTION 16.29#/cu. ft.

SCREEN ANALYSIS OF PUMICE

35.3 % COURSE 64.7 % FINE

% RETAINED

1"	0.00	#4	0.0
3/4"	2.17	#8	54.0
1/2"	7.70	#16	86.0
3/8"	21.75	#50	92.0
#4	92.50	#100	92.5
#8	100.00	PAN	100.0

SCREEN ANALYSIS OF SAND

% RETAINED

#4	0.0
#8	3.0
#16	9.0
#50	63.0
#100	90.0
PAN	100.0

**Brick cement

Fig. 8

CHAPTER VIII

DISCUSSION OF RESULTS

In calculating the mix all materials other than pumice, sand, regular Portland cement, high-early strength cement, and water were considered as admixtures. Brick cement was used in some mixes. Although it imparts strength to the mix, its chief purpose was to produce plasticity. Sample number forty-seven contained brick cement instead of regular cement and its strength was very low. If the cement content had been increased, the strength of the block would have increased, but the block was very soft and crumbly, since brick cement does not possess the cementatious qualities of regular Portland cement. Therefore, brick cement has also been classified as an admixture. Pozzolith, adobe, and calcium chloride are other materials used as admixtures in these tests. These will be discussed briefly.

Pozzolith is a material produced by the Master Builders Company of Cleveland, Ohio. It is used in regular concrete as an air-entraining agent and a dispersing agent. By using pozzolith the cement content can be reduced and the same strength of concrete is obtained. The Master Builders recommend that 0.9 pounds of pozzolith be used per sack of

In calculating [illegible]

end, results [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

The block [illegible]

not [illegible]

rent. Therefore, [illegible]

[illegible]

[illegible]

[illegible]

Uzzell [illegible]

[illegible] Company [illegible]

[illegible]

uniform [illegible]

[illegible]

[illegible]

cement.

Adobe was used as an admixture in order to obtain more plasticity in the mix. It was used in varying amounts and produced a dense block.

Calcium Chloride was used to speed up the drying of the blocks. It would be an advantage in cold-weather curing, but seemed rather unessential for warm-weather curing.

I. COMPRESSIVE STRENGTH

As previously stated, all blocks tested were units having a minimum face shell thickness over one and one-quarter inches, and in almost every case the blocks met the American Society for Testing Materials compressive-strength requirements, seven hundred pounds per square inch over the gross area. A block failing the strength test is immediately rejected if being tested for commercial use.

The blocks that were in the moist room during the curing periods gave the highest strengths in the majority of the cases (twenty-nine out of forty-seven). In only nine samples of the first thirty-five did the ideally-cured blocks fail to give the highest strengths. In the samples thirty-six through forty-seven, nine ideally-cured blocks failed to give the highest strengths. It is conclusive, however, upon con-

sidering all tests, that the highest strengths are obtained from blocks cured under ideal conditions.

The reasons for the blocks failing to meet the strength specifications is apparent in most cases. Sample number five had a high-cement content and yet the strength was very low. Thus failing to meet specifications. See Table V. However, it is evident, since this block was lighter than the other blocks in its group, that it was not properly consolidated. In this particular case, the speed of the vibrator was entirely too slow.

Sample number forty-seven, as previously explained, contained brick cement instead of regular Portland cement; therefore, its strength was low. See Table IX.

Samples twenty-seven and twenty-eight (Table X) and samples forty-one and forty-two (Table XI) had low strengths because of the lean mix, although other samples of these groups had higher strengths. Low strengths can be expected from mixes containing over fourteen cubic feet of aggregate per sack of cement.

Some of the units had exceedingly high strengths, and this can be explained in most cases. The blocks containing adobe usually had higher strengths, sometimes even higher

than those blocks containing pozzolith, high-early strength cement, or brick cement. In general, the use of admixtures increased the strength over mixes not using admixtures.

A comparison was made of the compressive strength of mixes using the two colors of pumice, white and brown. From the results of this research there is little or no difference in the compressive strengths of identical mixes using the two pumices.

Tables V through XI give the comparative mixes, unit weights, average twenty-eight day strengths over both the gross area and the net area, and the color of the pumice used.

II. ABSORPTION

The majority of the blocks met the American Society for Testing Materials absorption requirements of fifteen pounds of water per cubic foot of material. Sixteen samples failed to meet the absorption requirements, but five of these also failed the strength specifications. Therefore, the remaining eleven, all of which contained brown pumice, will be discussed and considered.

Only three samples (nineteen, forty-four, and forty-five) of the eleven contained an admixture, and the mixes exceeded ten cubic feet of aggregate per sack of cement, ex-

than these blocks containing [illegible], all [illegible]
cement, or brick [illegible]. In general, [illegible]
increased the strength and [illegible] of [illegible].

A [illegible] of [illegible]
blocks using the [illegible], water and [illegible]. From
the results of [illegible]
in the concrete strength of [illegible]
mortar.

[illegible]
soil, [illegible]
block [illegible].

[illegible]

The [illegible]
testing [illegible]
[illegible]
meet the [illegible]
of the strength [illegible]
least, all of which [illegible]
and [illegible].

Only three samples ([illegible])
[illegible] of the [illegible]
exceeded [illegible]

cept in two samples (three and fourteen). Samples thirty-four and thirty-seven contained high-early strength cement, while the others contained regular Portland cement. None of the blocks containing white pumice failed the absorption test; however, admixtures had been added to all these specimens tested.

The only plausible explanation that could be derived from this data for reducing excessive absorption would be to convert to a richer mix, or if using a lean mix, to use a good admixture. The writer would advise using either brick cement or pozzolith. Brick cement contains lime which is a water proofing agent. There are certain anti-hydro admixtures manufactured by various cement companies, and the use of these tend to waterproof concrete. The use of any of these admixtures will reduce the absorptive qualities of the blocks.

Any blocks that fail the absorption test cannot be placed in sub-grade construction or exposed to the weather. The results of the absorption test can be waived if the blocks are to be covered with a water proofing paint or stucco.

Table XII gives the tabulated absorption values and the per cent moisture of the blocks at the time of testing.

TABLE V

MIX: 6.0 TO 7.5 CUBIC FEET AGGREGATE/SACK OF CEMENT

Sample Number	Sand Cubic Feet	Pumice Cubic Feet	Total Aggregate Cubic Feet	Unit Weight	Admixture Cubic Feet	28-Days Strength Gross	28-Days Strength Net	Color of Pumice
5	1.41	4.85	6.26	75.5		619	1049	White
10	1.65	4.84	6.49	87.2	.415 A	1455	2180	Brown
21	1.965	4.96	6.925	80.1		1192	1674	Brown
11	1.06	5.95	7.01	78.9	.75 A	1435	2199	White
12	1.06	5.95	7.01	77.7	.75 A	1370	2137	White
13	1.06	5.95	7.01	79.6	.75 A	1750	2330	White

A - Adobe

TABLE VI

MIX: 7.5 TO 8.1 CUBIC FEET AGGREGATE/SACK OF CEMENT

Sample Number	Sand Cubic Feet	Pumice Cubic Feet	Total Aggregate Cubic Feet	Unit Weight	Admixture Cubic Feet	Strength at 28-Days Gross	Strength at 28-Days Net	Color of Pumice
6	2.36	5.33	7.69	81.9	.614 A	1090	1582	White
7	2.36	5.33	7.69	82.0	.7675 A	1215	1756	White
8	2.36	5.33	7.69	84.8	.7675 A	1283	1837	White
16	1.99	5.84	7.83	84.7	.734 A	1035	1778	White
14	2.64	5.38	8.02	86.9		1265	1755	Brown

A - Adobe

TABLE VII

MIX: 8 TO 10.0 CUBIC FEET AGGREGATE/SACK OF CEMENT

Sample Number	Sand Cubic Feet	Pumice Cubic Feet	Total Aggregate Cubic Feet	Unit Weight	Admixture Cubic Feet		Strength at 28-Days Gross	Strength at 28-Days Net	Color of Pumice
4	1.615	6.5	8.115	82.6	.8	A	1180	1556	White
1	3.61	4.6	8.21	89.3	14⅛ oz.	P	1315	1787	Brown
22	1.041	7.3	8.3413	85.60	.9#	P	1146	1550	Brown
3	2.50	6.0	8.50	85.8			1172	1645	Brown
9	2.54	6.55	9.09	85.1	.4	A	872	1315	White

A - Adobe
P - Pozzolith

TABLE VIII

MIX: 10.0 TO 11.0 CUBIC FEET AGGREGATE/SACK OF CEMENT

Sample Number	Sand Cubic Feet	Pumice Cubic Feet	Total Aggregate Cubic Feet	Unit Weight	Admixture Cubic Feet	Strength at 28-Days Gross	Strength at 28-Days Net	Color of Pumice
29	3.125	7.3	10.425	83.93		895	1262	Brown
30*	3.125	7.3	10.425	84.52	.9# P	1300	1760	Brown
31*	3.125	7.3	10.425	82.26		913	1235	Brown
17	2.62	7.86	10.48	77.30		906	1242	Brown
35	2.50	8.0	10.50	80.10		1190	1633	Brown
36	2.50	8.0	10.50	80.20		1008	1396	Brown
37*	2.50	8.0	10.50	81.19		1413	1934	Brown
38*	2.50	8.0	10.50	81.51		1499	2054	Brown
43	2.50	8.0	10.50	82.06	.5# P	1056	1455	Brown
44	2.50	8.0	10.50	83.41	.5 A	1189	1632	Brown

* - High-Early Strength Cement
A - Adobe
P - Pozzolith

TABLE IX

MIX: 11.0 TO 12.0 CUBIC FEET AGGREGATE/SACK OF CEMENT

Sample Number	Sand Cubic Feet	Pumice Cubic Feet	Total Aggregate Cubic Feet	Unit Weight	Admixture Cubic Feet	Strength at 28-Days Gross	Strength at 28-Days Net	Color of Pumice
24	3.125	8.525	11.65	83.22	.9# P	985	1339	Brown
25	3.125	8.525	11.65	83.79		1007	1361	Brown
26	3.125	8.525	11.65	90.61	.9# P	1402	1897	Brown
32*	3.125	8.525	11.65	83.59		897	1226	Brown
33*	3.125	8.525	11.65	84.59	.9# P	1141	1596	Brown
18	3.000	9.000	12.00	76.60	.9# P	1000	1372	Brown
40*	3.000	9.000	12.00	80.72		1018	1396	Brown
45	3.000	9.000	12.00	81.63	.5 A	1153	1583	Brown
47**	3.000	9.000	12.00	75.44		482	725	Brown

* - High-Early Strength Cement
** - Brick Cement
A - Adobe
P - Pozzolith

TABLE X

MIX: 12.0 TO 15.0 CUBIC FEET AGGREGATE/SACK OF CEMENT

Sample Number	Sand Cubic Feet	Pumice Cubic Feet	Total Aggregate Cubic Feet	Cubic Weight	Admixture Cubic Feet	Strength at 28-Days Gross	Strength at 28-Days Net	Color of Pumice
20	3.330	10.00	13.33	66.60		710	1246	Brown
23	3.125	10.94	14.065	78.98	.9# P	746	1010	Brown
27	3.125	10.94	14.065	81.37		670	906	Brown
28	3.125	10.94	14.065	82.21		695	939	Brown
34*	3.125	10.94	14.065	75.30		780	1056	Brown
19	2.680	12.10	14.780	73.10	.8725# P	732	1003	Brown

* - High-Early Strength Cement
P - Pozzolith

TABLE XI

MIX: OVER 15.0 CUBIC FEET AGGREGATE/SACK OF CEMENT

Sample Number	Sand Cubic Feet	Pumice Cubic Feet	Total Aggregate Cubic Feet	Unit Weight	Admixture Cubic Feet	Strength at 28-Days Gross	Strength at 28-Days Net	Color of Pumice
39	3.75	12.0	15.75	81.11	.5 BC	1265	1736	Brown
42	3.75	12.0	15.75	79.62	.5 BC	1030	1415	Brown
41*	4.00	12.0	16.00	74.25	.5# P	669	934	Brown
2	3.144	13.31	16.454	80.00	1.83 A	873	1352	White
15	5.84	11.0	16.84	86.60	.474 BC	890	1517	White
46*	4.67	14.0	18.67	75.44	.5# P .333 BC	650	890	White

* - High-Early Strength Cement
BC - Brick Cement
P - Pozzolith
A - Adobe

TABLE XII

ABSORPTION VALUES AND MOISTURE CONTENTS

Sample Number	Mix	Admixture	Unit Weight	Size of Block	Absorption #/Cu. Ft.	Moisture Content Per Cent
1	1:8.21	Pozzolith	89.3	3 1/2x8x12	14.32	52.60
2	1:16.45	Adobe	80.0	7 1/8x8x16	14.11	49.34
3	1:8.50		85.8	8x8x16	15.04	71.50
4	1:8.12	Adobe	82.6	5x8x12	13.75	49.00
5	1:6.26		75.5	8x7 1/2x16	14.60	17.90
6	1:7.69	Adobe	81.9	5x8x16	14.22	52.68
7	1:7.69	Adobe	82.0	5x8x16	14.88	49.00
8	1:7.69	Adobe	84.8	5x8x12	14.30	40.94
9	1:9.09	Adobe	85.1	6x8x12	14.32	33.90
		CaCl				
10	1:6.49	Adobe	87.2	5x8x12	14.43	63.60
11	1:7.01	Adobe	78.9	6x8x16	13.02	43.63
12	1:7.01	Adobe	77.7	5x8x12	12.65	37.60
13	1:7.01	Adobe	79.6	6x6x16	14.25	56.55
14	1:8.02		86.9	4. 5x8x12	15.31	22.00
15	1:16.84	Brick Cement	86.6	6x8x16	13.70	21.60

TABLE XII (CON'T.)

ABSORPTION VALUES AND MOISTURE CONTENTS

Sample Number	Mix	Admixture	Unit Weight	Size of Block	Absorption #/Cu. Ft.	Moisture Content Per Cent
16	1:7.83	Adobe	84.7	5x8x12	13.19	33.07
17	1:10.48		77.3	5.5x8x12	15.27	46.56
18	1:12.00	Pozzolith	76.6	5.5x8x12	14.70	29.80
19	1:14.78	Pozzolith	73.1	5.5x8x12	17.80	23.40
20	1:13.33		66.6	8x8x16	14.20	17.40
21	1:6.93		80.1	8x8x16	14.60	26.80
22	1:8.34	Pozzolith	85.6	3.5x6x12	13.60	32.15
23	1:14.06	Pozzolith	80.0	3.5x6x12	14.60	19.20
24	1:11.65		83.2	3.5x6x12	15.20	26.60
25	1:11.65		83.8	3.5x6x12	14.00	19.00
26	1:11.65	Pozzolith	90.6	3.5x6x12	14.60	33.40
27	1:14.06		81.4	3.5x6x12	16.90	16.20
28	1:14.06		82.2	3.5x6x12	15.70	14.80
29	1:10.42		83.4	3.5x6x12	14.80	16.20
30	1:10.42*	Pozzolith	84.5	3.5x6x12	12.40	23.70
31	1:10.42*		82.3	3.5x6x12	14.70	24.40

* - High-Early Strength Cement

TABLE XII (CON'T.)

ABSORPTION VALUES AND MOISTURE CONTENTS

Sample Number	Mix	Admixture	Unit Weight	Size of Block	Absorption #/Cu. Ft.	Moisture Content Per Cent
32	1:11.65*		83.6	3.5x6x12	14.50	23.60
33	1:11.65*	Pozzolith	84.6	3.5x6x12	13.30	79.65
34	1:14.06*		75.3	3.5x6x12	15.60	18.60
35	1:10.50		80.1	5.5x8x12	15.65	21.40
36	1:10.50		80.2	5.5x8x12	16.16	21.10
37	1:10.50*		81.2	5.5x8x12	15.26	68.71
38	1:10.50*		81.5	5.5x8x12	13.40	70.74
39	1:15.75	Brick Cement	81.1	5.5x8x12	13.34	83.44
40	1:12.00*		80.7	5.5x8x12	14.94	66.03
41	1:16.00*	Pozzolith	74.3	5.5x8x12	17.13	15.54
42	1:15.75	Brick Cement	79.6	5.5x8x12	15.59	23.52
43	1:10.50	Pozzolith	82.1	5.5x8x12	14.99	22.01
44	1:10.50	Adobe	83.4	5.5x8x12	15.03	22.83
45	1:12.00	Adobe	81.6	5.5x8x12	15.79	30.88
46	1:18.67	Pozzolith	71.4	5.5x8x12	14.73	15.00
		Brick Cement				
47	1:12.00**		75.4	5.5x8x12	16.29	12.85

* - High-Early Strength Cement
** - Brick Cement

III. MOISTURE CONTENT

The moisture content of a block is expressed as a percentage of the total absorption at the time of sampling and should not exceed forty per cent.

Since the test for moisture content was run as soon as the block met compressive-strength requirements, many of the blocks contained an excessive percentage of moisture. Blocks that were tested for moisture content at the age of three days rarely contained less than forty per cent moisture, but when allowed to cure for a few more days, the percentage of moisture dropped rapidly.

The test for moisture content is not to determine whether a block is of good quality but merely to restrict its use in a building or construction until it contains less than forty per cent water. The moisture content of blocks should be carefully checked, because when units are sealed in a wall, they should be able to take up any water that might penetrate the protective covering. If the block were saturated with over forty per cent water, it might be unable to take up the moisture and cause cracks in the plaster.

Table XII gives the tabulated moisture contents of the samples.

IV. NET VOLUME

Table XIII gives the tabulated values of the net volume as determined by the formula given before, and they are recorded as the exact net volume. This is in contrast to the net volume calculated from the measurements of the blocks. (A diagram of each sample is shown on the data sheets Figure 8.) As stated before, the procedure of measuring the blocks was not exact, and this is shown by comparing the exact net volume and the measured net volume in Table XIII. In cases where the difference is small, the difference might be due to shrinkage or chipping of the blocks in handling. The blocks of samples twenty-two to thirty-five received rather rough treatment and many of them were chipped. Some of the comparisons show very little difference, while others vary considerably, although the exact volumes of identical blocks are rather consistent. This proves that most of the blocks produced were uniform.

V. UNIT WEIGHT

It was the belief of the author that the unit weight of the block might be an indication of its compressive strength and in some instances the heavier blocks had the

TABLE XIII

COMPARISON OF ACTUAL AND THEORETICAL NET VOLUMES

Sample Number	Size of Block Inches	Gross Area Sq. In.	Net Area Sq. In.	Gross Vol. Cu. Ft.	Net Vol. Cu. Ft. Measured	Net Vol. Cu. Ft. Actual
1	3.5x8x12	96.0	70.70	.1947	.1432	.1385
2	7.125x8x16	128.0	82.75	.5280	.3415	.3788
3	8x8x16	128.0	91.22	.5935	.4225	.3770
4	5x8x12	96.0	72.84	.2780	.2109	.1976
5	8x7.5x12	120.0	70.84	.5550	.3280	.3380
6	5x8x16	128.0	88.40	.3701	.2560	.2700
7	5x8x16	128.0	88.40	.3701	.2560	.2700
8	5x8x12	96.0	66.65	.2780	.1930	.1930
9	6x8x12	96.0	63.45	.3335	.2200	.2140
10	5x8x12	96.0	64.14	.2780	.1859	.1890
11	6x8x16	128.0	81.78	.4450	.2840	.2700
12	5x8x12	96.0	61.73	.2780	.1788	.1720
13	6x6x16	96.0	72.05	.3335	.2501	.2440
14	4.5x8x12	96.0	69.15	.2500	.1801	.1660
15	6x8x16	128.0	75.10	.4450	.2610	.2760

TABLE XIII (CON'T.)

COMPARISON OF ACTUAL AND THEORETICAL NET VOLUMES

Sample Number	Size of Block Inches	Gross Area Sq. In.	Net Area Sq. In.	Gross Vol. Cu. Ft.	Net Vol. Cu. Ft. Measured	Net Vol. Cu. Ft. Actual
16	5x8x12	96.0	55.70	.2780	.1603	.1835
17	5.5x8x12	96.0	70.00	.3060	.2130	.2145
18	5.5x8x12	96.0	70.00	.3060	.2130	.2175
19	5.5x8x12	96.0	70.00	.3060	.2130	.2130
20	8x8x16	128.0	73.00	.5935	.3380	.3120
21	8x8x16	128.0	91.20	.5935	.4220	.3802
22	3.5x6x12	72.0	53.24	.2195	.1079	.1000
23	3.5x6x12	72.0	53.24	.2195	.1079	.1000
24	3.5x6x12	72.0	53.24	.2195	.1079	.1000
25	3.5x6x12	72.0	53.24	.2195	.1079	.1000
26	3.5x6x12	72.0	53.24	.2195	.1079	.1000
27	3.5x6x12	72.0	53.24	.2195	.1079	.0980
28	3.5x6x12	72.0	53.24	.2195	.1079	.1000
29	3.5x6x12	72.0	53.24	.2195	.1079	.0990
30	3.5x6x12	72.0	53.24	.2195	.1079	.1000
31	3.5x6x12	72.0	53.24	.2195	.1079	.1000

TABLE XIII (CON'T.)

COMPARISON OF ACTUAL AND THEORETICAL NET VOLUMES

Sample Number	Size of Block Inches	Gross Area Sq. In.	Net Area Sq. In.	Gross Vol. Cu. Ft.	Net Vol. Cu. Ft. Measured	Net Vol. Cu. Ft. Actual
32	3.5x6x12	72.0	53.24	.2195	.1079	.0990
33	3.5x6x12	72.0	53.24	.2195	.1079	.1000
34	3.5x6x12	72.0	53.24	.2195	.1079	.1035
35	5.5x8x12	96.0	70.00	.3160	.2130	.2130
36	5.5x8x12	96.0	70.00	.3160	.2130	.2120
37	5.5x8x12	96.0	70.00	.3160	.2130	.2100
38	5.5x8x12	96.0	70.00	.3160	.2130	.2180
39	5.5x8x12	96.0	70.00	.3160	.2130	.2100
40	5.5x8x12	96.0	70.00	.3160	.2130	.2100
41	5.5x8x12	96.0	70.00	.3160	.2130	.2100
42	5.5x8x12	96.0	70.00	.3160	.2130	.2100
43	5.5x8x12	96.0	70.00	.3160	.2130	.2100
44	5.5x8x12	96.0	70.00	.3160	.2130	.2100
45	5.5x8x12	96.0	70.00	.3160	.2130	.2100
46	5.5x8x12	96.0	70.00	.3160	.2130	.2100
47	5.5x8x12	96.0	70.00	.3160	.2130	.2100

highest strength, but also some of the highest strengths were from light blocks. Therefore, the unit weight could be a slight indication of the strength, but not a definite measure. If the unit weight of the concrete was close to the average of 83.5 pounds per cubic foot, it would be safe to expect the blocks of that mix to meet the compressive strength requirements.

The total aggregate is the sum of the sand and pumice, and the unit weight is an indication of the percentage of sand to the percentage of pumice, providing an admixture was not used. The use of an admixture usually increased the unit weight of the units. The unit weights varied from 66.0 pounds per cubic foot to 90.61 pounds per cubic foot, the average being about 83.5 pounds per cubic foot.

The unit weight of each sample is given in Tables V through XI.

VI. FREEZE-THAW TESTS

Table XIV gives the tabulated results of the freeze-thaw tests performed on sections of blocks containing adobe, sand, pumice, and sections containing only pumice and sand. The bone-dry weight of each sample is given before the test was started, and the weight, loss of weight, and percentage of

loss is given for every third cycle of alternate freezing and thawing.

Specimens one through four contained pumice and sand with adobe being used as an admixture, specimens five through eight contained only pumice and sand.

Specimen numbers one, two, and three failed after fifteen cycles of alternate freezing and thawing, number six failed after eighteen cycles, number eight failed after twenty-one cycles, numbers four, five, and seven showed very little disintegration.

It is evident that adobe is deleterious when used in blocks, if the blocks are subjected to adverse climatic conditions. See Table XIV.

The specimens started losing weight too soon because they were taken from blocks and the structure was naturally weakened when the blocks were broken. It was evident from the samples that the adobe particles tend to adhere to each other and form lumps of adobe in the blocks. This weakens the block in every respect. If adobe is to be used, the writer does not recommend its use in any extent, it should be screened and thoroughly powered before being mixed with the other materials.

TABLE XIV

RESULTS OF FREEZE-THAW TESTS

	Specimen 1			Specimen 2			Specimen 3			Specimen 4		
	Wt.	Loss in Wt.	% Loss	Wt.	Loss in Wt.	% Loss	Wt.	Loss in Wt.	% Loss	Wt.	Loss in Wt.	% Loss
Start	2.155			0.898			1.719			1.375		
3rd. Cycle	2.141	.014	.065	0.898	.000	0.000	1.710	.009	.0525	1.368	.007	.0509
6th Cycle	2.117	.038	1.764	0.890	.008	0.089	1.703	.016	.0931	1.359	.016	1.163
9th Cycle	2.109	.046	2.125	0.875	.023	2.56	1.703	.016	.0931	1.359	.016	1.163
12th Cycle	2.109	.046	2.125	0.875	.023	2.56	1.703	.016	.0931	1.359	.016	1.163
15th Cycle	2.054 (Failed)	.101	4.69	0.875 (Broke)	.023	2.56	1.656 (Failed)	.063	3.665	1.359	.016	1.163
18th Cycle										1.359	.016	1.163
21st Cycle										1.359	.016	1.163

TABLE XIV (CON'T.)

RESULTS OF FREEZE-THAW TESTS

	Specimen 5			Specimen 6			Specimen 7			Specimen 8		
	Wt.	Loss in Wt.	% Loss	Wt.	Loss in Wt.	% Loss	Wt.	Loss in Wt.	% Loss	Wt.	Loss in Wt.	% Loss
Start	0.938			2.234			1.304			2.281		
3rd Cycle	0.938	.000	0.000	2.234	.000	0.000	1.304	.000	0.000	2.281	.000	0.000
6th Cycle	0.929	.009	0.096	2.203	.031	1.389	1.281	.023	1.762	2.250	.031	1.359
9th Cycle	0.929	.009	0.096	2.196	.038	1.701	1.281	.023	1.762	2.242	.039	1.709
12th Cycle	0.929	.009	0.096	2.188	.046	2.060v	1.281	.023	1.762	2.240	.041	1.795
15th Cycle	0.929	.009	0.096	2.172	.052	2.330	1.281	.023	1.762	2.226	.055	2.410
18th Cycle	0.921	.016	1.810	2.156	.078 (Failed)	3.490	1.281	.023	1.762	2.219	.062	2.710
21st Cycle	0.921	.016	1.810				1.281	.023	1.762		(Broke)	

Table XV contains all the samples that failed any test. As previously stated, the moisture content test does not determine the qualities of a block, but it has also been included in this table.

The absorption test can be waived if a block is to be waterproofed. Therefore, the strength test is actually the only disqualifying test. Table XV shows that only six samples failed.

TABLE XV

SAMPLES FAILING TEST

Sample Number	Absorption	Moisture Content	Compressive Strength
1	Passed	Failed	Passed
2	Passed	Failed	Passed
3	Failed	Failed	Passed
4	Passed	Failed	Passed
5	Passed	Passed	Failed
6	Passed	Failed	Passed
7	Passed	Failed	Passed
8	Passed	Failed	Passed
10	Passed	Failed	Passed
11	Passed	Failed	Passed
13	Passed	Failed	Passed
14	Failed	Passed	Passed
17	Failed	Failed	Passed
19	Failed	Passed	Passed
24	Failed	Passed	Passed

TABLE XV (CON'T.)

SAMPLES FAILING TEST

Sample Number	Absorption	Moisture Content	Compressive Strength
27	Failed	Passed	Failed
28	Failed	Passed	Failed
33	Passed	Failed	Passed
34	Failed	Passed	Passed
35	Failed	Passed	Passed
36	Failed	Passed	Passed
37	Failed	Failed	Passed
38	Passed	Failed	Passed
39	Passed	Failed	Passed
40	Passed	Failed	Passed
41	Failed	Passed	Failed
42	Failed	Passed	Passed
44	Failed	Passed	Passed
45	Failed	Passed	Passed
46	Passed	Passed	Failed
47	Failed	Passed	Failed

CHAPTER IX

CONCLUSIONS

On the basis of this investigation, the following conclusions may be drawn:

1. Pumice obtained in New Mexico is an acceptable aggregate for lightweight-concrete blocks provided sand is used with the pit-run material to supplement the deficiency of fine material, or provided it is screened and proportioned to meet the required grading and gives a well-graded aggregate.

2. The pumice tested contains a very small amount of injurious organic matter -- not enough to be considered.

3. Concrete blocks using pumice and sand as the aggregate can be designed to meet all the American Society for Testing Materials specifications. (Table XV gives the samples that failed to meet specifications of any test.) It would be unsafe to use any mixes or designs in this thesis without first testing the results on the specific equipment being used. The different degrees of vibration of the various machines alter the results considerable. The higher the vibrating speed the greater the density of the block, and this tends to increase the strength. These designs and mixes

only give an indication of the range of mixes and strengths.

4. Admixtures: Pozzolith, brick cement, and adobe increase the compressive strength of the blocks. Calcium chloride is a good mixture to use in cold weather.

5. Pozzolith, brick cement, and adobe used as admixtures tend to reduce the absorption of the blocks.

6. Curing of the blocks under ideal conditions increases the compressive strength.

7. There was little or no difference noted in the blocks made of white and brown pumice, except as mentioned in the absorption test.

8. High-early strength cement usually produce blocks that have higher ultimate strengths.

9. The freeze-thaw tests proved that adobe has a deleterious effect on blocks subjected to adverse climatic conditions.

10. It is evident, since the compressive strengths of comparative mixes varied so greatly, that better control of proportionment of materials is needed in most block plants.

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