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QUALITIES OF High-Grade Paving Brick and Tests Used in Determining Them

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[By Arthur N. Talbot.]

Introduction.

The extensive use of brick for street paving purposes makes the formulation of the qualities requisite for a good paving brick a matter of importance to both producer and consumer. Although it may not be difficult to agree on these qualities in the abstract, it is not easy to express the requirements in definite and concrete form and in terms acceptable to both manufacturer and municipality. It is an accepted principle that the quality of an engineering material should not be left merely to the judgment of an individual, no matter how experienced the individual may be; recourse should be had to physical tests and these should be definite and discriminating. Such tests may not of themselves be conclusive, the results are in the nature of evidence which must be interpreted and judged in the light of other information. Perfect materials for a pavement may not be obtained and high quality usually means increased cost of production, but on the other hand the additional cost of a good article is usually made up many times over in the increased length of life and improved surface of the pavement as compared with a pavement in which an inferior brick is used. The problem of formulating requirements and making tests is further complicated by the difficulties encountered in selecting brick for test and comparison from the piles of brick along the street and in judging whether the variation from the average throughout these piles is sufficient of itself to be cause for rejection. Enough has been said to justify the view that the formulation of the qualities needed in a high grade paving brick and the use and interpretation of physical tests for determining the qualities of the brick for aiding in deciding whether brick come up to the required grade, are matters worthy of discussion by engineers and manufacturers. A general statement of matters connected with brick testing may be of advantage to many who are interested in the construction and use of brick pavement.

Most specifications for materials set forth qualities of materials to be furnished by the producer to the consumer. In the case of brick pavements the producer (i. e., the manufacturer) and the consumer (i. e., the municipality and the property owner, as represented by the municipal administrative officers) are to use certain requirements to define the material to be put into the pavement. Some of the purposes of these requirements and tests may be expressed as follows:

1. To make a basis or definition of what is wanted and what is to be furnished. This is the commonly accepted purpose of such requirements and tests.

2. To enable the city to secure material which will be as serviceable as other material which has passed the requirements and which has stood the test of traffic and time. This makes the tests in a sense a guaranty of quality.

3. To enable comparisons to be made between the products offered. It is quite possible that tests may show that a given brick is above the requirements, or that a slight difference in price is made up many times by the superior quality of the article.

4. To improve the general quality of the product put on the market. It has frequently happened that the formulation of requirements and the careful inspection of the articles offered have resulted in improved quality and this in many cases even without increasing the cost of production. The manufacturer has been stimulated thereby to study the process of production and to seek to improve methods of manufacture and quality of product. One need instance only structural steel and paints and oils to show improvements in quality following carefully made requirements and tests to show the beneficial influence of adequate inspection and tests.

5. To safeguard the interests of the public and of the taxpayer. The Illinois law requires, and rightfully, too, that the nature and quality of the improvement shall be explicitly stated, and evidently intends that the taxpayer may be able to determine (1) what the improvement is to be, and (2) whether it is being put in as described.

6. In the occasional cases where abuse of authority or improper or dishonest construction may require a check, to enable control to be exercised over incapable or dishonest contractors or city officials, and to restrain careless or inefficient employes, or men who may have a mistaken notion of what their employer's interests are.

7. To educate producer, consumer, and their agents in a knowledge of the qualities needed in paving brick,—from the manufacturer and the contractor and their employes to the mayor, the engineer, the inspector, and the property owner. It should be recognized that those who have charge of municipal work are a constantly changing class, and that the property owner may have little knowledge of pavement construction.

8. Not the least important of the reasons for having an explicit and definite statement of the qualities and requirements for a paving brick is to give the opportunity for all bids to be made on the same basis and for the bidder to fix his price according to the quality of the article wanted and thus to facilitate fair competition.

It is evident that a knowledge of the qualities of a high-grade paving brick and of the defects to be avoided in the selection of brick will be useful in making up the requirements defining the grade of brick to be used and that the method of making tests ought to be studied both in relation to the wear of the brick in the street and to the bearing of the results of the physical tests upon the wearing and other qualities of the brick. In this article a discussion of the qualities needed in a paving brick will be given first, and the bearing of the tests upon these qualities will then be taken up, though it will be seen that the relation between the method of testing and the quality to be determined is so intimate that their discussion must be carried on together to a considerable extent.

QUALITIES FOR A HIGH GRADE PAVING BRICK.

General.—Paving brick should possess the following qualities: 1. Toughness, hardness, and strength. 2. Uniformity of quality throughout a given lot of brick. 3. Homogeneity of structure and freedom from laminations. 4. Weather-resisting quality. 5. Regularity in form and size. These qualities are named somewhat in the order of their importance, though it should be recognized that several of them are mutually inclusive.

1. *Toughness, Hardness, and Strength.*—Toughness is that property of a material which indicates its ability to withstand destruction by shock or impact or by a marked distortion of the form of the piece. It is the opposite of brittleness. Of course toughness differs in different materials, and it varies in a given material. Mild steel has the property of toughness to a marked degree and will withstand distortion and abuse. One test of the toughness of a specimen of mild steel is to bend the piece cold 180° flat on itself without sign of fracture. Cast iron is a more brittle material and ordinarily is not used to take shock except in large masses and at low stresses. Different grades of cast iron, however, possess different degrees of toughness, and a good quality of cast iron will bend considerably before rupturing. With such materials the physical property of toughness which will permit bending and distortion in relatively thin pieces will give ability to withstand blows and the sudden application of loads in thicker masses. In the case of paving brick, a lack of toughness causes the brick to chip and spall under the action of horses' hoofs and not to resist blows and abuse under the action of traffic. This element of toughness is one of the most important qualities in a good paver.

Hardness is that property of a material which indicates its ability to resist abrasion. The necessity for hardness is self-evident. The grinding action of loaded wheels sliding sidewise or even rolling forward wears away the surface of the brick and forms grit or dust. This abrasion is the principal source of wear in a well-constructed pavement made of a good quality of brick. Soft brick will wear rapidly under the action of traffic. Hardness is therefore a desirable property for paving brick to possess.

Strength is another important element. The loads of wheels are concentrated on a small area, possibly a ton on a fraction of a square inch. With an uneven bedding of a brick or other conditions like its being supported on a pebble or by an adjoining brick, considerable flexural action is developed, and even twisting action, and the brick acts as a beam. With uneven surfaces there may be considerable horizontal thrust. It has been argued that lack of strength in the brick does not seriously affect brick pavements and that pavements do not fail from this source, but the writer has seen brick of a mediocre quality spall under the trust of a loaded wheel again and again, and it is not uncommon to see brick broken in two by the passage of loaded wagons. Moreover, when a material is otherwise severely strained the effect of abrasion and impact is greater, and the brick which under heavy stresses remains well below its ultimate strength will be better able to withstand the abrasive action which takes place under such conditions. Besides, high compressive strength is generally conducive to hardness, and for granular materials a relatively high tensile strength such as accompanies high values in cross breaking is an indication of toughness and high resilience in the material.

The elements of toughness, hardness, and strength are difficult to differentiate, since one involves the other. On the other hand, a very hard brick may be quite brittle, so much so as to be an inferior article. Some very tough bricks are not hard enough to resist abrasive action sufficiently. Where this is so, there may be some defect in the process or treatment during manufacture. Generally flexural strength goes with toughness and compressive strength with hardness. Not all these qualities may be expected to exist to the same degree in brick of different makes, and hence the different properties should be considered in discussing the merits of a variety of brick.

2. *Uniformity of Quality.*—In the enumeration of properties needed in a paving brick, uniformity of quality throughout a given lot has been placed second in the list, and it is believed by the writer that it is hardly secondary to the qualities of toughness, hardness, and strength. It is highly desirable that all the brick in a given lot shall be as nearly uniform in make-up as is practicable with the best materials and manufacture, and especially that brick which will be near each other shall be of uniform quality. If one brick is soft and the next one hard, an uneven surface will be produced more quickly than otherwise, the resulting soft spots receiving harder wear as the low spots appear. A pavement of soft but uniform bricks will wear away at a uniform rate, and its surface may remain less objectionable than one containing a fair proportion of harder brick. The products of some plants are particularly troublesome in this direction, while those of others are fairly uniform. This quality or lack of this quality renders inspection on the street very difficult, and has done as much as any thing to throw discredit on brick pavement. Brick manufacturers will render service to their industry by striving to secure greater uniformity and municipalities must, on their part, protect their interests by holding stricter requirements than in the past. The importance of uniformity has not generally been sufficiently recognized.

3. *Homogeneity of Structure and Freedom from Laminations.*—Homogeneity of structure gives uniformity of wear throughout the brick and adds to ability to resist wear and breakage. A brick of homogeneous texture is more likely to possess toughness and strength to the requisite degree than is one of variable texture. Laminations in a brick are particularly objectionable, since they markedly decrease toughness and strength, and permit chipping and spalling. It is important that tests for toughness, hardness, and strength be made in such a way as to bring out the effect of laminations and other defects which may not be apparent near the surface of the brick. The brick should be uniform throughout, evenly vitrified, and free from spots which result from imperfect crushing and mixing of materials and from any element which will tend to disrupt the brick by later changes in condition.

4. *Weather-resisting Quality.*—Strong, tough, hard brick of low porosity and even texture are not injured by weather changes. Soft, weak and porous brick are affected by frost and other weather conditions, and a laminated and coarse structure promotes disintegration.

Generally speaking, high grade paving brick are of sufficient strength to withstand weather influences, but the combination of weather effect and traffic is more noticeable. The writer has observed the spalling and grinding of soft brick under heavy loads during the time when they were wet and frozen on pavement where the wear was much slower under better weather conditions. Occasionally a pavement is found where rapid deterioration takes place during the early spring. Part of the trouble of this sort is due to improper bedding and filling.

5. *Regularity in Form and Size.*—Well-formed brick of uniform size give a smooth and regular surface to the pavement, and thus add to its attractiveness. Besides, such brick will have uniform bearing and exert even pressure on the sand cushion below, and thus will remain in position during the life of the pavement. Desirable as this uniformity is, it does not pay to obtain it at the expense of the wearing qualities, and pavements with the smoothest surfaces do not always give the best results. Some irregularity in shape and form must be expected and permitted, especially with clays of a certain character. No general rule may be formulated, and the amount of irregularity may easily be settled upon in connection with any given lot of brick.

Tests For Quality.

GENERAL STATEMENT.

The main advantage of physical tests of paving brick lies in giving definite evidence having a bearing upon the properties and qualities of the brick. To make this evidence useful, the relation of the method of making the tests and their results to the qualities thereby determined must be understood. In several of the tests numerical standards may be set for general use. However, in many cases and especially for some of the tests which may be made, it is best to consider that the results are advisory in nature and that hard and fast limits may not be set. In subsidiary tests the results may give evidence which confirms findings otherwise made or which throws light upon unsettled questions and aids in interpretation of data obtained by other tests.

In tests of materials it is not essential that the material shall be subjected to the same action in the process of testing as it will receive in the structure in which it is to be placed. The cold bend test of steel is one of the most useful and instructive of tests, but it differs radically from any condition of service in which the steel will be placed. The value of a test will depend upon the properties determined, and the criterion will be, does the test establish definitely certain properties of the material, or does it give definite evidence concerning specific qualities, and does not the method give results similar to those found in service. Thus the ordinary rattler test is quite unlike the action of traffic on a street, but if it determines the toughness and hardness of a brick sufficiently well it serves its purpose. Because high grade paving brick do not crush in service is not conclusive evidence that the results of crushing tests do not give important information concerning the qualities of a given lot of brick. Of course, a test which approximates the conditions of wear and stress in the street pavement has a distinct advantage in that it appeals to the lay mind and gives the municipal officer and the tax payer confidence in the findings which would not be possible in a test of seemingly less direct applicability. Whatever the test, its purpose and the bearing of the results on the qualities desired in the brick should be understood and accepted by all.

The tests which have been used, some of them very commonly, others only occasionally, are: 1. the rattler test (called also the impact and abrasion test); 2. the absorption test; 3. the crushing test; 4. the cross-breaking test; 5. the specific gravity test. The rattler test is commonly considered to determine toughness and hardness, or resistance to impact and abrasion. The absorption test gives information bearing upon the degree of hardness to which the brick has been burned. The cross-breaking test and the crushing test determine strength and incidentally give evidence of the hardness and toughness of the brick. The specific gravity test must be classed among those tests which are of value in giving general information. The manner of making these tests will now be described and some discussion given of the meaning of the results found by the various tests.

THE RATTLER TEST.

It may be of interest to recount some of the efforts which have led up to the present standing of the rattler test. During the earlier years' experience in the construction of brick pavement the judgment of those in charge of the work was the only guide used when passing upon the quality of paving brick. It was soon seen that some test to measure the ability of a brick to resist wear was needed, and the use of the foundry rattler or tumbler, employed in foundries for cleaning castings, was suggested. Brick were placed in these rattlers with a charge of foundry shot, which is generally composed of a miscellaneous lot of broken castings of various sizes and weights and of varying degrees of roughness and irregularity. The rattler, with its charge of brick and shot, was then rotated for some time, and the loss in weight of the brick was determined. It is easy to see that there was small chance of anything like uniformity in making this test. Each individual used the rattler which was available for the purpose, without reference to its size. The speed used in the test was whatever the foundry happened to be using. The total number of revolutions depended also upon the time the rattler was run, and this varied. The weight of the foundry shot used and the size and condition of the pieces were whatever happened to be in use in the foundry where the test was made, though this was sometimes varied by using what the individual making the tests considered to be better. Some engineers were somewhat more definite and specified that a given weight of miscellaneous foundry shot was to be used. In 1896, H. J. Burt* reported that specifications from fifteen cities showed the following ranges in the dimensions of the rattler and conditions of the test: Length of rattler, 24 to 54 inches; diameter, 15 to 40 inches; speed, revolutions per minute, 15 to 45; duration of test, 30 to 360 minutes; weight of iron in the charge, 50 to 800 pounds; Loss permissable in one hour, 3 to 10 per cent. These figures show something of the variation in practice at that time.

It is quite evident that this lack of uniformity was conducive to confusion. The engineer was not able to compare the brick which he accepted with the material which the engineer of a neighboring city rejected. The manufacturer could not tell definitely whether his product

*The Technograph, University of Illinois, No. 10, p. 93.

would fill the requirements in a city where he had not furnished brick. There was considerable difference of opinion on the effectiveness of the tests specified in certain cities in determining the toughness and hardness of brick. The amount and nature of the foundry shot used in some cases rendered the test merely an abrasion test. Perhaps the greatest confusion was due to the lack of explicitness in the specifications. As an illustration the following example is cited. In 1895 when the writer was engage by the city of Chicago to make tests of brick from thirty yards in several states to find what makes of brick came up to the requirement of the specifications that the loss in one hour test should not exceed 12 per cent, he asked for instructions on the size of rattler, speed, and amount and nature of the foundry shot to be used in the test, and was told that these matters had not been specified and that he was to use his own judgment concerning them. Of course, in such cases manufacturers were not able to determine what grade of brick was wanted, and municipalities were uncertain about the quality of the pavement which they were putting down.

A number of efforts were made to standardize the rattler test. One of the earliest attempts was made by Prof. Ira O. Baker, in 1890, by subjecting brick which had seen service in a pavement and pieces of natural stones cut to standard form and size to the action of a rattler in which were also placed small pieces of scrap iron. This method was unsatisfactory on account of the trouble and expense of preparing the test pieces of natural stone and the lack of uniformity in the stone, as well as because as used it did not properly combine the two actions of impact and abrasion. Later, the same investigator made a series of tests using 2-inch cubes of brick and stone with a charge of foundry "stars," but this method did not prove satisfactory.

In 1895 the National Brick Manufacturers Association appointed a commission to investigate the subject of paving brick tests and to recommend standard methods for their conduct. This commission was made up of representative men, and they had unusual facilities for their investigation. The work done marked a distinct advance in the testing of paving brick. The report of this commission* made in February, 1897, contains much valuable data on the subject of testing paving brick. The investigation of the rattler test was made by Prof. Edward Orton, Jr., of Ohio State University. His experiments were conducted upon Canton red granite repressed brick pavers, burned so as to have a high degree of uniformity. These brick were of as high quality as is generally available for paving purposes. A general summary of the results of Professor Orton's investigation of the rattler test may prove of interest in this discussion.

Tests were made with charges of foundry shot made up of small scraps which had been used in a foundry as an abrasive to clean rough castings. These pieces composing the foundry shot were small, averaging less than one-half pound and in no case being more than one and one-half pounds. The resulting loss was small and, of course, was due

*Pamphlet published by T. A. Randall & Co., Indianapolis, Ind.

almost wholly to abrasive action, the impact effect being very slight. Cast-iron bricks weighing approximately seven pounds each were next used in the rattler. Charges of these cast-iron shot equivalent to 10, 15, 20 and 25 per cent of the volume of the rattler were tried, five paving brick being tested each time. The bricks subjected to this test sustained comparatively little loss by abrasion, the principal loss being by breaking and chipping. The effect of the impact with these heavy shot was very severe. Without trying another size of shot or attempting to blend the abrasive and impact effect by means of a mixture of sizes, the use of iron was abandoned, though Professor Orton felt that its cheapness, its long life, and its uniformity at all parts of the country would make it particularly suited for a standard filling if its action as an abrasive were favorable.

Tests were then made using natural stone of the general size of paving brick. It was found that limestone, sandstone, and granite were as variable in their losses as are brick, that the results obtained with the paving brick when tested with blocks of stone were exceedingly erratic, and that the accompanying expense and trouble themselves rendered this method unacceptable.

Tests were made with paving brick alone in the rattler, no other abrasive or filling material being used. After an elaborate set of tests made with a few of determining the best speed, size of charge, etc., Professor Orton reported that with brick alone in a rattler of 28-in. diameter the volume of the charge of brick should be from 10 to 15% of the volume of the rattler, the test should be continued for at least 1500 revolutions, that the speed should be between 24 and 36 revolutions per minute, and that the length of the rattling chamber should not be less than 18 inches. These conditions were found to give the least variation in results, the most severe wear, and to be the most convenient.

The commission also had the advantage of the tests made by Mr. E. F. Harrington, of the testing department of the city of St. Louis, which were along the same lines and gave confirmatory evidence. Professor Orton's report submitted specifications for the conducting of a standard rattler test and these were adopted by the commission almost without modification. These specifications are now known as the old National Brick Manufacturers Association test and sometimes as Orton's test. The making of a standard for the size and speed of rattler and for the charge was a great step in advance, but the peculiar feature of the test, the use of brick alone in the rattler, did not prove to be a fortunate arrangement, as it was soon shown that this test failed to discriminate to a sufficient degree between good and poor paving brick. This feature has since been eliminated, and a definite charge of cast-iron shot is now used in the standard test. However, as its reproduction here may make it convenient for reference for some, the specifications adopted by the Paving Brick Commission of the National Brick Manufacturers Association are here given.

ORIGINAL SPECIFICATIONS FOR A STANDARD METHOD OF CONDUCTING THE RATTLER TEST FOR PAVING BRICK. (KNOWN AS THE OLD N. B. M. A. TEST OR ORTON'S TEST).

I. Dimensions of the Machine.

The standard machine shall be 28 inches in diameter and 20 inches in length, measured inside the rattling chamber.

Other machines may be used varying in diameter between 26 and 30 inches, and in length from 18 to 24 inches, but if this is done a record of it must be attached to official report. Long rattlers may be cut up into sections of suitable length by the insertion of an iron diaphgram at the proper point.

II. Construction of the Machine.

The barrel shall be supported on trunnions at either end; in no case shall a shaft pass through the rattling chamber. The cross section of the barrel shall be a regular polygon, having fourteen sides. The heads and staves shall be composed of gray cast iron, not chilled or case hardened. There shall be a space of one-fourth of an inch between the staves for the escape of dust and small pieces of waste. Other machines may be used having from twelve to sixteen staves, with openings from one-eighth to three-eighths of an inch between staves, but if this is done a record of it must be attached to the official report of the test.

III. Composition of the Charge.

All tests must be executed on charges composed of one kind of material at a time. No test shall be considered official where two or more different bricks or materials have been used to compose a charge.

IV. Quantity of the Charge.

The quantity of the charge shall be estimated by its bulk and not its weight. The bulk of the standard charge shall be equal to 15 per cent of the cubic contents of the rattling chamber, and the number of whole brick whose united volume comes nearest to this amount shall constitute a charge.

V. Revolutions of the Charge.

The number of revolutions for a standard test shall be 1,800 and the speed of rotation shall be 30 per minute. The belt power shall be sufficient to rotate the rattler at the same speed, whether charged or empty. Other speeds of rotation between 24 and 36 revolutions per minute may be used, but if this is done a record of it must be attached to the official report.

VI. Condition of the Charge.

The bricks composing a charge shall be dry and clean, and as nearly as possible in the condition in which they are drawn from the kiln.

VII. The Calculation of the Results.

The loss shall be calculated in per cents of the weight of the dry brick composing the charge, and no result shall be considered as official unless it is the average of two distinct and complete tests, made on separate charges of brick.

The abandonment of cast-iron shot as a feature of the rattler test was not in accord with the experience of others, and many engineers felt that it was a mistake. The results of tests made independently of the Paving Brick Commission pointed to this conclusion. The use of high grade brick only in the N. B. M. A. investigation of this new form of test was itself an element of weakness and a very bad feature as it proved to be.

Among experiments which threw some light on the discussion which came up about the efficacy of the new test were those conducted at the

University of Illinois from 1895 to 1899 under the direction of the writer to determine the best composition of the rattling material. The investigation showed that shot composed of small pieces gave an effect which was almost wholly abrasive and that the heavier cast-iron shot produced a spalling and breaking effect which was altogether too severe. It was felt that the rattler test should include the effect of both abrasion and impact, and a series of tests were made to determine what mixture of two sizes of shot would give the best combined effect of impact and abrasion, such as would approximate to the wear of brick in service in the street. The tests were conducted principally with a rattler 24-in. in diameter and 36-in. long. The small shot were 1x1½x2½-in. with rounded edges and weighed about 1 pound each. The large shot were 2½x3⅛x5¼-in. with edges rounded to ½-in. radius, and weighed about 8 pounds each. From the results of the experiments it was concluded that for the 24x36-in. rattler, 150 pounds of 8-pound shot and 150 pounds of 1-pound shot gave results with a satisfactory proportion of abrasion and impact. When a rattler 18-in. long was used, one-half of this charge was selected. The speed was about twenty revolutions per minute. Twelve brick were used in the full rattler and six in the half. The test was conducted for 1800 revolutions. These tests were reported to the Illinois Society of Engineers and Surveyors, and were described in an article on standard methods of tests of paving brick printed in The Technograph,* and reprinted in a number of technical journals. The tests brought out the facts that a combination of large and small shot give a test which will provide both impact and abrasive effects to any degree and that such a test will distinguish soft from hard brick to a fair degree.

The investigations by the writer also called attention to the fact that the test then adopted by the National Brick Manufacturers Association, using brick alone in the rattler, was defective in that it failed to distinguish in any marked degree between hard brick and soft brick. Objections were also made in various quarters. In some tests reported at that time, brick called by the maker as entirely too soft for paving purposes gave a smaller loss than the selected paving brick of the same manufacturer. In another test, three makes of brick of the same general quality made practically the same showing by other methods of testing, while by the National Brick Manufacturers Association, one brick lost less than two-thirds of that lost by either of the other two. It was also stated that in some instances the test gave as good standing to an inferior brick as to a superior paving brick. Soft brick soon broke in the rattler, and thereafter the loss was lighter, so that the final results were likely to be lower than would be expected from the apparent quality of the brick. In general, the test was not very efficient in measuring the toughness of brick. It seems that in the investigations conducted by Professor Orton the use of only one quality of brick, and that a high grade paver, did not permit the real deficiencies of the test to be discovered. The discussion of this test created wide-spread interest. Finally, as a result of a paper presented at the meeting of the Na-

*The Technograph No. 12, University of Illinois.

tional Brick Manufacturers Association in 1899, the association asked Professor Orton to make a further investigation of the subject.

The report of this second investigation, made by Professor Orton, as well as of the reports of tests made with the rattler designed by Gomer Jones, were submitted in January, 1900, to a committee consisting of Messrs. D. V. Purington, J. L. Hegley, H. A. Wheeler, Gomer Jones, Edward Orton, Jr., J. B. Johnson, and A. N. Talbot, which committee had been authorized to discuss these reports for the National Brick Manufacturers Association. In the Jones rattler a few brick were clamped edgewise in pockets around the inside surface of a cylindrical rattler and 1½-in. cubes of cast-iron were used for the impact and abrading material. The report of Professor Orton's tests showed that the device of Mr. Jones embodied several objectionable features and the committee concluded that while the machine might appeal to the public as in a sense representing conditions of wear in the street and while the reports show that the machine is distinctly more sensitive in indicating the softer grades of brick, the variable amount of surface exposed on the brick and the discordant results coming from variations in sizes, as well as other defects of the machine, rendered it less satisfactory as a general matter of testing than the rattler already in use. The series of tests with the standard rattler reported by Professor Orton enabled a comparison to be made between the National Brick Manufacturers Association method in which brick alone were placed in the rattler and the method recommended by the writer which involved the use of cast-iron shot of two sizes. The investigation included the effect of variation in quality of brick, the effect of a change in the amount of shot, the effect of a variation in the proportion of small and large shot, the effect of the speed of the rattler and the effect of size of the brick themselves. The committee in their report advised the National Brick Manufacturers Association to abandon the old N. B. M. A. test and to adopt in its place the test with cast-iron shot of two sizes, definite proportions of small and large shot and of the total charge being adopted. This report was presented to the association in February, 1900, and the association changed its standard method of test to conform with the specifications recommended by the committee. It also accepted the recommendation that further tests and investigations be made.

The idea of clamping the brick in position seemed a promising one and soon after this the writer constructed a rattler in which the brick were securely held around the circumference of a cylinder, their inner faces thereby forming the surface of the cylinder. This machine will be described under the head of "Talbot-Jones Rattler Test." During the first months of 1901, Professor Orton experimented with this machine and reported the results of the tests together with the results of tests made with the standard rattler to a committee consisting of J. B. Johnson, W. K. Hatt, A. Marston, and A. N. Talbot, in August, 1901. This committee reported and recommended a continuance of the standard adopted in 1900, on the grounds that it is somewhat cheaper and simpler than the ordinary rattler in general use, and that the findings by the new N. B. M. A. standard tests are in accord with the results of other tests and with the results of the use of the paving brick in actual service. The committee on Technical Investigation of the National Brick Manufacturers Association accepted this report and by virtue of the authority vested in them by the association reaffirmed the method of tests adopted in February, 1900, as the standard rattler test of the National Brick Manufacturers Association.

National Brick Manufacturers Standard Rattler Test.—The specifications for the present National Brick Manufacturers Association standard rattler test thus finally adopted are here given in full. It will be seen that they include requirements for the dimensions of the rattler chamber and the number of its sides, for the composition of the charge in the number of the paving brick or blocks and the amount of the cast-iron shot and the sizes and form of the shot to be used, for the speed of the rattler, for the number of revolutions for a test, for the condition of the brick, and for the method of calculation of the results.

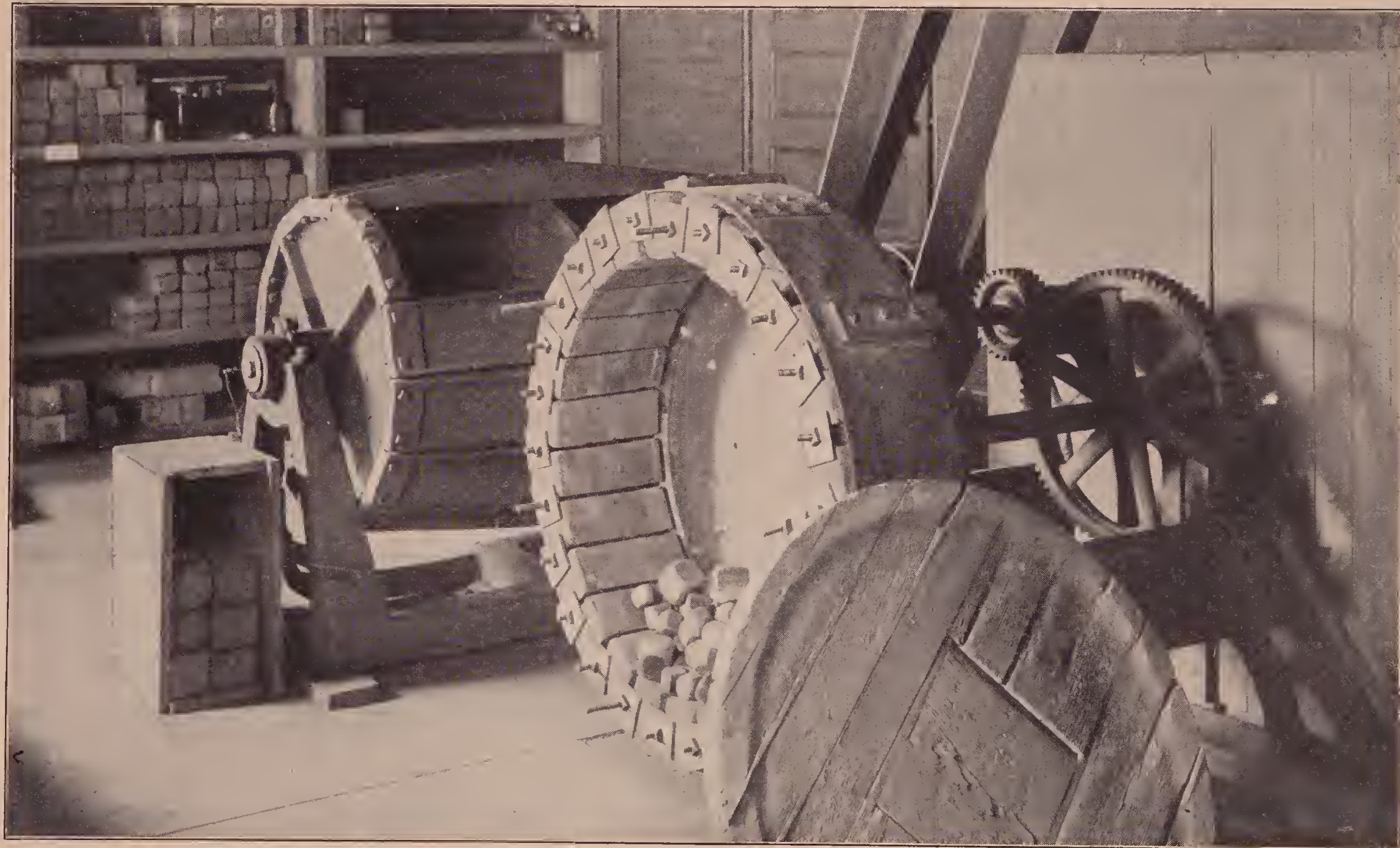
AMENDED SPECIFICATIONS FOR THE RATTLER TEST.
PRESENT N. B. M. A. TEST.

1. *Dimensions of the Machine.*—The standard machine shall be 28 inches in diameter and 20 inches in length, measured inside the rattling chamber.
Other machines may be used, varying in diameter between 26 and 30 inches, and in length from 18 to 24 inches, but if this is done, a record of it must be attached to the official report. Long rattlers must be cut up into sections of suitable length by the insertion of an iron diaphgram at the proper point.

2. *Construction of the Machine.*—The barrel may be driven by trunnions at one or both ends, or by rollers underneath, but in no case shall a shaft pass through the rattler chamber. The cross section of the barrel shall be a regular polygon, having fourteen sides. The heads shall be composed of gray cast-iron, not chilled nor case-hardened. The staves shall preferably be composed of steel plates, as cast-iron peans and ultimately breaks under the wearing action on the inside. There shall be a space of one-fourth of an inch between the staves for the escape of the dust and small pieces of waste.
Other machines may be used having from twelve to sixteen staves, with openings from one-eighth to three-eighths of an inch between staves but if this is done a record of it must be attached to the official report of the test.

3. *Composition of the Charge.*—All tests must be executed on charges containing but one make of paving material at a time. The charge shall be composed of the brick to be tested and iron abrasive material. The brick charge shall consist of that number of whole bricks or blocks whose combined volume most nearly amounts to 1,000 cubic inches, or 8 per cent of the content of the rattling chamber. (Nine, ten, or eleven are the number required for the ordinary sizes on the market). The abrasive charge shall consist of 300 pounds of shot made of ordinary machinery cast-iron. This shot shall be of two sizes, as described below, and the shot charge shall be composed of one-fourth (75 lb.) of the larger size and three-fourths (225 lb.) of the smaller size.

4. *Size of the Shot.*—The larger size shall weigh about seven and one-half pounds and be about two and one-half inches square and four and one-half inches long, with slightly rounded edges. The smaller size shall be one and one-half inch cubes, weighing about seven-eighths of a pound each, with square corners and edges. The individual shot shall be replaced by new ones when they have lost one-tenth of their original weight.



The Talbot-Jones Rattler.

5. *Revolutions of the Charge.*—The number of revolutions of the Standard test shall be 1,800, and the speed of rotation shall not fall below 28 nor exceed 30 per minute. The belt power shall be sufficient to rotate the rattler at the same speed whether charged or empty.

6. *Condition of the Charge.*—The bricks composing a charge shall be thoroughly dried before making the test.

7. *The Calculation of the Results.*—The loss shall be calculated in percentages of the weight of the dry brick composing the charge, and no result shall be considered as official unless it is the average of two distinct and complete tests, made on separate charges of brick.

Talbot-Jones Rattler Test.—In the machine constructed by the writer in 1900 (shown in Plate 2) and named "The Talbot-Jones Rattler" by the committee of expert engineers, the head which forms one end of the rattling cylinder overhangs the frame of the machine. The ends of the brick are placed so as to abut on this head and are securely clamped by bolts so that their inner faces form the concave surface of the rattler cylinder. Spacers of wood of triangular or trapezoidal form are placed between the brick to keep them a fixed distance apart and to aid in holding the brick in place. An end, or second head of wood or of wire screen, is bolted on to close the cylinder. A sheet of metal is fastened to the head of the machine around the outside of the circle of brick and holds the brick in place during the process of inserting them and assists in taking the jar in making the test. In the original form this band was in a fixed position and since brick vary in thickness it was necessary to vary the spacing in order to divide up the space between the bricks throughout the entire circle. In the tests made by Professor Orton with this machine the brick were spaced one inch or more apart. This wide spacing and the variation found in filling the circle with bricks of different thickness seemed undesirable. The machine has now been modified so that the circle is adjustable and the spacing may be made uniform throughout the entire circumference. The average internal diameter of this chamber is 28 inches and the machine may be adjusted from 27½-in. to 28½-in. This permits a full ring to be made with an even spacing and any thickness of brick. It is recommended that the space between brick be made ¼-in. Other details of the machine are that the end of the band lacks about ¼ inch of being in contact with the head of the machine, this space being left for the escape of dust and chips; the heads of the bolts lie in a T-shaped groove in the head of the machine so that they are readily adjustable; the central portion of the head is recessed about ¾ inches so that the iron shot may strike the brick for their full length; the cover of the cylinder for the same reason is held away from the outer ends of the brick.

It will be seen that in this rattler the brick themselves form the outer surface of the rattling chamber and are laid at right angles to the direction of action of the shot, and that one face of the brick receives the wear about as it does in the street. The shot gives the abrading and grinding and impact effect. In many ways the test resembles the wear of brick in the street; it naturally appeals to the mind as resembling and approximating the wear in the street.

This method of testing is a promising one in many directions. The machine is a special one, but its cost is hardly more than the standard rattler. Its use requires but little more skill. The time taken in charging the machine and in making the test is greater, so that the cost of a test by the Talbot-Jones process would be somewhat more than with the N. B. M. A. standard. If, however, it should be found to define the wearing qualities of a brick more definitely and with greater accuracy than does the ordinary rattler, these features would not interfere with its adoption. While considerable experimental work has been done with this machine, it is felt that the investigation has not proceeded far enough to standardize it nor to show its qualifications sufficiently to recommend it for adoption as a standard for testing purposes. The writer has been unable to carry on the necessary investigations, but he hopes that full tests may be made to determine its usefulness. All the tests which have been made are favorable to its efficiency and adaptability for general testing purposes. The uniformity of conditions for the tests and the opportunity to determine relative wear of individual brick are among the attractive features.

ABSORPTION TEST.

There has been a change of view in reference to the value, applicability, and purpose of the absorption test. In the early experience with brick pavement, soft and porous brick were used and the fear was expressed that the brick would crumble and disintegrate under the effect of a re-

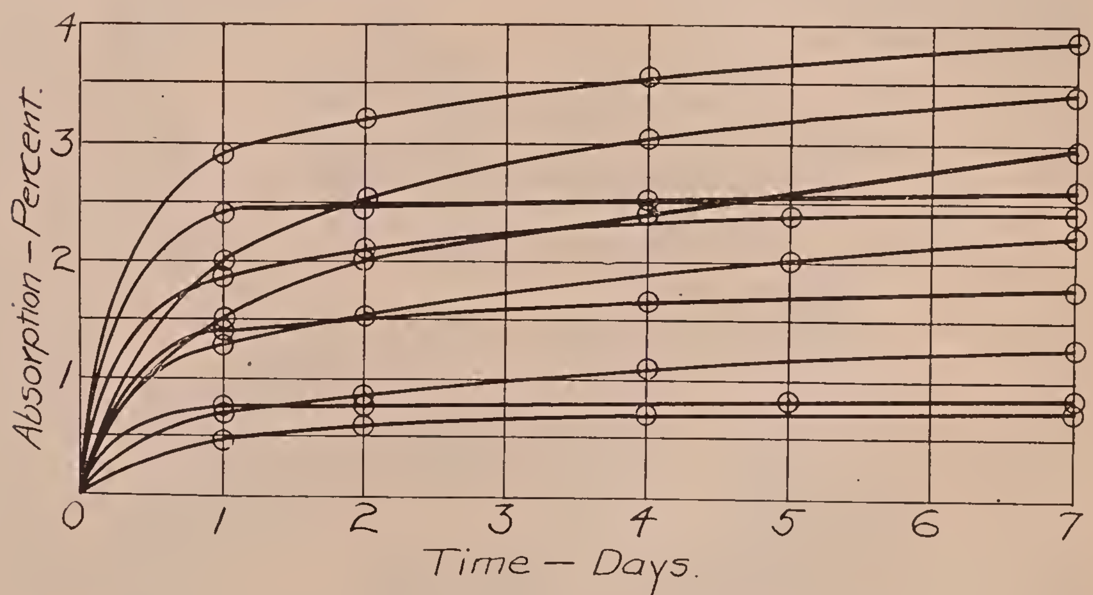


Fig. 1. Rate of absorption of paving brick.

peated freezing and thawing, and an absorption test with an arbitrary limit was included in the specifications. This test was used without full information of the properties of the brick and frequently without good judgment. The experience of years and tests made by repeatedly freezing and thawing bricks have established the fact that the action of freezing and thawing is not likely to disintegrate brick of a high grade which will pass the requirements of other tests. This statement should not be interpreted to mean that the action of frost and traffic together will not cause disintegration of brick which, when dry and cold, would resist the wear of the traffic fairly well. The improper use of the absorption test resulted in an indiscriminate condemnation of it and also in a lack of appreciation of its value and usefulness as an auxiliary test and as a means for studying properties of the brick. The absorption test is a valuable adjunct for use in interpreting the results of the rattler and cross breaking tests and in studying the peculiarities of the particular make of brick which will be put into a pavement.

A good paving brick will absorb water quite slowly, the rate of absorption varying from hour to hour. Fig. 1 shows the rate of absorption through the period of some days, as given by Mr. F. F. Harrington. If the outside of the brick is more dense than the interior the rate of absorption is still slower. A broken brick or a rattled brick will absorb water more readily than whole brick for this reason, and such brick should be selected for the test. In some tests the brick have been partially submerged for some time to allow the escape of air. The absorption of water is more rapid in the beginning, is quite slow after 24 hours, and still slower after 48 hours. The absolute value of the absorption power is not required, and for comparative purposes the result at the end of 24 hours, or better, at the end of 48 hours, will be sufficient. Brick which absorb but a small part of their final amount are usually so dense that the total absorption would be very small and the variation in value for such brick will not affect comparisons. Since brick in their usual condition contain some moisture, the sample should be dried for several hours at a temperature at or above the boiling point of water. The method given below requires 48 hours, but this protracted period seems unnecessary for ordinary purposes.

The absorption test should be conducted under the following conditions: The test will be made on five brick which have been exposed to the action of the rattler, or if these are not available, on five brick which have been broken into halves. The brick shall be dried at a temperature of 200° to 300° F. for 24 hours and then after weighing shall be immersed in water for 48 hours. Before reweighing the brick, surplus water shall be wiped from its surface. The absorption shall be expressed in per cents of the dry weight of the brick.

The idea that low absorption is a guaranty of excellency of the wearing qualities of paving brick was held by engineers for many years. As brick are burned in the kiln the amount of their porosity becomes less and less until a point is reached when another change occurs and further burning will not decrease the porosity. The absorption test may determine or distinguish underburned brick, but overburned brick may not give a test much different from brick which have received the best degree of burning. The best limits for absorption will vary with the clay and method of manufacture and will have to be determined for every make of brick. This determination may be made by comparison with the results of other tests and by experience with the brick. In other words, no general limits can be placed for the absorption test, but special limits may be specified for particular makes of bricks used in any city. For a given brick, then, it may be said that the absorption test is able to distinguish underburned brick, and that it will be helpful in determining the length of burning permissible with a given grade and make of brick.

CRUSHING TEST.

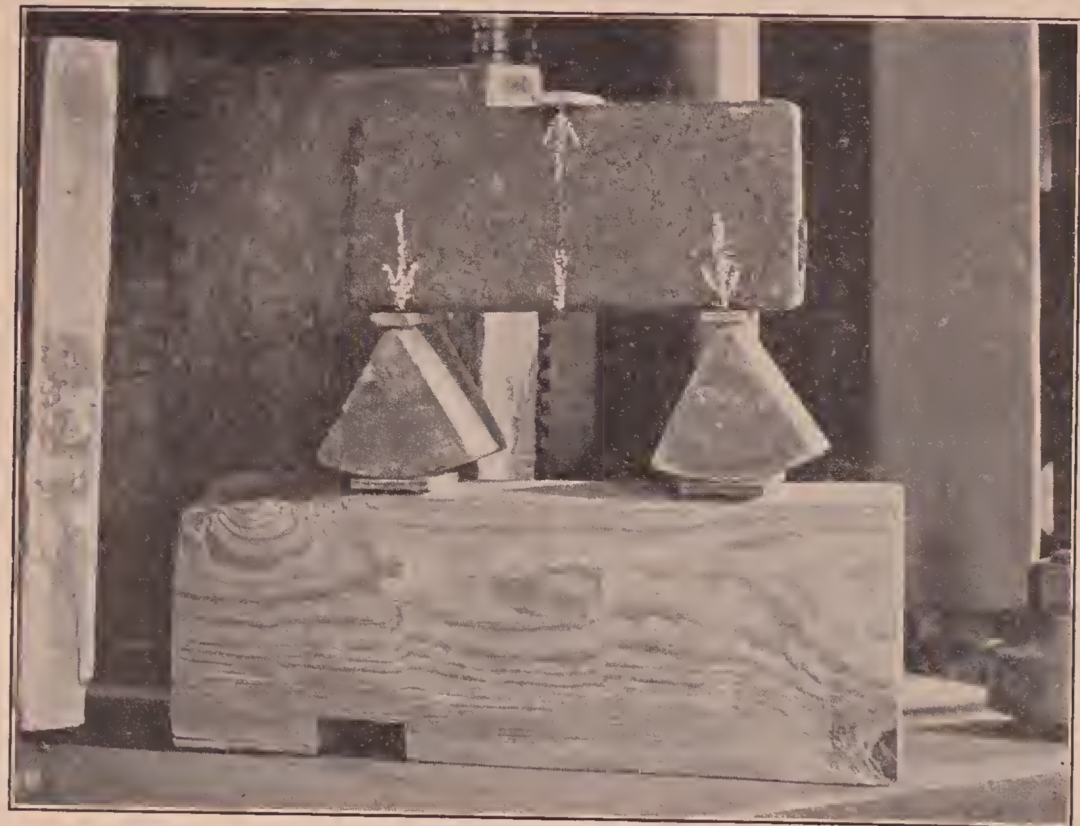
Tests for crushing strength are open to the objection that the results obtained are extremely variable, especially as the method of making the test is not uniform. When the faces of the test cubes are ground accurately to plane surfaces, the results with high-grade paving brick are very high, running up to 20,000 pounds per square inch. The use of prepared test cubes makes an expensive and slow method of testing. Whole brick or half brick are tested on edge, sometimes with the bearing faces ground and in other cases not. If not ground, the faces may be bedded in plaster of Paris and crushed after the plaster has fully set, or the faces may be bedded in card-board or heavy paper. The last named method of testing is more readily made and if at least five specimens are tested the average may be expected to give representative results. In the tests described in this paper, half bricks were tested, several thicknesses of heavy building paper being used as bedding plates. Soft brick will give results as low as 1,000 pounds per square inch, when tested by this method. Occasionally a brick will run as high as 18,000 pounds per square inch. It may be expected that overburned or poor paving brick will stand a load up to 3,000 pounds per square inch. Good pavers will range between 6,000 and 12,000 pounds per square inch.

Crushing strength is a desirable property in a paving brick. The argument that such heavy loads as are indicated by crushing values will not come upon the brick and that the brick will not be crushed in the street is a negative one. There is a relation between crushing strength and hardness. The stronger the brick the better it will resist wear in the pavement. This quality of strength is particularly desirable where pavement is subject to heavy traffic. In comparing two bricks giving about the same rattler results, the one with high crushing strength will stand heavy traffic much better than the weaker one. For light traffic high crushing strength is not essential. It is further true that the crushing test throws light on other physical properties of a brick and is a source of evidence in the study of quality. Generally speaking, however, this test is not of a character to be included in specifications, but it is of value in connection with the study of the properties of different bricks. It will be seen, also, that the cross breaking test gives information which may permit it to take the place of the crushing test.

CROSS-BREAKING TEST.

The cross-breaking test is for the purpose of determining the general strength of the brick; incidentally it gives evidence of the toughness and the hardness of the brick. It indicates the ability to resist cross-breaking, twisting, or spalling by concentrated loads and is an index of the crushing strength of the brick.

Two objections to this test have at times been raised: (1) that the quality indicated by the test is not needed in a paving brick, and (2) that the results of the cross-breaking test are variable and even erratic. It is believed, however, that the test is helpful in judging of the quality and strength and toughness required of a good brick. It may be suffi-



Brick being tested for cross-breaking strength.

cient to specify only a medium value for the modulus of rupture, and yet a brick with a fairly high value will be of higher grade. The brick which does not have the quality of high resistance to cross-breaking is likely to spall or break in the street and not to withstand traffic, even though the rattler test may show a low loss. Brick which have the toughness and strength which go with a good modulus of rupture may show a somewhat higher loss by the rattler and yet give better results in the street than other brick whose rattler losses are lower. It must be expected that there will be a variation in the results shown in tests of individual brick, for quality varies considerably in ordinary paving brick. The rattler tests of individual brick vary widely. Much of the variation which has been reported in the results of cross-breaking tests is due to the method of making the test commonly employed. It is believed by the writer that the method here given reduces the variation due to the method to a reasonable amount and that the variation now found represents quite closely the lack of uniformity in the brick. With the test made in the manner here described cross-breaking tests, if properly judged, become a valuable adjunct in the determination of the qualities of a paving brick.

Brick should be tested as a beam on edge with a span of 6 inches and with the load applied at the middle of the span. The modulus of rupture is determined by the usual formula:

$$S = \frac{3}{2} \frac{Wl}{bd^2} \quad \ldots\ldots\ldots\ldots \quad (1)$$

where W is the load applied, l is the span, b is the breadth of the brick, and d the depth.

Plate 3 gives a view of a brick being tested, and Fig. 32 shows details.

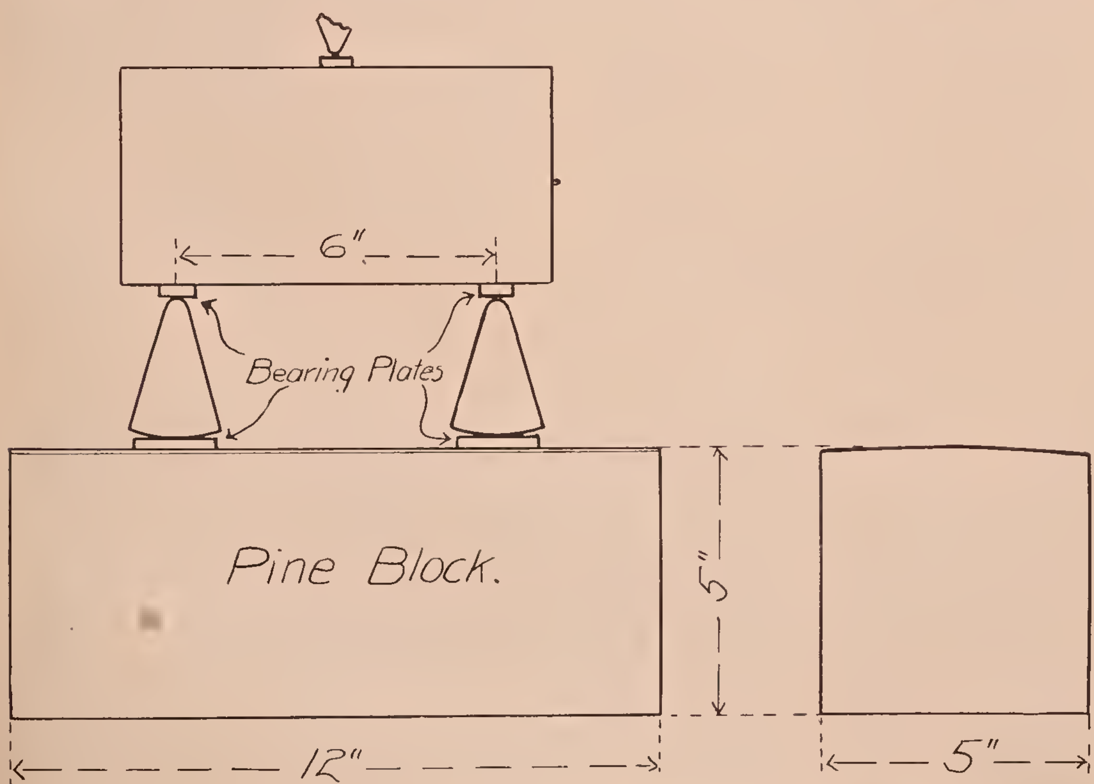


Fig. 2. Arrangement for testing cross-breaking strength of brick.

Attention is called to the use of steel bearing plates and to the use of the wooden block. The narrow soft steel plate gives a bedding on the brick which is slightly adjusting and overcomes the tendency to cutting. The knife edges are slightly curved in the direction of their length, to allow for irregularities or warping in the brick. The lower knife edges rest upon a wooden block which is curved laterally somewhat to allow a rocking movement. The main purpose of the wooden block, however, is to allow adjustment by its compression so that the load will be more evenly distributed and so that the work of applying the load and making the test will extend over a longer time. This arrangement allows a more accurate determination of the amount of the load and greater freedom in making the test. The results of the tests which are discussed later on, show that this method gives results well within the range of uniformity of the brick. Requirements for the cross-breaking test should specify that the brick be tested on edge, that the span be 6 inches, that the knife edges be slightly curved in the direction of their length, say with a radius of 20 inches, and that the test be made upon a wooden block similar to the one shown.

SPECIFIC GRAVITY.

The test for specific gravity gives general information but is not of service for general use. The specific gravity of a brick depends upon the material, the method of making, and the amount of burning. For certain clays and processes the specific gravity of a brick depends upon the amount of burning, up to a certain point, which varies with different clays. A dense, heavy brick has a high specific gravity. The range of specific gravity for shale paving brick is from 2.2 to 2.4. In making tests of specific gravity, the amount of water absorbed by the brick must be allowed for. The brick is weighed in air and then in water and again in air. Then specific gravity may be determined by the formula, $\frac{W}{W'-W''}$, where W is the weight of the dry brick, W^1 is the weight of the saturated brick in air, and W'' is the weight of the saturated brick in water.

Discussion of Tests and Comparison of Qualities.

A comparison of the various tests may be made by studying the results of the extensive series of tests of brick of a wide range of character and quality made at the University of Illinois for the Department of Ceramics and State Geological Survey. These tests are more fully reported elsewhere. The brick were obtained from twenty-seven manufacturers in the states of Illinois, Ohio, Indiana, Missouri, and Kansas. From one to five grades of each make of brick were obtained. Duplicate rattler tests were made for each grade, and five or more brick were tested in cross-breaking and in crushing for each grade. The bricks used in the tests were generally selected and graded at the yards by a representative of the Ceramics Department, who was skilled in selecting and grading brick. When more than one grade was obtained, the first selection made was the best grade for paving purposes, according to the judgment of the representative, care being taken not to select too hard burned a brick. A grade harder or somewhat overburned and one softer or even underburned were selected. When there seemed to be an opportunity for error in judgment, intermediate grades slightly harder or softer than the first were also picked out. The N. B. M. A. Standard rattler test was used, and the other tests were made by the methods already described. Rattled brick were used in the absorption tests.

The general results of these tests are plotted in Fig. 3. The three makes of brick on which transverse and crushing tests were not made are not included in this diagram. The average for the tests on a particular grade are shown. The brick were placed on the diagram generally in the order of the rattler loss, the grade which gave the lowest rattler loss being used to fix the order of any make of brick. The crushing strength is plotted in connection with the modulus of rupture, (cross-breaking test), to enable a ready comparison between these two tests to be made, the scale for the crushing strength being one-third of the actual value. The figures given with the modulus of rupture show the average variation of the modulus of rupture for the individual brick in any grade from the mean of the test on that grade as given in per cent of the mean value of the modulus of rupture. In studying this diagram attention should be given to the amount of variation in the absorption test for each make of brick, to the range in the amount of absorption producing little change in the desirable qualities in some brick and to the rapid change in quality for small changes in absorption for others, and to the relation between the rattler test and the other tests.

Attention is called to the following particulars shown on the diagrams.

Brick No. 2.—A range of absorption from ½% to 3% gives an excellent quality of brick, as shown by the rattler tests, the cross bending test, and the crushing test. Even with 6% absorption this brick gives a good rattler test and a high crushing strength. It is apparent that there may be considerable variety of burning with this brick and yet secure a good article, providing, of course, that the heat treatment is otherwise suitable.

Brick No. 5.—In this make a change in the absorption amount is accompanied by a considerable change in the quality of the brick as shown by the rattler test and the other tests. Much care must then be used in selecting the right degree of burning.

Brick No. 7.—This is a fire clay brick and its strength can not well be compared with the other brick. It seems probable that the smoothness of this material gives it a higher rating in the rattler test than the brick should have.

Brick No. 10.—In this brick the grading for hardness as made secured a brick with but a small range in the absorption test, three grades varying less than 1% in the absorption test. All of these were of very good quality.

Brick No. 12.—Absorption up to 5% has little effect upon the quality of the brick, the cross-breaking strength being good for the grade having 5 per cent absorption. The overburned brick is of poorer quality. The range in absorption from one to five per cent allows considerable latitude in the selection of the brick.

Brick No. 15.—In this brick the amount of burning seems to affect the quality very much and it is difficult to say just what range of absorption is allowable. 3½% absorption accompanies a fairly good brick, but variations on either side of this are very detrimental to the quality. The crushing and cross breaking tests for this brick are low. All of these conditions are indications of an undesirable brick for use as they would be delivered on the street.

Brick No. 14.—This brick has low cross breaking and high absorption. The samples tested do not indicate a first class brick.

Brick No. 16.—This brick permits a wide range of burning without much change in its quality.

The results of the absorption test show that there is generally little or no difference in the amount of water absorbed in overburned brick and

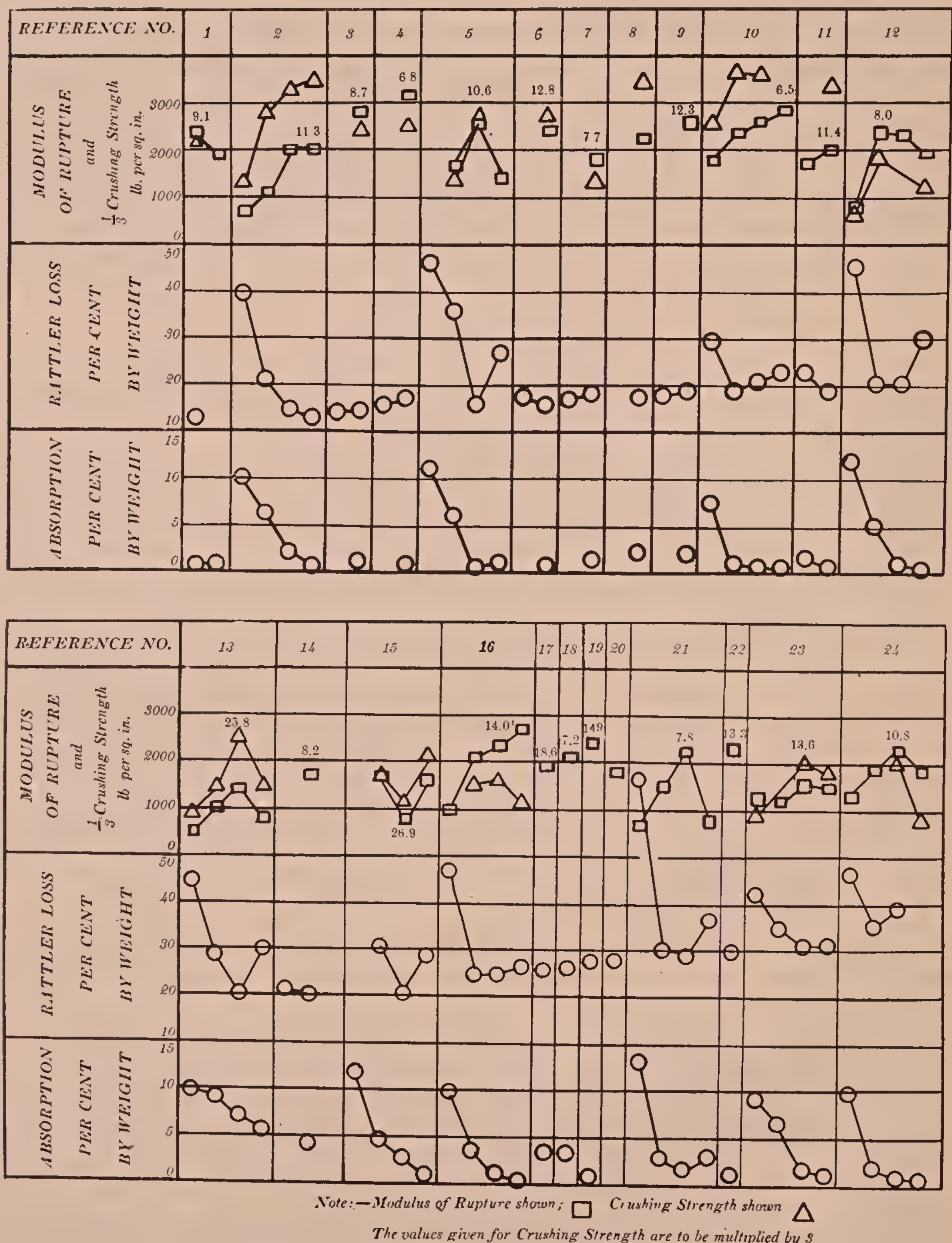


Fig. 3—Results of Tests of Paving Brick.

well burned brick. This agrees, of course, with our knowledge of the change which takes place at vitrification. The amount of variation in absorption between brick of different degrees of harness (of the same make) which show practically the same good wearing quality by all the other tests is of interest. A favorable or wide range of absorption for the same wearing qualities must be considered advantageous to the manufacturer and also to the consumer, both by reason of the wider latitude allowed in burning and also upon the ease of inspection on the street. Other brick like No. 10 give a considerable difference in appearance with only a slight change in the qualities of the absorption test and without any marked change in the wearing qualities of the brick. The absorption test appears to be of value in studying a given make of brick or in learning of its properties and giving information bearing upon the inspection of the brick delivered on the street. For any given make of brick the specific range of absorption which will give a good article may be determined and required.

The results show that generally the rattler test made a fair determination of the quality of the brick, if we may judge by the appearance of the brick, the results of other tests, and the reputation of the brick. In some cases the rattler test gave a rank better than would be given by the character and appearance of the brick and by the results of the other tests. A few of the makes showed rather high rattler loss and gave a fairly good modulus of rupture and cross-breaking strength and uniformity, and some of these brick are reported to have given excellent service under light traffic. Brick 17, 18, 19, and 20 are in this class. The range of difference between that of a single test and the mean of the duplicate rattler tests averaged from about .5 to 1% for the better grades of brick, although in one case the variation was as high as 1.8% from the mean. The variations are smaller than is usual in the rattler test, and attest the care in selecting the brick. The value of the crushing strength was generally between three and four times the modulus of rupture. There was a fairly close agreement between these two tests. A high value in one test was accompanied by increased values in the other test. Generally speaking, it may be said that a value of 2,500 pounds per square inch for the modulus of rupture and 7,500 pounds per square inch for the crushing strength may be expected in first class paving brick. Lower values like 2,000 and 6,000 pounds respectively, are not especially objectionable. In the cross-breaking test the variation in the values for individual bricks is of interest and in some respects this variation may be considered a measure of the uniformity of the brick. As already stated, the numbers given with the cross-breaking test in Fig. 33 show the average range of variation in the modulus of rupture for individual brick from the average modulus for the given grade expressed in per cent of the mean modulus of rupture. In other words, a range of 10 per cent means that if the difference between the modulus of rupture for each individual brick and the average modulus for that grade be expressed in per cents of this average modulus, the average of the results for the given grade of brick will be 10 per cent. It will be noted that for the better grades of brick this range is within 12 per cent. Attention is called to the much greater variation in bricks No. 13, 15, 16 and 17. Since uniformity of quality in a lot of brick is of considerable importance a test of this kind may be used to rate different makes of brick on the score of uniformity.

It should be understood that the brick tested were much more nearly uniform in quality than would be obtained in taking brick at random from piles along the street, since the selection was made with a view to securing uniformity. The variation between duplicate rattler tests is therefore smaller than may be expected in tests of brick from the street, and the uniformity in the modulus is also greater. There was greater freedom from the accidental variations which frequently affect the rattler test. Although the rattler test was fairly discriminating in determining quality, the results must not be taken to indicate that the rattler test may be used to settle the exact order of various makes of brick with respect to wearing quality; it should rather be considered a means of determining whether a brick is up to a required standard. The objection sometimes made that the rattler test does not easily permit determination of variation in individual bricks was not considered in the investigation, since so careful a selection of brick was made. The information given in the cross-breaking and absorption tests is valuable, and the usefulness of these tests is shown, particularly in connection with the study of the qualities of different grades of the same make of brick.

The effect of size of the brick upon the loss found in the rattler was not included in these tests. It is established that the brick size will sustain a greater loss than the block size of the same grade and quality. This excess is due to the greater relative exposure of the corners which chip off more or less, and to the greater proportional wearing surface exposed in the brick size. The amount of this difference depends upon various conditions, but with good material the brick size may be expected to lose, say, 3 per cent more than the block size. Of course, only a part of this difference would show up in the wear of pavements constructed with brick of the two sizes. The effect of accidental differences, or of variations in the quality of the shot, or of the smoothness or other conditions of the rattler was not studied, and will not be discussed here.

A study of Table II shows that the best grade of brick received in the first 450 revolutions of the rattler test from 47 to 53 per cent of the total loss and that the poorer grades lost during this stage a smaller percentage of their total loss, as little as 30 per cent in some cases. Similarly at 900 revolutions, the better grades had received 67 to 77 per cent of their total loss, while the poorer grades had received a smaller proportion of their total loss. It seems that the better grades wear more slowly, comparatively, after the corners are rounded off; and the poorer grades continue to grind off or break up during the latter part of the test.

This extensive series of tests gives data on a wide range of brick and enables comparison to be made of a wide variety of conditions. It is valuable for making a study of the properties of paving brick, as well as for making a comparison of the various tests and requirements for paving brick. It will be seen from Fig. 3 that the best grades of brick in the first ten makes of brick, as shown by the samples tested, are of excellent quality and will make a durable and satisfactory pavement. The remaining makes are less valuable as paving material, and besides many of these may not be judged from their general characteristics since they vary widely with slight changes in general appearance. The rattler test is a fairly satisfactory test for a particular make of brick in picking out the best degree of burning, etc., but in determining the ranking of several makes of brick it should be supplemented with the transverse and crushing tests. The absorption test is of value in studying the characteristics of a given make of brick and in judging of the effect of changes in the amount of burning.

Reference may well be made to the information which a careful observer will obtain in such a series of tests by means of the ocular examination of the structure and appearance of the brick. It suggests the desirability of a study by inspection of the structure and behavior of the brick in connection with the tests made on the brick to be used.

Requirements for Paving Brick.

The rigidity of the requirements to be inserted in specifications or to be taken as standard in selecting paving brick for a street will depend upon the conditions under which the brick are to be used. The amount of traffic and the methods and details of construction used in the construction of the pavement, including such matters as the kind of filler used and the character of the foundation, will naturally have a bearing upon the requirements. A brick may be used on a street where there will be little traffic if it has sufficient weather-resisting qualities when it should be rejected for use with heavy traffic. A large amount of light traffic produces less wear than a much smaller amount of heavy traffic. In a pavement made with a high-grade cement filler the brick will be protected and the effect of spalling and impact may be much less than in a pavement with a sand filler. In a similar way the character of the foundation has to do with the grade of the brick to be chosen. For the purposes of this article it will be sufficient to divide traffic into four classes: (1) Very heavy traffic; (2) Heavy traffic; (3) Medium traffic; and (4) Light traffic. Very heavy traffic would be such as would occur in the business district of our large cities and in certain districts of smaller cities. Heavy traffic would include that found in the business districts of smaller cities. Medium traffic would be such as is found on the streets used as main thoroughfares in the smaller cities. Light traffic is such as is found in the remotest residence portions of the small cities, or streets not frequented. For very heavy traffic it is evident that only the very best brick should be used and that a heavy foundation and a high-grade filler to protect the brick should be used. For the other classes of traffic the requirements may be less rigid except that a high degree of uniformity in the brick should be maintained.

The following limiting values for the requirements for brick for the several classes of traffic are suggested. They are given for the usual block size of brick. The maximum loss by the N. B. M. A. standard rattler test: (1) Very heavy traffic, 15 per cent; (2) Heavy traffic, 17 per cent; (3) Medium traffic, 21 per cent; (4) Light traffic, 24 per cent. For the brick size, 3 or 4 per cent may be added to the above limits, except that the brick size would not be used for very heavy traffic. No values are suggested for the Talbot-Jones rattler since the standardization of this machine is not yet complete. For the cross-breaking test the limits for the modulus of rupture may be made as follows: (1) Very heavy traffic, 3,000 pounds per square inch; (2) Heavy traffic, 2,500 pounds per square inch; (3) Medium traffic, 2,000 pounds per square inch; (4) Light traffic, 1,500 pounds per square inch. It should be noted that these values are subject to modifications, according to requirements of traffic and conditions of the brick, and are not to be taken as iron-clad limits. They are intended to apply to average samples of brick taken from piles along the street. The requirements for uniformity and the methods of determining this uniformity from a separate consideration. The limiting variation from the specified value for the modulus of rupture may be made a requirement. It is frequently possible to select from the piles of brick of varying degrees of quality and make tests of these. In case that one of these grades representing a certain percentage of the brick on a portion of the street, say, 5 or 10 per cent, falls below the requirements, they should be rejected. The matter of the selecting of these samples will be discusssd under "Inspection."

Inspection of Paving Brick.

In taking up the subject of inspection of paving brick it must be admitted that inspection is generally an unsatisfactory topic to both contractor and municipality. Inspection is a difficult task requiring skilled judgment, expert knowledge, intelligent action, and ability of no mean order, as well as the qualities of tact, balance and horse sense. Men having these qualities and available for this purpose are rare. It is not so much that the politician desires to appoint a favored citizen or that the residents on a street feel that one of their number will best serve their interests. The municipal administrative officer will usually gladly waive these considerations if an inspector of the ideal type can be found. But the work for an inspector is spasmodic, and the season is short, and his importance in the constructive world is not yet so well established that he receives a high salary; we must expect ideal inspectors to be rare. However, the first requisite of paving brick inspection is a level-headed and wide-awake inspector, and it is to the interest of all concerned that this class of men be developed.

Inspection involves a study of the brick put on the street. An inspector whose work came under my observation selected types of brick which he found—what he thought to be soft or hard or brown or brittle or red or black or what not—and made a lot of rattler tests and absorption tests to determine the relative place of these various types and to aid his judgment in the inspection. This is a step in the right direction. It illustrates what was meant by saying that tests and requirements should be useful in educating inspector and citizen and contractor.

The difficulties of inspection are increased by the way material is loaded on cars and piled on the streets. Good and poor are mixed together indiscriminately, even when the change of quality is apparent as the wagon is loaded. Lack of uniformity is the bane of paving brick. May not the manufacturer remedy this in part at least, and place the mediocre brick on streets which want cheap brick and selected brick on streets which are willing to pay for a serviceable article?

Evidently the inspection of paving brick and the selection of the test brick form an important matter, and upon this depends, to a large extent. the quality of the brick used in the pavement. As it is an utter impossibility to test any considerable part of the brick, great care must be taken to select representative samples and samples which will show the variation of the materials To make severe requirements for the results of tests is only a part of the problem; the inspection must be efficient and thorough and wise in order that the results may be fair to both producer and consumer.

It is obvious, then, that in addition to the making of standard tests the work of supervision of the pavement must include a fair and definite method of securing sample brick, a fair and general method for standards of rejection, and a way of throwing out imperfect brick during the time of laying the pavement and before the filler is applied. The work of inspection, then, may be divided into the following: (1) A general inspection; (2) Rough culling of imperfect and inferior brick in pile and barrow; (3) A culling of inferior brick as they are about to be laid and immediately after they are laid. In the general inspection different car loads or loads of the same quality should be considered together. Samples representing as near as may be the average of the brick of a given lot should be made by a man skilled in such work. If any considerable number of a poorer grade are to be found in any lot, representative samples of these should be selected and tests made upon the selected brick. If the results of the tests of the average samples are not up to the requirements the whole lot of brick should be rejected. If the results of the poorer grade are also not up to the requirements and this grade constitutes such a part of the whole lot that they are not likely to be culled carefully during laying. the lot should be rejected with the provision that they be culled and then reinspected. In case the poorer brick in a pile show great inferiority by their appearance it may be sufficient to permit workmen to cull the brick as they are loaded into barrows, but this arrangement is not usually very satisfactory. The culling of brick as they are laid in the street should be permitted only for such brick as show by their size, color, shape, or surface defects that they are inferior brick and there should be few enough of this class to enable satisfactory results to be obtained. With some makes of brick color or other appearance furnishes evidence of defect or of inferior grade, but in other makes little can be told by these methods and the quality can be established only by physical tests.

Some time ago the writer made the suggestion that a desirable solution of the inspection problem would be to have the brick inspected at the yards much as steel is inspected at the mills. This could be done by bureaus of inspection which would employ expert inspectors, as is done in the case of steel inspection, and this service would be paid for by the thousand of bricks inspected, or yard of pavement to be put down, instead of at a dollar and a half a day. The Bureau of Inspection would be given the requirements specified for the brick in the ordinance and the contract, and would certify to the quality of the brick. This inspection would not entirely relieve inspection on the street and in the pavement, for chipped, broken, and otherwise defective brick would still show up, but it would insure a better grade of brick and would make rejection of a poor lot of brick less objectionable to the producer, and if properly carried out would, in my opinion, result in great gain for both the manufacturer and the municipality.

Altogether, inspection covers a multitude of details, involves everlasting vigilance, and entails patience and even temper, and the city which can get good inspection is indeed fortunate. A reputation for severe inspection is said to cause an undue increase in the bids for work, but this charge must not be accepted without consideration. Five cents a yard extra is only the cost of a year's life of a pavement on a residence street or six months on a business street, and who will not say that the difference in quality of brick may not make five or ten years, or even more, difference in the life of the pavement? Surely, adequate and judicious inspection pays for itself many times over.

In this article the writer has not attempted to go into some of the details of testing and inspection; he has discussed principles governing the selection of the brick. Many questions arise between the producer and the consumer, and these may not always be decided according to numerical values of tests. It seems probable that brick will continue to be the principal material for street pavement in inland cities of Illinois, and the quality of the pavements may be improved if manufacturers and municipalities agree on definite and trustworthy requirements and tests and there is adequate and judicious inspection. An improvement in quality and uniformity will be advantageous to producer and consumer.

TESTS OF PAVING BRICKS.

GENERAL STATEMENT.

The tests herein reported were made on paving brick from twenty-four paving brick factories in Illinois, Indiana, Ohio, Missouri and Kansas. The samples of each make and grade were selected by representatives of the State Geological Survey at the yards of the factory. An effort was made to secure representative samples. The collectors were familiar with paving brick and their properties and exercised care in the selection, and it is believed that the brick obtained are fairly representative of the product of the various factories at the time the selection was made. In many cases samples of two to five grades of brick, varying from the softer grade to very hard burned, were obtained. The letter at the beginning of the mark or designation of the various samples is the initial of the collector who selected the brick, and the letter at the end refers to the grade of burning of the brick, *a* being the softest burned lot. In some cases the *a* grade was considerably under-burned and in others it represented the best grade.

The brick were held before making the tests, and the samples which were collected early in the spring were left for some time in their original packages in the open air and were subjected to dampness from the spring rains. However, before the tests were made, the brick were stacked openly under a tent and left for some time through hot dry weather so that each brick had ample opportunity to become dried throughout. The bricks which arrived last came direct from the kilns to the tent during dry weather without having become damp and were tested first. In this way the earlier brick were given from three to five weeks in which to dry. As the tent was open at the ends so that good circulation of air prevailed, the bricks had the opportunity to be thoroughly dried. While no tests were made on the amount of moisture contained, it is thought that all the bricks were as dry as they could be under the average humidity conditions of summer weather and without being dried in an oven. It is certain that the amount of moisture in the brick was as low as is required by the provisions of the N. B. M. A. specifications for the rattler test.

The rattler test of the brick was made in the Road Laboratory of the Civil Engineering Department of the University of Illinois. The standard N. B. M. A. rattler of the Road Laboratory was used. The number of bricks and blocks agreed closely with the standard specifications, although the relative cubical content of the rattler and the charge was not calculated for each lot, but the charge was varied with the judgment of the operator. At least 9 and not more than 10 blocks were considered a charge, and at least 10 and not more than 12 of the brick size. The results of the rattler test are given in Table I. The brick were weighed at the end of 450, 900, 1,350 and 1,800 revolutions and the corresponding losses are given in the tables. Table II shows the proportions of the final or total loss at the end of each of these periods given in per cent of the final loss, and Table III shows the percentage of the total loss for each of the four stages.

The rattler tests were made under the direction of Mr. R. C. Purdy. Acknowledgment is made to Professor I. O. Baker of the Civil Engineering Department of the University of Illinois for the facilities afforded in making the rattler tests.

After the brick were rattled, five of each set, two from one chamber and three from the other chamber, were taken to the Laboratory of Applied Mechanics and the amount of absorption determined. The brick were not dried further, but the conditions were such that the amount of moisture present would have little effect upon the determinations reported.

From the remainder of the brick not rattled, as many as could be spared up to ten of each kind were taken to the Laboratory of Applied Mechanics of the University of Illinois, and the transverse or cross-breaking test made upon them. The method of making this test is fully explained in the paper by Professor Talbot on the Quality of a High Grade Paving Brick and the Tests used in Determining Them. Crushing tests were made on half-brick placed flat-wise as described in the paper just referred to. The results for the absorption, transverse, and crushing tests, as furnished by Professor Talbot, are given in the tables. The average values for absorption, cross-breaking, and crushing are given in Table IV, and the detailed results follow in Table V. Transverse and crushing tests were not made on the Purington, Edwardsville and Streator Paving Brick Co. brick.

The absorption and transverse tests were made by Mr. C. H. Pierce, Instructor in Theoretical and Applied Mechanics, and the crushing tests by Mr. H. L. Whittemore, Associate in Applied Mechanics, and this work was under the direct supervision of Professor A. N. Talbot.

The general selection of the brick at the yards and the arrangements therefor were made by the State Geological Survey. Mr. R. C. Purdy, of the Department of Ceramics of the University of Illinois, had general supervision of the arrangements for testing.

TABLE I.

N. B. M. A. RATTLER TEST.

MARK, NAME OF BRICK.	GRADE OF BRICK.	AVERAGE TOTAL % LOSS OF TWO CHARGES AT END OF				Size of Brick in cm.
		450 Rev.	900 Rev.	1350 Rev.	1800 Rev.	
K3b Albion, Ill	Soft	18.5	29.5	38.4	46.2	22.5x10.5x8
K3c Albion, Ill	Alley	11.3	17.5	21.2	24.6	21x9.5x8
K3d Albion, Ill	No. 1 paver	12.7	19.0	22.5	24.9	21x9.5x8
K3e Albion, Ill	Overburned	11.1	18.6	24.1	26.4	21x9.5x8
K1b Alton, Ill	Soft burned	17.4	28.6	40.0	46.1	22x10x7
K1c Alton, Ill	Alleys	13.3	21.5	28.2	33.9	21.5x9.5x7
K1d Alton, Ill	No. 1 paver	8.4	11.5	14.1	15.8	21.5x9.5x7
K1e Alton, Ill	Overburned	9.4	16.2	21.8	27.0	......
B-IIa Atchison, Kan	No. 1 paver	......	......	......	28.0	20x9.5x6.7
B-IIb Atchison, Kan	..do	13.6	19.5	23.9	27.9	......
K15b Bar Clay Co., Streator, Ill	Soft	14.5	20.9	25.4	29.5	21x9.5x8.5
K15c Bar Clay Co., Streator, Ill	Alley	10.2	15.4	19.0	21.8	......
K15d Bar Clay Co., Streator, Ill	No. 1 paver	10.3	13.9	16.7	18.4	......
K15e Bar Clay Co., Streator, Ill	Overburned	9.1	14.5	18.7	22.0	21x10x8
K11b Brazil, Ind	Soft	28.9	45.1	56.8	67.1	24x11x8.5
K11c Brazil, Ind	Alley	13.6	20.1	25.3	29.8	23x10x8
K11d Brazil, Ind	No 1 paver	13.5	20.1	24.5	28.1	22.5x10x8
K11e Brazil, Ind	Overburned	14.5	23.5	30.8	36.7	23.5x10.5x8
I-IIb Caney, Kan	......	9.7	17.3	22.0	25.7	22.5x10.5x6.5
K13b Clinton, Ind	Soft	16.1	26.0	33.6	41.6	24.5x11x9
K13c Clinton, Ind	Alley	14.5	22.7	29.0	34.7	23.5x10.5x8.8
K13d Clinton, Ind	No. 1 paver	12.9	19.6	26.2	31.5	23.5x10.5x8.5
K13e Clinton, Ind	Overburned	14.4	21 6	27.5	31.6	23.5x10.5x8.5
G-IIa Coffeyville, Kan	Brick	......	......	......	13.7	21x10x5.5
G-IIb Coffeyville, Kan	......	5.6	8.5	10.9	12.8	......
G-IIc Coffeyville, Kan	No. 1 block	......	......	......	15.0	21x10x8
F-Ib Danville Brick Co	Soft	19.3	29.3	38.9	46.7	22.5x11x8.5
F-Ic Danville Brick Co	Alley	12.7	19.8	25.1	30.2	22x10x8
F-Id Danville Brick Co	No. 1 paver	9.1	13.9	17.6	20.8	21x10x8
F1e Danville Brick Co	Overburned	9.8	17.2	23.3	28.4	22x10x8.5
K5b Edwardsville, Ill	Soft	17.8	28.7	37.0	44.9	21.8x11.3x7.3
K5c Edwardsville, Ill	Alley	12.6	19.5	24.3	28.7	21.2x10.4x7.0
K5d Edwardsville, Ill	No. 1 paver	7.8	12.5	16.3	19.4	......
K5e Edwardsville, Ill	Overburned	8.2	12.2	15.2	18.1	20.6x10.4x7.0
S2b Kansas City, Mo., Diamond	No. 1 paver	14.8	20.9	24.9	27.9	20.5x9.5x6.5
L-IIb Lawrence, Kan	..do	10 4	15.2	18.8	22.9	......
L-IIc Lawrence, Kan	No. 2 paver	8.7	11.0	16.0	18.6	20x9.5x6.5
K9b Poston B, Crawfordsville, Ind.	Soft	14.3	23.6	31.9	39.5	23x10x9
K9c Poston B, Crawfordsville, Ind.	Alley	8.9	14.3	18.0	21.7	23x10x9
K9d Poston B, Crawfordsville, Ind.	No. 1 paver	6.4	9.7	12.4	14.8	22.5x10x9
K9e Poston B, Crawfordsville, Ind.	Overburned	6.1	9.3	11.8	13.7	22.5x9.5x9
J-II Pittsburg, Kan	No. 1 paver	8.4	12.3	15.1	17.1	20.5x9.75x6.5
K6b Purington block, Galesburg, Ill	Soft	7.8	13.4	18.2	22.8	21.5x10.2x8.9
K6c Purington block, Galesburg, Ill	Alley	7.5	11.7	15.4	18.3	21.5x10 2x8.9
K6d Purington block, Galesburg, Ill	No. 1 paver	5.8	9.1	11.6	13.3	20.9x10.2x8.9
K6e Purington block, Galesburg, Ill	Overburned	8.4	12.9	16.5	20.3	20.9x10.2x8.9
K6b2 Purington block, Galesburg, Ill	......	14.7	23.7	31.7	38.6	21.5x10.2x8.9
K6c2 Purington block, Galesburg, Ill	......	9.9	16.6	21.9	26.6	21.5x10.2x9.5
K4a Springfield, Ill	No. 1 paver	......	......	......	19.8	......
K4b Springfield, Ill	Soft	19.7	30.6	38.2	45.2	22x10.5x7
K4c Springfield, Ill	Alley	9.2	14.5	17.0	19.9	21x9.5x6.7
K4d Springfield, Ill	No. 1 paver	9.9	14.2	16.9	19.1	21x10x6.5
K4e Springfield, Ill	Over-burned	14.8	18.9	......	......	21x10x6.5
K2a St. Louis, Mo., hydraulic	No. 1 paver	......	......	......	17.5	21x10x7
K2b St. Louis, Mo., hydraulic	......	7.9	12.2	14.2	15.9	......
V8c Streator Paving Brick Co	Soft	14.7	20.1	25 2	29 0	20.9x10.2x5.7
V8d Streator Paving Brick Co	Alley	10.7	16.8	21.6	24.3	20.3x10.2x5.7
V8e Streator Paving Brick Co	No. 1 paver	10.6	15.5	18.4	21.9	20.3x10.2x5 7
K10b Terre Haute, Ind	Soft	23.1	32.8	40.8	46.5	22x10x8.5
K10c Terre Haute, Ind	Alley	19.9	28.2	32.9	35.7	21.5x10x8

TABLE I—*Concluded.*

Mark, Name of Brick.	Grade of Brick.	Average Total % Loss of Two Charges at End of				Size of Brick in cm.
		450 Rev.	900 Rev.	1350 Rev.	1800 Rev.	
K10d Terre Haute, Ind.	No. 1 paver	22.6	29.8	35.3	39.4	21.5x10x8
K10e Terre Haute, Ind	Over-burned	19.0	26.7	32.0	36.1	22x10x8 5
H-IIa Topeka, Kan	......	......	......	......	33.0	21x9.5x6.5
H-IIb Topeka, Kan	......	14.1	20.5	26.0	29.6	......
K8b Wabash Clay Co., Veedersburg Indiana	Soft	26.5	32.7	45.6	53.5	23.5x10x9
K8c Wabash Clay Co., Veedersburg, Indiana	Alley	11.3	17.6	24.2	28.1	23.5x10x9
K8d Wabash Clay Co., Veedersburg Indiana	No. 1 paver	10.2	15.0	18.5	20.2	22.5x9.75x8.5
K8e Wabash Clay Co., Veedersburg Indiana	Over-burned	12.5	18.7	......	......	23x10x9
K14b Western Brick Co., Danville, Ill	No. 1 paver	8.4	13.4	17.3	20.8	23x10x8.5
K14a Western Brick Co., Danville, Ill	do	......	......	......	21.2	......
			600 Rev.	1200 Rev.	1800 Rev.	
R3a Imperial, Canton, O	No. 1 paver	......	......	......	14.2	22x10x9
R3b Imperial, Canton, O	do	......	8.7	12.2	14.8	......
S1b Moberly, Mo	......	......	13.9	20.9	26.3	20x9x8.5
R1a Nelsonville, O	No. 1 paver	......	......	......	16.9	23.3x10x8 2
R1b Nelsonville, O	do	......	9.0	13.9	18.2	......
R2a Portsmouth, O	do	......	......	......	17.8	22.75x9.9x8
R2b Portsmouth, O	do	......	9.8	14.8	18.6	......
R4a Royal, Canton, O	do	......	......	......	15.3	21.8x10x9
R4b Royal, Canton, O	do	......	10.3	10.7	16.7	......

TABLE II.

PROPORTIONAL RATTLER LOSS.

	450 Rev.	900 Rev.	1350 Rev.	1800 Rev.
K3b	40.1	63.9	63.0	100.00
K3c	46.0	70.9	86.3	100.00
K3d	51.0	76.4	90.4	100.00
K3e	41.9	70.3	87.5	100.00
K1b	37.7	62.0	82.4	100.00
K1c	39.2	63.3	83.2	100.00
K1d	53.3	72.7	89.0	100.00
K1e	34.9	59.8	80.7	100.00
B11b	48.8	69.7	85.5	100.00
K15b	49.2	70.9	85.3	100.00
K15c	47.0	71.8	87.2	100.00
K15d	56.1	75.5	90.7	100.00
K15e	41.2	66.0	84.9	100.00
K11b	43.1	67.2	84.6	100.00
K11c	45.7	67.5	84.8	100.00
K11d	48.0	71.4	87.0	100.00
K11e	39.5	64.2	84.0	100.00
I11b	37.1	67.4	85.6	100.00
K13b	38.8	62.2	80.6	100.00
K13c	41.7	65.3	83.4	100.00
K13d	40.8	62.1	83.2	100.00
K13e	45.6	68.4	87.3	100.00
G11b	44.0	66.6	85.3	100.00
F1b	41.4	62.8	83.3	100.00
F1c	42.1	65.7	83.2	100.00
F1d	43.8	66.6	84.6	100.00
F1e	34.4	60.7	82.2	100.00
S2b	52.9	74.7	89.1	100.00
L11b	45.4	66.5	82.0	100.00
L11c	46.9	58.9	85.9	100.00
K9b	36.0	59.7	80.8	100.00
K9c	42.0	67.4	85.0	100.00
K9d	43.3	65.4	83.4	100.00
K9e	44.3	67.7	85.5	100.00
J11b	49.2	71.5	88.1	100.00
K4a	....	....	....	....
K4b	43.7	67.8	84.6	100.00
K4c	46.2	72.6	85.3	100.00
K4d	51.8	74.2	88.3	100.00
K4e	....	....	....	....
K2a	....	....	....	....
K2b	50.0	76.8	89.8	100.00
K10b	49.6	70.4	87.7	100.00
K10c	55.6	78.9	92.1	100.00
K10d	57.3	75.7	89.6	100.00
K10e	52.7	74.1	88.9	100.00
H11b	47.7	69.3	87.8	100.00
K8b	49.5	61.1	85.2	100.00
K8c	40.3	62.7	86.2	100.00
K8d	50.3	74.1	91.2	100.00
K14b	40.2	64.2	83.2	100.00
		600 Rev.	1200 Rev.	1800 Rev.
R3b	....	59.0	82.6	100.00
S1b	....	53.1	79.4	100.00
R1b	....	49.5	76.6	100.00
R2b	....	52.4	79.4	100.00
R4b	....	61.6	82.2	100.00

TABLE III.

SHOWING PERCENTAGE OF THE TOTAL LOSS IN EACH STAGE OF RATTLER LOSS.

	0-450 Rev.	450-900 Rev.	900-1350 Rev.	1350-1800 Rev.
K3b	40.2	23.8	19.1	17.0
K3c	46.1	24.8	15.4	13.7
K3d	51.0	25.4	14.9	9.7
K3e	41.9	28.4	17.2	12.5
K1b	37.7	24.3	20.4	17.6
K1c	39.2	24.1	19.9	16.8
K1d	53.3	19.4	16.3	11.0
B11b	48.8	20.9	15.8	14.5
K15b	49.2	21.7	15.4	18.7
K15c	47.0	23.8	16.5	12.8
K15d	56.1	19.5	15.1	9.3
K15e	41.2	24.8	18.8	15.1
K11b	43.1	24.1	17.4	15.4
K11c	45.7	21.8	17.3	15.2
K11d	47.9	23.4	15.7	12.9
K11e	39.5	24.7	19.8	16.0
I11b	38.0	29.4	18.3	14.4
K13b	38.8	23.5	18.4	19.4
K13c	41.7	23.6	18.1	16.6
K13d	40.8	21.3	21.1	16.8
K13e	45.6	23.8	18.9	12.7
G11b	44.0	22.6	18.7	14.7
F1b	41.4	21.4	20.5	16.7
F1c	42.1	23.6	17.5	16.8
F1d	43.8	22.8	18.0	15.4
F1e	34.4	26.3	21.6	17.7
S2b	52.9	21.8	14.4	10.9
L11b	45.4	21.1	15.5	18.0
L11c	46.9	12.1	27.0	14.1
K9b	36.0	23.7	21.1	19.2
K9c	42.0	25.4	17.6	15.0
K9d	43.3	22.2	18.0	16.6
K9e	44.3	23.4	17.8	14.5
J11b	49.2	22.3	16.7	11.9
K4b	43.6	24.2	16.8	15.4
K4c	46.2	26.3	12.7	14.8
K4d	51.4	22.4	14.0	11.7
K2b	50.0	26.8	13.0	10.2
K10b	49.6	20.8	17.3	12.3
K10c	55.7	23.3	13.2	7.9
K10d	57.3	18.4	13.9	10.4
K10e	52.8	21.5	14 7	11.1
H11b	47.7	21.5	18.5	12.2
K8d	49.5	11.6	24 2	14.8
K8c	40.3	22.4	22.5	13.8
K8b	50.3	23.8	17.2	3.8
K14b	40.2	24 1	19.0	16.8
		0-600 Rev.	600-1200 Rev.	1200-1800 Rev.
R3b	....	59.1	23.5	17.4
S1b	....	54.1	26.3	20.6
R1b	....	49.5	27.1	23.4
R2b	....	52.4	27.0	20.6
R4b	....	61.6	20.7	17.8

TABLE IV.

ABSTRACT OF REPORT OF TESTS OF PAVING BRICK.

NAME OF BRICK.	Lab. No.	Per Cent Abs. Water.	Modulus of Rupture.	Crushing Strength
"Albion," Albion, Ill.	K3b	10.0	995	....
	K3c	3.5	2100	4500
	K3d	1.05	2350	4800
	K3e	0.7	2700	3200
"Alton," Alton, Ill.	K1b	11.2	....	....
	K1c	6.1	1630	4000
	K1d	0.9	2535	8400
	K1e	1.2	1420	....
Atchison, Kans.	B2	....	1800	....
"Barr Clay Co.," Streator, Ill	K15b	7.67	1776	7800
	K15c	1.0	2365	11200
	K15d	0.83	2600	11700
	K15e	0.8	2870	8500
"Caney Brick Co.," Caney, Kans.	I2	3.416	1970	....
"Caney Vitrified Brick Co.," Topeka, Kans	H2	1.27	2300	....
"Clinton," Clinton, Ind.	K13b	9.3	1240	2700
	K13c	6.9	1280	....
	K13d	1.7	1620	6000
	K13e	1.1	1500	5600
"The Coffeyville Brick and Tile Co"	....	....	....	....
"Coffeyville Brick"	G2	0.8	2320	6500
"Coffeyville Block"	G2	0.83	1900	....
"Danville," Danville, Ill.	F1b	13.2	....	....
	F1c	4.8	1700	5200
	F1d	2.8	980	3400
	F1e	1.7	1670	6100
"Diamond," Kansas City, Mo.	S2b	0.72	2410	....
"Hydrulic," St. Louis, Mo.	K2a	....	....	....
	K2b	0.6	2430	8300
"Indiana Block," Brazil, Ind.	K11b	13.1	685	....
	K11c	2.9	1510	....
	K11d	1.89	2260	....
	K11e	2.7	870	....
Lawrence, Kans.	L2b	8.6	1770	....
	L2c	0.94	1960	10000
"Metropolitan Block," Canton, Ohio	R4a	....	....	....
	R4b	1.05	3130	7600
"Metropolitan Block" (Imperial), Canton, O.	R3a	....	....	....
	R3b	1.27	2800	7200
"Missouri," Moberly, Mo.	S1b	3.313	2130	....
"Nelsonville," Nelsonville, Ohio	R1a	....	....	....
	R1b	1.68	1790	3800
"Peebles Block," Portsmouth, Ohio	R2a	....	....	....
	R2b	2.211	2505	....
Pittsburg, Kans	J2	2.313	2220	....
"Poston Block," Crawfordsville, Ind.	K9b	10.2	705	3900
	K9c	6.3	1080	8400
	K9d	2.513	2050	9800
	K9e	0.8	2050	10300

TABLE IV—*Concluded.*

ABSTRACT OF REPORT OF TESTS OF PAVING BRICK.

NAME OF BRICK.	Lab. No.	Per Cent Abs. Water.	Modulus of Rupture	Crushi'g Strength
Springfield, Ill	K4a	....	....	....
	K4b	12.2	980	2100
	K4c	5.0	2360	5200
	K4d	1.16	2250	....
	K4e	0.6	1890	3600
"Terre Haute Block," Terre Haute, Ind	K10b	9.1	1375	....
	K10c	2.0	1910	....
	K10d	1.05	2340	6000
	K10e	0.8	1880	2400
"Wabash Clay Co.," Culver Block, Veedersburg, Ind	K8b	9.9	585	2700
	K8c	3.9	1035	4400
	K8d	3.9	1440	7600
	K8e	1.6	810	4400
"Western Paver," Danville, Ill	K14a	....	....	....
	K14b	4.218	1617	5200

TABLE V.

K_3b—ALBION, ILL.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq in.	Av.Mod.	Variation from average.	Per cent variation.
1	3.25	4.25	6	6020	925	995	— 70	7.0
2	3.30	4.25	6	6560	990	....	— 5	0.5
3	3.28	4.28	6	5500	820	....	—175	17.6
4	3.22	4.15	6	6260	1020	....	+ 25	2.5
5	3.28	4.40	6	6770	1050	....	+ 55	5.5
6	3.25	4.25	6	6030	925	....	— 70	7.0
7	3.20	4.15	6	7180	1170	....	+175	17.6
8	3.22	4.08	6	8160	1370	....	+375	37.7
9	3.30	4.25	6	4550	690	....	—305	30.6
				57030	8960	....	....	126.0
			Av.....	6337	995	....	....	14.0

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$b_1$1	2.385	2.615	.23	9.7
2	2.72	2 965	.245	9.0
3	2.65	2.885	.235	8.9
$b_2$1	2.04	2.285	.245	12.0
2	2.23	2.46	.23	10.3
				49.9
			Average	10.0

K_3c—ALBION, ILL.

TRANSVERSE.

No.	Breadth, inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture, pounds per sq.in.	Av.Mod.	Var. from av.	Per cent var.	Remarks
1.....	3.15	3.85	6	10650	2050	2100	—50	2.4	
2.....	3.30	3.80	6	12830	2420		+320	15.2	
3.....	3.20	4.00	6	4700	830		—1270	60.5	Fracture glassy on one side.
4.....	3.40	3.55	6	12470	2610		+510	24.3	
5.....	3.20	4.00	6	8360	1470		—630	30.0	
6.....	3.15	3.85	6	14710	2840		+740	35.3	
7.....	3.18	3.80	6	8950	1760		—340	16 4	
8.....	3.15	3.80	6	14100	2800		+700	33.3	
9.....	3.30	3.78	6	11330	2160		+60	2.9	
				98100	18940			220.3	
			Average	10900	2100			24.5	

Table No. 5—Continued.

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$c_1$1	3.165	3.23	.065	2.1
2	3.02	3.145	.125	4.1
3	2.9	3.055	.155	5.3
$c_2$1	3.26	3.34	.08	2.5
2	2.775	2.875	.10	3.6
				17.6
			Av.	3.5

CRUSHING.

Number.	Size—inches.	Area—square inches.	Load—pounds.	Stress lb. per sq. in.
2	3⅜ x 3¼	10.9	39400	3600
4	3⅜ x 3⅜	11.3	42000	3700
5	3⅜ x 3	10.1	63700	6300
8	3⅜ x 2½	8.4	37200	4430
9	3⅜ x 3⅛	10.5	51200	4870
9	3⅜ x 4¾	16.0	66600	4160
				27060
				Av 4510

K_3d—ALBION, ILL.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av.Mod.	Variation from average.	Per cent variation.
1	3.20	3.72	6	12380	2520	2350	+170	7.2
2	3.20	3.78	6	14450	2840	....	+490	20.8
3	3.20	3.75	6	9300	1860	....	—490	20.8
4	3.15	3.80	6	9880	1960	....	—390	16.6
5	3.10	3.75	6	12350	2550	....	+200	8.5
				58360	11730			73.9
			Av	11672	2350	....	....	14.8

Table 5—Continued.

ABSORPTION.

Number.	Kilos.			Per cent.
	Dry.	Wet.	Gain.	
1	2.88	2.93	.05	1.7
2	2.96	2.975	.015	0.5
3	2.96	2.975	.015	0.5
4	3.045	3.08	.035	1.2
5	2.98	3.02	.04	1.3
				5.2
			Average	1.0

CRUSHING.

Number.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lbs. per sq. in.
1	3¼ x 3½	11.4	61000	5350
3	3¼ x 3¼	10.6	68000	6420
4	3¼ x 3⅝	11.8	58200	4930
5	3½ x 3½	11.4	34400	3000
5	3¼ x 3⅜	11.0	35100	3200
3	3¼ x 4	13.0	78300	6020
				28920
			Average	4820

K_3e—ALBION, ILL.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Variation from average.	Per cent variation.
1	3.20	3.80	6	10600	2070	2700	—630	23.3
2	3.18	3.72	6	13960	2860	....	+160	5.9
3	3.18	3.76	6	14860	2970	....	+270	10.0
4	3.20	3.80	6	15650	3060	....	+360	13.3
5	3.20	3.70	6	12360	2540	....	—160	5.9
6	3.18	3.82	6	13930	2700	....	0	0
				81360	16200			58.4
			Av	13560	2700	....	....	9.7

Table 5—Continued.

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
1	2.84	2.875	.035	1.2
2	2.785	2.81	.025	0.9
3	2.915	2.93	.015	0.5
4	2.84	2.86	.02	0.7
5	2.92	2.925	.005	0.2
				3.5

CRUSHING.

Number.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lbs. per sq. in.
1	3¼ x 3	9.7	29700	2960
2	3¼ x 3¼	10.6	45400	4280
4	3½ x 2⅞	9.3	26700	2880
6	3¼ x 3¾	12.2	41400	3380
6	3¼ x 4⅛	13.4	35800	2670
				16170
			Average	3234

K_1b—ALTON, ILL.

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$b_1$1	1.28	1.435	.155	12.1
2	1.08	1.215	.135	12.5
3	1.07	1.205	.135	12.6
$b_2$1	1.79	1.98	.19	10.6
2	1.875	2.025	.15	8.0
				55.8
			Average	11.2

Table 5—Continued.

K_1c—ALTON, ILL.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sqr. in.	Av.Mod.	Variation from average.	Per cent variation.
1......	2.85	3.90	6	8030	1660	1630	+ 30	1.8
2......	2.70	3.78	6	8390	1960	....	+330	20.2
3......	2.82	3.85	6	5770	1240	....	—390	23.9
4......	2.85	3.60	6	8120	1980	....	+350	21.5
5......	2.88	3.75	6	6480	1440	....	—190	11.7
6......	2.74	3.68	6	6200	1500	....	—130	8.0
				42990	9780			97.1
			Average	7165	1630	....	....	16.2

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$c_1$1..................................	2.53	2.63	.10	4.0
2..................................	2.08	2.23	.15	7.2
$c_2$1..................................	1.945	2 085	.14	7.2
2..................................	1.945	2.085	.14	7.2
2..................................	2.44	2.555	.115	4.7
				30.3
			Average	6.1

CRUSHING.

NUMBER.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lh. per sq. in.
1.....................	2¾ x 4	11.0	47800	4350
1.....................	2¾ x 4¼	11.7	41000	3500
3.....................	2¾ x 4¼	11.7	52000	4440
5.....................	2¾ x 4¼	11.7	33000	2820
5.....................	2¾ x 4	11.0	55800	5070
				20180
			Average	4036

Table 5—Continued.

K_1d—ALTON, ILL

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Variation from average.	Per cent variation.
1......	2.75	3.68	6	8580	2080	2535	—455	18.0
2......	2.78	3.70	6	11420	2700	....	+165	6.5
3......	2.70	3.85	6	11100	2500	....	—32	1.4
4......	2.78	3.70	6	13020	3100	....	+565	22.3
5......	2.70	3.85	6	9860	2220	....	—315	12.4
6......	2.70	3·80	6	11330	2610	....	+75	3.0
				65310	15210			63.6
			Average	10885	2535	....	....	10.6

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$d_1$1................................	2.795	2.82	.025	0.9
2................................	2.815	2.83	.015	0.5
3................................	2.64	2.675	.025	1.0
$d_2$1................................	2.925	2.955	.03	1.0
2................................	2.655	2.68	.025	0.9
				4.3
			Average	0.9

CRUSHING.

NUMBER.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lb. per sq. in.
1....................	3¾ x 3	11.2	87700	7850
2....................	3¾ x 2¾	10 3	112000	10800
4....................	3¾ x 2¾	10.0	99000	9600
6....................	3¾ x 2¾	10.3	58000	5600
6....................	3¾ x 3	11.2	92300	8250
				42100
			Average	8420

Table 5—Continued.

K_1e—ALTON, ILL.

TRANSVERSE.

No.	Breadth, inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture, pounds per.sq. in	Av.Mod.	Var. from av.	Per cent var.	Remarks.
1.....	2.90	4.48	6	7800	1200	1420	—220	15.5	Very irregular and badly out of shape.
2.....	2.90	4.20	6	9940	1750	....	+350	24.6	
3.....	3.02	4.15	6	9650	1680	....	+260	18.3	
4	3.00	3.90	6	6290	1240	....	—130	12.7	
5.....	3.25	3.80	6	6380	1220	....	—200	14.1	
				40060	7090			85.2	
			Average	8012	1420	....	....	17.0	

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$e_1$1..........	2.49	2.515	.025	1.0
2	2.495	2.525	.03	1.2
3..........	2.435	2.455	.02	0.8
$e_2$1..........	2.27	2.3	.03	1.3
2..........	2.38	2.415	.085	1.5
				5.8
			Average	1.2

B_2b—ATCHISON, KAN.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Average	Variation from average	Per cent variation.
1	2.46	3.90	6	8140	1960	1800	+160	8.9
2	2.46	3.93	6	6950	1660	....	—140	7.8
3	2.46	3.90	6	6750	1630	....	—170	9.5
4	2.46	3.90	6	7920	1910	....	+110	6.1
5	2.52	3.90	6	9000	2120	....	+320	17.8
6	2.46	3.82	6	6650	1670	....	—130	7.2
7	2.46	3.84	6	6110	1520	....	—280	15.6
8	2.50	3.94	6	5940	1380	....	—420	23.4
9	2.52	3.90	6	7920	1860	....	+ 60	3.3
10	2.46	3.84	6	8950	2220	....	+420	23.4
11	2.46	3.84	6	6300	1560	....	—240	13.3
12	2.52	3.84	6	8670	2100	....	+300	16.7
				89300	21590			153.0
			Av	7440	1800	....	....	12.7

Table 5—Continued.

F_1b—ATCHISON, KAN.

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$B_1$1	1.926	2.175	.249	12.9
2	1.882	2.155	.273	14.5
3	2.105	2.385	.28	13.3
$B_2$1	2.032	2.325	.293	14.2
2	2.42	2.695	.275	11.3
				66.2
			Average	13.2

K_{15}b—BARR CLAY CO., STREATOR, ILL.

TRANSVERSE TEST.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq.in.	Av.Mod.	Variation from average.	Per cent variation.
1	3.36	4.02	6	10400	1724	1776	— 54	3.4
2	3.36	3.96	6	10950	1870	....	+ 94	5.3
3	3.36	4.06	6	11580	1881	....	+105	5.9
4	3.36	4.02	6	11800	1956	....	+180	10.1
5	3.34	4.06	6	11250	1847	....	+ 71	4.0
6	3.34	4.08	6	10350	1675	....	—101	5.7
7	3.38	3.98	6	11360	1911	....	+135	7.6
8	3.38	4.08	6	9790	1558	....	—218	12.3
9	3.34	3.91	6	11100	1959	....	+183	10.3
10	3.42	4.14	6	8980	1379	....	—397	22.4
				107560	17760			87.0
			Average	10756.0	1776.0	....		8.70

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$B_1$1	2.965	3.155	.19	6.4
2	2.915	3.145	.23	7.9
3	2.88	3.105	.225	7.8
$B_2$1	2.808	3.035	.227	8.1
2	3.025	3.275	.25	8.3
				38.5
			Average	7.7

Table 5—Continued.

CRUSHING.

Number.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lbs. per sq. inch.
3	3⅜ x 2½	8.4	60000	7150
4	3⅜ x 3	10.0	68600	6860
5	3⅜ x 2½	8.4	84000	10000
7	3⅜ x 2½	8.4	66000	7850
8	3⅜ x 2¾	9.3	67500	7250
				39110
				Average 7822

K_{15}d—BARR CLAY CO., STREATOR, ILL.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Variation from average.	Per cent variation.
1	3.36	3.84	6	12990	2360	2365	— 5	0.2
2	3.36	3.84	6	12780	2320		— 45	1.9
3	3.36	3.74	6	12330	2360		— 5	0.2
4	3.26	3.84	6	9800	1840		—525	22.2
5	3.26	3.82	6	11920	2200		—165	7.0
6	3 30	3.94	6	14240	2500		+135	5.7
7	3.30	3.84	6	13700	2530		+165	7.0
8	3.34	3.78	6	13640	2580		+215	9.1
9	3.30	3.84	6	13780	2540		+175	7.4
10	3.34	3.84	6	13270	2420		+ 55	2.3
				128450	23650			63.0
			Av	12845	2365	....	....	6.3

K_{15}c—ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$C_1$1	3.175	3.20	.025	.8
2	3.29	3.318	.028	.9
3	3.47	3.51	.04	1.2
$C_2$1	3.282	3.318	.036	1.1
2	3.315	3.348	.033	1.0
				5.0
			Average	1.0

Table 5—Continued.

CRUSHING.

Number.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lb. per sq. in.
3	3⅜ x 2	6.7_2	56000	8360
3	3⅜ x 2¾	9.3	105200	11300
5	3⅜ x 1½	5.5	97100	17700
8	3⅜ x 1¼	4.2	37800	9000
8	3⅜ x 1¼	4.2	40600	9700
				56060
				Av....... 11212

$K_{15}c$—BARR CLAY CO., STREATOR, ILL.

TRANSVERSE.

No.	Breadth, inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture, pounds per sq. in.	Av. Mod.	Variation from average.	Per cent variation.
1	3.34	3.84	6	14610	2670_2	2600	+ 70	2.7
2	3.30	3.84	6	14620	2720		+120	4.6
3	3.30	3.78	6	11870	2260		—340	13.1
4	3.24	3.96	6	14880	2640		+ 40	1.5
5	3.26	3.84	6	14730	2760		+160	6.2
6	3.26	3.90	6	15600	2840		+240	9.2
7	3.24	3.90	6	12000	2200		—400	15.4
8	3.26	3.86	6	15040	2810		+210	8.1
9	3.30	3.84	6	14270	2650		+ 50	1.9
10	3.30	3.90	6	13690	2490		—110	4.2
				141310	26040			66.9
			Av	14130	2600	....	....	6.7

$K_{15}d$—ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$D_1$1	3.115	3.14	.025	0.8
2	3.005	3.038	.033	1.1
3	3.09	3.105	.015	0.5
$D_2$1	3.165	3.195	.03	0.9
2	3.255	3.282	.027	0.8
				4.1
			Average	0.8

Table 5—Continued.

CRUSHING.

Number.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lb. per sq. in.
3	3⅜ x 2⅜	8.0	90500	11300
6	3⅜ x 2½	8.4	100300	11900
7	3⅜ x 2½	8.4	109100	13000
9	3⅜ x 2⅝	8.8	118200	13500
10	3⅜ x 3	10.2	90800	8900
				58600
				Av......... 11720

$K_{15}e$—BARR CLAY CO., STREATOR, ILL.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Variation from average.	Per cent variation.
1	3.36	3.90	6	17330	3050	2870	+180	6.3
2	3.22	4.14	6	18360	3000	....	+130	4.5
3	3.48	3.98	6	15110	2520	....	—350	12.2
4	3.36	3.84	6	14040	2560	....	—310	10.8
5	3.36	3.84	6	15710	2860	....	— 10	0.3
6	3.38	3.90	6	16020	2630	....	—240	8.4
7	3.30	3.90	6	19360	3460	....	+590	20.6
8	3.42	3.78	6	15760	2960	....	+ 90	3.1
9	3.26	3.84	6	13580	2540	....	—330	11.5
10	3.36	3.96	6	18470	3160	....	+290	10.1
				163740	28740	....	....	87.8
			Av	16370	2870			8.8

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$e_1$1	2.94	2.965	.025	0.8
2	3.17	3.195	.025	.8
3	3.245	3.275	.030	.9
$e_2$1	2.96	2.98	.02	.7
2	3.01	3.04	.03	1.0
				4.2
			Average	0.8

Table 5—Continued.

CRUSHING.

NUMBER.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lb. per sq. in.
3	3⅜ x 2⅜	8.0	55000	6880
5	3⅜ x 2½	8.4	56900	6780
6	3⅜ x 2¼	7.6	78000	10300
8	3⅜ x 2¾	9.3	92300	9930
9	3⅜ x 2	6.7	57200	8550
				42440
			Average	8488

I_2b—CANEY, KAN.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av.Mod.	Variation from average.	Per cent variation.
1	2.34	4.26	6	8900	1890	1970	— 80	4.1
2	2.28	4.22	6	4940	1090	....	— 880	44.6
3	2.16	4.21	6	11920	2830	....	+ 860	43.6
4	2.28	4.21	6	7040	1570	....	— 400	20.3
5	2.22	4.08	6	12250	3000	....	+1030	52.2
6	2.28	4.21	6	8380	1860	....	— 110	5.6
7	2.22	4.14	6	9230	2190	....	+ 220	11.2
8	2.22	4.14	6	9050	2150	....	+ 180	9.1
9	2.28	4.08	6	6170	1460	....	— 510	25.9
10	2.26	4.26	6	7350	1620	....	— 350	17.8
11	2.26	4.08	6	8550	2050	....	+ 80	4.1
12	2.21	4.08	6	7700	1880	....	— 90	4.6
				101480	23590	....	....	233.1
			Av	8460	1970	....	....	18.6

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
b_1 1	2.39	2.498	.108	4.5
2	2.517	2.63	.113	4.5
3	2.676	2,748	.072	2.7
b_2 1	2.42	2.495	.075	3.1
2	2.45	2.505	.055	2.2
				17.0
			Average	3.4

Table 5—Continued.

R_3b—CANTON METROPOLITAN (Imperial.)

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Variation from average.	Per cent variation.
1	3.48	4.02	6	16130	2580	2800	—220	7.9
2	3.48	4.02	6	16740	2680	....	—120	4.3
3	3.60	4.02	6	14680	2270	....	—530	18.9
4	3.54	3.96	6	20690	3350	....	+550	19.6
5	3.60	3.90	6	18110	2980	....	+180	6.4
6	3.48	4.02	6	19770	3170	....	+370	13.2
7	3.48	3.96	6	15730	2590	....	—210	7.5
8	3.48	3.90	6	16680	2830	....	+ 30	1.1
9	3.48	3.96	6	16970	2800	....	0	0
10	3.48	4.02	6	19610	3150	....	+350	12.5
11	3.48	3.96	6	16640	2470	....	— 60	2.1
12	3.48	3.96	6	15100	2490	....	—310	11.1
				206850	33630	....	....	104.6
			Av	17238	2800	....	....	8.7

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$b_1$1	3.295	3.355	.06	1.8
2	3.975	4.015	.04	1.0
3	4.075	4.105	.03	0.7
$b_2$1	3.995	4.025	.03	0.8
2	3.775	3.83	.055	1.5
				5.8
			Average	1.2

CRUSING.

NUMBER.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lb. per sq. in.
2	3½ x 4	14.	94550	6750
3	3½ x 4⅛	14.4	109700	7620
6	3½ x 4⅜	15.3	99250	6500
7	3½ x4 ¼	14.9	141700	9500
1	3¼ x 4⅜	15.3	83500	5460
				35830
			Average	7166

Table 5—Continued.

R_4b—CANTON, METROPOLITAN, (Block).

TRANSVERSE.

No.	Breadth, inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av.Mod.	Var. from av.	Per cent variation.
1	3.60	3.96	6	19480	3100	3130	— 30	1.0
2	3.54	3.96	6	18980	3080	....	— 50	1.6
3	3.60	3.96	6	15480	2470	....	—660	21.1
4	3.58	3.96	6	18230	2930.	....	—200	6.4
5 ...	3.58	3.96	6	20400	3280	....	+150	4.8
6	3.58	3.96	6	19830	3180	....	+ 50	1.6
7	3.60	3.96	6	21220	3380	....	+250	8.0
8	3.54	3.90	6	18690	3130	....	0	0
9	3.58	3.96	6	20770	3320	....	+190	6.1
10	3.58	3.96	6	17350	2780	....	—350	11.2
11	3.54	3.90	6	22170	3710	....	+580	18.5
12	3.54	3.90	6	18870	3170	....	+ 40	1.3
				231470	37530	....		81.6
			Average	19290	3130	....		6.8

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$b_1$1	3.835	3.885	.05	1.3
2	3.705	3.745	.04	1.1
3	4.12	4.155	.035	0.9
$b_2$1	3.755	3.785	.03	0.8
2	3.74	3.77	.03	0.8
				4.9
			Av	1.00

CRUSHING.

NUMBER.	Size inches.	Area inches.	Load—pounds.	Stress—lb. persq. in.
10	3½x4½	15.7	126700	8070
4	3½x4	14.0	128000	9150
5	3½x4⅛	14.4	135800	9440
7	3½x2⅜	8.3	58300	7030
8	3½x3⅞	13.6	61000	4500
				38190
				Av.........7638

Table 5—Continued.

$K_{13}b$—CLINTON, IND.

TRANSVERSE.

No.	Breadth, inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Sr.	Var. from av.	Per cent. var.
1	3.35	4.15	6	9000	1400	1240	+160	12.9
2	3.48	4.15	6	7410	1110	....	—130	10.5
3	3.48	4.22	6	11190	1630	....	+390	31.4
4	3.50	4.25	6	7090	1010	....	—230	18.5
5	3.38	4.42	6	8670	1180	....	— 60	4.8
6	3.32	4.10	6	7290	1180	....	— 60	4.8
7	3.40	4.38	6	6850	945	....	—295	23.8
8	3.52	4.30	6	8000	1110	....	—130	10.5
9	3.38	4.32	6	9620	1380	....	+140	11.3
10	3.48	4.20	6	10120	1490	....	+250	20.2
				85240	12430	....		148.7
			Av	8520	1240	....		14.9

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$b_1$1	3.46	3.678	.218	6.3
2	3.495	3.745	.250	7.2
3	2.66	2.698	.338	12.7
$b_2$1	3.59	3.81	.22	6.1
2	2.35	2.678	.328	14.0
				46.3
			Av.......	9.3

CRUSHING.

NUMBER.	Size inches.	Area inches.	Load—pounds.	Stress—lb. per sq. in.
1	3⅜x4⅝	15.6²	40100	2580
6	3⅜x3½	11.8	19400	1640
7	3⅜x4	13.5	19500	1440
9	3⅜x3⅝	12.2	36700	3000
10	3⅜x4½	15.2	75600	5000
				13660
				Av 2732

Table 5—Continued.

$K_{13}c$—CLINTON, IND.

TRANSVERSE.

No.	Breadth, inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of rupture,—pounds per sq. in.	Av. Sr.	Var. from av.	Per cent var.
1......	3.48	4.08	6	8310	1290	1280	+10	0.8
2......	3.36	4.21	6	10550	1590		+310	24.2
3......	3.42	4.02	6	6850	1120		—160	12.5
4......	3.28	4.32	6	9960	1470		+190	14.8
5......	3.36	4.10	6	7820	1250		—30	2.3
6.. ...	3.42	4.08	6	7720	1220		—60	4.7
7......	3.40	4.02	6	7410	1220		—60	4.7
8......	3.42	4.16	6	9020	1380		+100	7.8
9......	3.38	4.10	6	6310	1000		—280	21.9
				73950	11544			93.7
			Average	8220	1280			9.4

ABSORPTION.

Number.	Kilos.			Per cent
	Dry.	Wet.	Gain.	
$c_1$1	3.308	3.495	.187	5.7
2	3.288	3.512	.224	6.8
3	3 215	3.42	.205	6.4
$c_2$1	3.265	3.48	.215	6.6
2	3.23	3.525	.295	9.1
				34.6
			Av.....	6.9

$K_{13}d$—CLINTON, IND.

TRANSVERSE.

No.	Breadth, inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of rupture,—pounds per sq. in.	Av. Sr.	Var. from av.	Per cent var.
1.....	3.20	4.10	6	10240	1710	1620	+90	5.5
2.....	3.40	3.95	6	8580	1460		—160	9.9
3.....	3.20	4.05	6	8640	1490		—130	8.0
4.....	3.28	4.00	6	11100	1900		+280	17.3
5....	3.30	4.02	6	8930	1510		—110	6.8
6.....	3.20	4.10	6	11620	1940		+320	19.8
7.....	3.25	4.02	6	5380	925		—695	42.8
8.....	3.35	3.98	6	12040	2040		+420	25.9
9.....	3.38	4.10	6	10040	1590		—30	1.9
10.....	3.15	3.90	6	8580	1610		—10	0.6
				95150	16170			136.5
			Average	9515	1620			13.6

Table 5—Continued.

ABSORPTION.

Number.	Kilos. Dry.	Kilos. Wet.	Kilos. Gain.	Per cent.
$d_1$1	3.51	3.545	.035	1.0
2	3.575	3.625	.05	1.4
3	3.46	3.545	.085	2.5
$d_2$1	3.035	3.078	.043	1.4
2	3.768	2.835	.067	2.4
				8.7
			Av.	1.7

CRUSHING.

Number.	Size—inches.	Area—square inches.	Load—pound.	Stress—lb. per sq. in.
5	3⅜x4	13.5	54700	4050
6	3⅜x2½	8.4	66000	7860
8	3⅜x4	13.5	82300	6100
8	3⅜x3¾	12.7	54000	4250
9	3⅜x4	13.5	105400	7800
				30060
				Av. 6012

K_{13}e—CLINTON, IND.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av.Mod.	Variation from average.	Per cent variation.
1	3.36	4.20	6	6230	950	1500	− 550	36.7
2	3.38	4.14	6	3430	530		970	64.6
3	3.36	3.96	6	10650	1820		+ 320	21.4
4	3.40	4.26	6	22940	3350		+1850	123.2
5	3.36	4.20	6	9450	1440		− 60	4.0
6	3.42	4.50	6	12210	1600		+ 100	6.7
7	3.36	4.08	6	4950	795		− 705	47.1
8	3.36	4.24	6	6660	995		− 505	33.7
9	3.36	4.08	6	13400	2160		+ 660	44.1
10	3.42	4.02	6	8200	1350		− 150	10.0
				100120	14990			391.5
			Av.	10000	1500			39.2

Table 5—Continued.

ABSORPTION.

Number.	Kilos. Dry.	Wet.	Gain.	Per cent.
$e_1$1	3.778	3.812	.034	0.9
2	3 363	3.40	.037	1.1
3	3.58	3.62	.04	1.1
$e_2$1	3.122	3.15	.028	0.9
2	2.91	2.95	.04	1.4
				5.4
			Average	1 1

CRUSHING.

Number.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lbs. per sq. in.
2	3½ x 3¼	11.4	63700	5600
3	3½ x 2¾	9.6	45400	4740
5	3½ x 4¼	14.9	71000	4760
9	3½ x 4¼	14.9	102900	6900
10	3½ x 4	14.	80700	5760
				27760
			Average	5552

G₂—COFFEYVILLE BLOCK, KANSAS.

TRANSVERSE TEST.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Variation from average.	Per cent variation.
1	3.18	4.02	6	7010	1240	1905	—665	34.9
2	3.12	3.96	6	13580	2500	....	+595	31.3
3	3.14	4.02	6	12970	2320	....	+415	21.8
4	3.18	4.02	6	7550	1330	....	—575	30.2
5	3.18	4.02	6	12060	2120	....	+215	11.6
6	3.18	4.02	6	6950	1220	....	—685	36.0
7	3.18	4.02	6	11370	2000	....	+ 95	5.0
8	3.18	3.96	6	10990	1980	....	+ 75	4.0
9	3.24	4.02	6	11550	1990	....	+ 85	4.5
10	3.18	3.94	6	12880	2350	....	+445	23.4
				106940	19050			202.7
			Av	10694	1905	....	....	20.3

ABSORPTION.

(See Coffeyville "Brick.")

Table 5—Continued.

G_2—COFFEYVILLE BRICK, KANSAS.

TRANSVERSE TEST.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Variation from average.	Per cent variation.
1	2.16	3.84	6	8890	2511	2325	+186	8.0
2 ...	2.14	3.78	6	9040	2659	....	+334	14.4
3	2.28	3.84	6	7520	2014	....	—311	13.4
4	2.18	4.14	6	7960	1918	....	—407	17.5
5	2.22	3.89	6	10630	2844	....	+519	22.3
6	2.16	3.84	6	8490	2398	....	+ 73	3.1
7	2.22	3.84	6	8610	2370	....	+ 45	1.9
8	2.18	3.82	6	7670	2171	....	—154	6.6
9	2.32	3.84	6	8000	2105	....	—220	9.5
10	2.22	3.84	6	7780	2141	....	—184	7.9
11	2.22	3.88	6	8800	2371	....	+ 46	2.0
12	2.28	3.84	6	8940	2395	....	+ 70	3.0
				102330	27897			109.6
			Av	8528	2325	....	....	9.1

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$b_1$1	2.45	2.465	.015	0.0
2	2.322	2.35	.028	1.6
3	2.49	2.51	.02	0.2
$b_2$1	2.46	2.475	.015	0.8
2	2.408	2.425	.025	1.6
				4.2
			Average	0.8

CRUSHING.

Number.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lbs. per sq. in.
1	3¼ x 3⅜	11	73700	6700
2	3¼ x 4	13	65000	5000
2	3¼ x 4	13	94700	7300
9	3½ x 4	13	79000	6080
10	3½ x 3½	11.4	82500	7250
				32330
			Average	6466

Table 5—Continued.

F_1c—DANVILLE BRICK CO., DANVILLE, ILL.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modluus of Rupture—pounds per sq in.	Av. Mod.	Variations from Average.	Per cent Variation.
1.....	3.24	4.20	6	9890	1560	1700	—140	8.2
2.....	3.18	3.98	6	11540	2060	....	+360	21.2
3.....	3.24	4.20	6	8980	1420	....	—280	16.5
4.....	3.22	4.20	6	8460	1340	....	—360	21.2
5.....	3.18	4.02	6	11290	1980	....	+280	16.5
6.....	3.14	4.08	6	10970	1890	....	+190	11.2
7.....	3.15	4.10	6	11420	1950	....	+250	14.7
8.....	3.13	3.96	6	8090	1480	....	—220	12.9
9.....	3.24	4.14	6	9100	1480	....	—220	12.9
10.....	3.24	4.08	6	11370	1890	....	+190	11.2
				101110	17050	....	....	146.5
			Average	10110	1700	....	....	14.6

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$c_1$1	2.94	3.115	.175	6.0
2	3.015	3.15	.135	4.5
3	3 23	3.322	.092	2.9
$c_2$1	2.085	2.23	.145	7.0
2	3.155	3.275	.12	3.8
				24.2
			Average	4.8

CRUSHING.

NUMBER.	Size—square inches.	Area—inches.	Load—pounds.	Stress—lb. per sq. in.
1....................	3¼ x 3	9.7	39900	4100
4....................	3¼ x 2¼	7.3	48800	6700
6....................	3¼ x 2¾	8.9	37700	4240
6....................	3¼ x 2⅝	8.5	42300	5000
10....................	3¼ x 3	9.7	58900	6100
				26140
				Average 5228

Table 5—Continued.

F_1d—DANVILLE BRICK CO., DANVILLE, ILL.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Variation from average.	Per cent variarion.
1.....	3.34	4.24	6	4970	745	980	—235	24.0
2.....	3.48	4.26	6	7180	1020	....	+40	4.1
3.....	3.46	4.52	6	3000	420	....	—560	57.2
4.....	3.34	4.10	6	7690	1240	....	—260	26.6
5.....	3.36	4.20	6	8560	1310	....	+330	33.7
6.....	3.34	4.14	6	6910	1090	....	+110	11.2
7.....	....	....	....	....	....	....	....	....
8.....	3.30	4.32	6	4700	690	....	—290	29.6
9.....	3.30	4.26	6	5400	815	....	—165	16.8
10.....	3.36	4.08	6	9090	1460	....	+480	49.0
				57500	8790	....	....	242.2
			Av.....	6370	980			26.9

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$d_1$1..................................	2.955	3.03	.078	2.6
2..................................	3.16	3.268	.108	3.4
3..................................	3.18	3.285	.105	3 3
$d_2$1..................................	3.09	3.185	.095	3.1
3..................................	3.292	3.352	.06	1.8
				14.2
			Average	2.8

CRUSHING.

NUMBER.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lb. per sq. in.
6..................	3⅜ x 4½	15.2	60600	4000
6..................	3⅜ x 4¼	14.3	43400	3040
9..................	3⅜ x 4¼	14.3	55400	3880
9..................	3⅜ x 4⅜	14.7	37400	2550
10..................	3½ x 3⅝	12.2	40100	3280
				16750
				Average 3350

Table 5—Continued.

F_1e—DANVILLE BRICK CO., DANVILLE, ILL.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq.in.	Av.Mod.	Variation from average.	Per cent variation.
1	3.36	4.08	6	14380	2300	1670	+630	37.7
2	3.36	3.96	6	12650	2160	....	+490	29.4
3	3.24	3.72	6	8160	1640	....	— 30	1.8
4	3.30	3.84	6	9500	1760	....	+ 90	5.4
5	3.24	3.96	6	6330	1120	....	—550	32.9
6	3.42	4.20	6	13190	1980	....	+310	18.6
7	3.36	4.08	6	11440	1840	....	+170	10.2
8	3.42	3.96	6	7890	1330	....	—340	20.4
9	3.42	4.32	6	12260	1740	....	+ 70	4.2
10	3.48	4.44	6	6130	805	....	—865	51.8
				101930	16675			212.4
			Average	10190	1670	....	....	21.2

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$e_1$1	2.92	2.96	.04	1.4
2	3.105	3.135	.03	1.0
3	2.75	2.79	.04	1.5
$e_2$1	2.92	3.005	.085	2.9
2	2.81	2.85	.04	1.5
				8.3
			Average	1.7

CRUSHING.

Number.	Size—square inches.	Area—square inches.	Load—pounds.	Stress—lb. per sq. in.
1	3¼ x 2½	8.1	41300	5100
6	3¼ x 2	6.5	34200	5260
6	3¼ x 2	6.5	50900	7830
7	3¼ x 2	6.5	43200	6650
9	3¼ x 2	6.5	36000	5550
				30390
				Average 6078

Table 5—Continued.

K_5b—EDWARDSVILLE.

ABSORPTION.

Number.	Kilos. Dry.	Wet.	Gain.	Per cent.
b 1	....	....	....	8.67
2	....	....	....	10.71
3	....	....	....	10.36
$b_2$1	....	....	....	8.79
2	....	....	....	9.60
				48.13
				Average ..9.62
K_5c				
c 1	....	....	....	7.37
2	....	....	....	5.90
c 1	....	....	....	3.52
2	....	....	....	3.84
3	....	....	....	2.79
				23.42
				Average ..4.68
K_5d				
$d_2$1	....	....	....	2.42
2	....	....	....	2.86
d 1	....	....	....	2.71
2	....	....	....	2.59
3	....	....	....	2.54
				13.12
				Average ..2.62
K_5e				
$e_2$1	....	....	....	1.93
2	....	....	....	1.34
e 1	....	....	....	1.49
2	....	....	....	0.77
3	....	....	....	1.37
				6.90
				Average ..1.38

Table 5—Continued.

K_2b—HYDRAULIC, ST. LOUIS, MO.

TRANSVERSE.

No.	Breadth, inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture, pounds per sq.in.	Av.Mod.	Var. from av.	Per cent var.	Remarks
1....	2.88	3.90	6	11970	2460	2430	+ 30	1.2	
2....	2.82	3.84	6	11810	2570	....	+ 140	5.8	
3....	2.80	3.94	6	15750	3250	....	+ 820	33.7	
4....	2.88	3.88	6	16780	3480	....	+1050	43.2	
5....	2.86	3.96	6	13090	2640	....	+ 210	8.6	
6....	2.76	3.84	6	10340	2290	....	— 140	5.8	
7....	2.78	4.04	6	17380	3430	....	+1000	41.1	
8....	2.96	3.80	6	14150	2980	....	+ 550	22.6	
9....	2.80	4.05	6	5610	1100	....	—1330	54.6	
10....	2.85	3.95	6	6060	1230	....	+1200	49.3	
11....	2.78	4.05	6	14370	2830	....	+ 400	16.5	
12....	2.88	4.10	6	4640	860	....	—1570	64.6	Fracture glazed.
				141950	29120			347.0	
			Average	11830	2430	....	....	28.9	

ABSORPTION.

NUMBER.	KILOS. Dry.	Wet.	Gain.	Per cent.
$b_1$1....	3.005	3.025	.02	0.7
2....	3.23	3.24	.01	0.3
3....	3.235	3.275	.04	1.2
$b_2$1....	3.12	3.13	.01	0.3
1....	3.32	3.33	.01	0.3
				2.8
			Average	0.6

CRUSHING.

Number.	Size—square inches.	Area—inches.	Load—pounds.	Stress—lb. per sq. in.
11	2⅞ x 3¾	10.8	76200	7560
11	2⅞ x 3¾	10.8	69800	6940
7	2⅞ x 3¼	9.3	107500	11500
2	2⅞ x 3½	10.0	77900	7790
10	2⅞ x 3¼	9.3	80500	8650
9	2⅞ x 3½	10.0	75400	7540
				49980
			Average	8330

Table 5—Continued.

$K_{11}b$—INDIANA BLOCK, BRAZIL, IND.

TRANSVERSE.

No.	Breadth, inches.	Depth—Inches.	Span—inches.	Load—pounds.	Modulus of Rupture, pounds per sq. in	Av.Mod.	Var. from av.	Per cent var.	Remarks.
1....	3.30	4.35	6	4940	715	685	+30	4,4	
2....	3.35	4.40	6	6670	930		+245	35.8	
3....	3.35	4.30	6	4280	620		—65	9.5	
4....	3.35	4.40	6	3780	525		+160	23.4	
5....	3.35	4.34	6	5000	715		+30	4.4	
6....	3.40	4.30	6	3040	435		—250	36.5	
7....	3.35	4.38	6	6030	845		+160	23.4	
8....	3 30	4 35	6	5180	745		+60	8.8	
9....	3.32	4.42	6	7770	1080		+395	57.6	
10....	3.30	4.32	6	1740	255		—430	62.8	Break
				48430	6865			266.6	
			Average	4840	685			26.7	

ABSORPTION

NUMBER	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$b_1$1	1.5	1.745	.245	16.3
2	1.395	1.602	.207	14.8
3.	2.528	2.83	.302	11.9
$b_2$1	2.005	2.235	.23	11.5
2.	2.398	2.665	.267	11.1
			Av.........	65.6
				13.1

$K_{11}c$—INDIANA BLOCK, BRAZIL, IND.

TRANSVERSE

No.	Breadth, inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture, pounds per sq.in.	Av.Mod.	Var. from av.	Per cent var.
1....	3.18	3.94	6	10850	1980	1510	+470	31.2
2....	3.18	3.84	6	7650	1470		—40	2.6
3....	3.16	3.98	6	8340	1510		0	0
4....	3.10	3.96	6	7000	1300		—210	13.9
5....	3.12	3.96	6	6950	1280		—230	15.2
6....	3.24	4.18	6	8320	1320		—190	12.6
7....	3.12	3.96	6	8330	1540		+30	2.0
8....	3.12	4.02	6	7600	1360		—150	9.9
9....	3.18	3.86	6	9280	1760		+250	16.6
10....	3.18	3.90	6	8660	1610		+100	6.6
				82980	15130			110.6
			Average	8300	1510			11.1

Table 5—Continued.

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$c_1$1	2.938	3.062	.124	4.2
2	3.18	3.23	.05	1.6
3	3.003	3.095	.092	3.1
$c_2$1	2.993	3.10	.097	3.2
2	3.11	3.185	.075	2.4
				14.5
			Av.	2.9

K11d—INDIANA BLOCK, BRAZIL, IND.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Variation from average.	Per cent variation.
1	3.18	3.90	6	10490	1960	2260	—300	13.3
2	3.14	3.90	6	10500	1980		—280	12.4
3	3.14	3.90	6	10680	2020		—240	10.6
4	3.14	4.05	6	13980	2450		+190	8.4
5	3.15	3.94	6	12140	2250		— 10	0.4
6	3.22	3.85	6	12850	2430		+170	7.5
7	3.10	3.94	6	11960	2240		— 20	0.9
8	3.15	4.00	6	13950	2500		+240	10.6
9	3.10	3.95	6	13670	2540		+280	12.4
10	3.20	3.98	6	12450	2220		— 40	1.8
				122670	22590			78.3
			Av.	12270	2260		Av.	7.8

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$d_1$1	2.955	3.008	.053	1.8
2	2.96	3.015	.055	1.9
3	2.95	3.002	.052	1.8
$d_2$1	3.025	3.075	.050	1.7
2	3.045	3.10	.055	1.8
				9.0
			Average	1.8

Table 5—Continued.

K11e—INDIANA BLOCK, BRAZIL, IND.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture-pounds per sq.in.	Av. Mod.	Variation from average.	Per cent variation	Remarks.
1....	3.18	4.38	6	6480	955	870	+ 85	9.8	Overbur'd
2....	3.18	4.20	6	9260	1480	....	+610	70.1	..do........
3....	3.30	4.56	6	4810	635	....	—235	27.0	..do........
4....	3.42	4.80	6	6220	710	....	—160	18.4	..do........
5....	3.18	4.38	6	8520	1260	....	+390	44.8	..do........
6....	3.24	4.38	6	4310	625	....	—245	28.2	..do........
7....	3.18	4.56	6	4040	550	....	—320	36.8	..do........
8....	3.24	4.68	6	4830	615	....	—255	29.3	..do........
9....	3.24	4.68	6	6950	880	....	+ 10	1.1	..do........
10....	3.18	4.56	6	7350	1000	....	+130	14.9	..do........
				62770	8710			280.4	
			Av	6280	870	....	....	28.0	

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$e_1$1....................................	2.31	2.39	.08	3.5
2....................................	2.33	2.405	.075	3.2
3....................................	2.595	2.66	.065	2.5
$e_2$1....................................	2.625	2.678	.053	2.0
2....................................	2.675	2.74	.065	2.4
				13.6
			Average	2.7

S_2b—KANSAS CITY DIAMOND.

TRANSVERSE.

No.	Breadth, inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture, pounds per sq.in.	Av.Mod.	Var. from av.	Per cent. var.	Remarks.
1....	2.56	3.78	6	10480	2580	2410	+170	7.0	
2....	2.46	3.70	6	9590	2560		+150	6.2	
3....	2.50	3.66	6	9180	2470		+ 60	0.2	
4....	2.58	3.72	6	11400	2560		+150	6.2	
5....	2.46	3.82	6	5010	1260		—1150	47.6	Over-burned.
6....	2.54	3.66	6	7920	2090		—320	13.6	
7....	2.46	3.64	6	11620	3060		+650	27.0	
8....	2.58	3.78	6	7040	1720		—690	28.6	
9....	2.56	3.72	6	9000	2540		+130	5.4	
10....	2.52	3.66	6	10050	2680		+270	11.2	
11....	2.46	3.72	6	10620	2820		+410	17.0	
12....	2.52	3.60	6	9420	2610		+200	8.3	
				111330	28950			178.3	
			Average	9280	2410			14.9	

Table 5—Continued.

ABSORPTION.

Number.	Kilos.			Per cent.	Time.
	Dry.	Wet.	Gain.		
$b_1$1	2.180	2.200	0.020	0.9	48 hours.
2	2.315	2 330	.015	.6	..do
3	1.805	1.815	.010	.6	..do
$b_2$1	2.085	2.095	.010	.5	..do
2	2.185	2.205	.020	1.0	..do
				3.6	
			Av	0.7	

L_2b—LAWRENCE, KANSAS.

TRANVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Average Mod.	Variation from average.	Per cent variation.
1	2.53	3.61	6	9500	2600	1770	+830	46.8
2	2.55	3.62	6	6500	1750		— 20	1.1
3	2.55	3.68	6	5670	1470		—300	16.9
4	2.50	3.52	6	7200	2100		+330	18.6
5	2.53	3.65	6	6600	1770		0	0.0
6	2.52	3.60	6	6520	1800		+ 30	1.7
7	2.53	3.65	6	4870	1300		—330	18.6
8	2.50	3.68	6	5600	1490		—280	15.8
9	2.55	3.60	6	7250	1970		+200	11.3
10	2.55	3.65	6	5550	1480		—290	16.4
				65260	17730			147.2
			Av	6530	1770			14.7

ABSORPTION.

Number.	Kilos.			Per cent.
	Dry.	Wet.	Gain.	
$b_1$1	2.06	2.112	.052	2.5
2	2.175	2.202	.027	1.2
3	2.10	2.142	.042	2.0
$b_2$1	1.90	1.932	.032	1.7
2	2.215	2.242	.027	1.2
				8.6
			Av	1.7

Table 5—Continued.

L_2c—LAWRENCE, KAN.

TRANSVERSE.

No.	Breadth, inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av.Mod.	Var. from av.	Per cent var.
1....	2.40	3.60	6	9410	2730	1960	+770	39.3
2....	2.42	3.55	6	7380	2180		+220	11.2
3....	2.50	3.66	6	7120	1920		—40	2.0
4....	25.2	3.74	6	7240	1860		—100	5.1
5....	2.48	3.52	6	4820	1410		—550	28.0
6....	2.48	3.64	6	6100	1670		—290	14.8
7....	2.55	3.70	6	7020	1810		—150	7.6
8....	2.48	3.70	6	7610	2020		+60	3.0
9....	2.47	3.62	6	7090	1980		+20	1.0
10....	2.50	3.72	6	7630	2000		+40	2.0
				71220	19580			114.0
			Average	7120	1960			11.4

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$c_1$1.	2.385	2.408	.023	1.0
2	2.382	2.40	.018	0.8
3	2,34	2.36	.02	0.9
$c_2$1	2.45	2.47	.02	0.8
2	2.37	2.392	.022	0.9
				4.4
			Av	0.9

CRUSHING.

NUMBER.	Size—inches.	Area—square inches.	Load—pounds	Stress—lb. per sq. in.
7....................	2½ x 2½	6.2	52000	8400
8....................	2½ x 2½	6.2	58700	9500
9....................	2½ x 2½	6.2	45800	7400
10....................	2½ x 2¾	6.9	90000	13000
11....................	2½ x 2¼	5.6	67700	12000
				50300
				Av........10060

Table 5—Continued.

S_1b—MOBERLY, MISSOURI.

TRANSVERSE.

No.	Breadth, inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Var. from av.	Per cent var.
1....	3.24	3.62	6	9930	2100	2130	—30	1.4
2....	3,24	3.66	6	10900	2270		+140	6.6
3....	3.26	3.66	6	11570	2310		+180	8.4
4....	3.24	3.40	6	7840	1890		—240	11.3
5....	3.24	3.60	6	10910	2340		+210	9.9
6....	3.18	3.66	6	10070	2130		0	0
7....	3.18	3.62	6	10220	2210		+80	3.8
8....	3.30	3.72	6	9470	1860		—270	12.7
9....	3.30	3.66	6	10720	2180		+50	2.3
10....	3.18	3.66	6	11270	2380		—250	11.7
11....	3.30	3 62	6	9480	1970		—160	7.5
12....	3.22	3.66	6	9120	1910		—220	10.3
				121500	25550			85.9
			Average	10125	21300			7.2

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$b_1$1	2.59	2.655	.065	2.5
2	2.805	2.875	.075	2.7
3	2.39	2.475	.085	3.6
$b_2$1	2.66	2.775	.115	4.3
2	2.625	2 71	.085	3.2
				16.2
			Av	3.2

R_1b—NELSONVILLE, OHIO.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Var. from av.	Per cent var.
1....	3.24	4.02	6	9050	1560	1790	—230	12.8
2....	3.30	3.96	6	9350	1630		—160	8.9
3....	3.24	3.96	6	10910	1900		+110	6.1
4....	3.30	4.02	6	11050	1870		+80	4.5
5....	3.24	4.02	6	11750	2030		+240	13.4
6....	3.24	4.02	6	9610	1680		—110	6.1
7....	3.30	4.08	6	10900	1780		—10	0.6
8....	3.24	3.96	6	11820	2100		+310	17.3
9....	3.24	4.08	6	10390	1800		+10	0.6
10....	3.30	3.96	6	9580	1670		—120	6.7
11....	3.24	4.02	6	10860	1870		+80	4.5
12....	3.24	4.08	6	9600	1600		—190	10.6
				124870	21490			92.1
			Average	10406	1790			7.7

Table 5—Continued.

ABSORPTION.

NUMBER.	KILOS. Dry.	Wet.	Gain.	Per cent.
$b_1$1	3.465	3 53	.065	1.9
2	3.53	3.58	.05	1.4
3	3.54	3.60	.06	1.7
$b_2$1	3.66	3.71	.05	1.3
2	3.43	3.485	.055	1.6
				7.9
			Av	1 6

CRUSHING.

NUMBER.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lb. per sq. in.
1	3¼ x 4⅝	15	70500	4700
11	3¼ x 4	13	64425	4950
10	3¼ x 4¼	13.8	39525	2860
4	3¼ x 4⅜	14.2	52450	3680
7	3¼ x 4⅝	15	39550	2640
				18830
				Av 3766

R_2b—PEEBLE'S BLOCK, PORTSMOUTH, O.

TRANSVERSE TEST.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Variation from average.	Per cent variation.
1	3.22	3.90	6	10750	1980	2505	—525	21.0
2	3.18	3.90	6	14420	2690	....	+185	7.4
3	3.18	3.96	6	12590	2270	....	—235	9.4
4	3.22	3.94	6	12420	2250	....	—255	10.2
5	3.18	3.94	6	11980	2180	....	—325	13.0
6	3.12	3.90	6	12300	2340	....	—165	6.6
7	3.18	3.90	6	12140	2260	....	—245	9.8
8	3.14	3.86	6	15060	2900	....	+395	15.8
9	3.18	3.94	6	15290	2780	....	+275	11.0
10	3.12	3.96	6	16490	3040	....	+535	21.4
11	3.18	3.90	6	15850	2950	....	+445	17.8
12	3.22	3.96	6	13470	2410	....	— 95	3.8
				162760	30050			147.2
			Av	13563	2505	....	....	12.3

Table 5—Continued.

R_2b—ABSORPTION.

NUMBER.	KILOS. Dry.	Wet.	Gain.	Per cent.
$b_1$1	3.375	3.45	.075	2.2
2	3.525	3.6	.075	2.1
3	3.395	3.47	.075	2.2
$b_2$1	3.5	3.575	.075	2.1
2	3.46	3.535	.075	2.2
				10.8
			Average	2.2

J_2b—PITTSBURG, KAN.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Variation from average.	Per cent variation.
1....	2.60	3.70	6	9870	2500	2220	+280	12.6
2....	2.60	3.78	6	7830	1900	....	—320	14.4
3....	2.50	3.80	6	7860	1960	....	—260	11.7
4....	2.44	3.82	6	11600	2940	....	+720	32.5
5....	2.62	3.70	6	8420	2130	....	— 90	4.1
6....	2.55	3.80	6	10390	2530	....	+310	14.0
7....	2.58	3.85	6	10110	2380	....	+160	7.2
8....	2.60	3.94	6	8940	2000	....	—220	10.0
9....	2.45	3.86	6	9960	2460	....	+240	10.8
10....	2.58	3.85	6	7950	1870	....	—350	15 8
11....	2.45	3.80	6	8210	2100	....	—120	5.4
12....	2.52	3.92	6	8120	1890	....	—330	14.8
				109360	26660	....	....	153.3
			Av.....	9130	2220	....	....	12.8

ABSORPTION.

NUMBER.	KILOS. Dry.	Wet.	Gain.	Per cent.
$b_1$1	2.318	2.405	.087	3.8
2	2.33	2.37	.04	1.7
3	2.473	2.52	.047	1.9
$b_2$1	2.30	2.335	.035	1.5
2	2.49	2.55	.06	2.4
				11.3
			Average..	2.3

Table 5—Continued.

CRUSHING.

Number.	Size—inches.	Area—inches.	Load—pounds.	Stress—lbs. per sq. in.
6	2½ x 2½	6.2^{2}	52000	8400
6	2½ x 2¾	6.9	78000	11300
9	2½ x 2⅝	6.6	96900	14600
9	2½ x 3	7.5	74500	9940
12	2½ x 3	7.5	57700	7700
				51940
			Average.......	10388

K_9b—POSTON BLOCK, CRAWFORDSVILLE, IND.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av.Mod.	Variation from average.	Per cent variation.
1	3.68	4.10	6	4000	585	705	—120	17.0
2	3.53	3.95	6	6340	1040	....	+335	47.5
3	3.75	4.00	6	5030	755	....	+ 50	7.1
4	3.62	4.15	6	4390	635	....	— 70	9.9
5	3.65	4.02	6	3760	575	....	—130	18.4
6	3.60	4.05	6	4920	755	....	+ 50	7.1
7	3.65	4.10	6	4120	605	....	—100	14.2
8	3.50	4.02	6	4550	725	....	+ 20	2.8
9	3.65	3.88	6	4870	795	....	+ 90	12.8
10	3.62	4.05	6	3960	600	....	—105	14.9
				45940	7070	....	....	151.7
			Average	4594	705	....	....	15.2

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$b_1$1..................................	2.305	2.564	.259	11.2
2..................................	2.66	2 92	.26	9.8
3..................................	3.132	3.38	.248	7.9
$b_2$1..................................	2.415	2.68	.265	11.0
2..................................	2.37	2.636	.266	11.2
				51.1
			Average	10.2

Table 5—Continued.

CRUSHING.

NUMBER.	Size inches.	Area inches.	Load—pounds.	Stress—lb. per sq. in.
1	3⅝x4	14.5	56700	3900
4	3⅝x4¼	15.4	60500	3940
5	3⅝x4½	16.3	69700	4280
6	3⅝x4	14.5	50000	3950
7	3⅝x4	14.5	52400	3600
				19670
				Average..3934

K_9c—POSTON BLOCK, CRAWFORDSVILLE, IND.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Variation from average.	Per cent variation.
1	3.65	3.85	6	7300	1220	1080	+140	13.0
2	3.55	3.80	6	4790	840	....	—240	22.2
3	3.65	3.85	6	4960	830	....	—250	23.2
4	3.62	3.90	6	5230	860	....	—220	20.4
5	3.55	3.90	6	8230	1380	....	+300	27.8
6	3.50	3.90	6	5470	930	....	—150	13.9
7	3.55	3.95	6	10380	1690	....	+610	56.6
8	3.55	3.98	6	5690	910	....	—170	15.7
9	3.60	3.95	6	6490	1040	....	— 40	3.7
				58540	9700			196.5
			Av......	6505	1080	....	....	21.8

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$c_1$1	3.555	3.79	.235	6.7
2	3.22	3.444	.222	6.9
3	3.71	3.87	.16	4.3
$c_2$1	3.34	3.542	.202	6.0
2	3.23	3.478	.248	7.7
				31.6
			Average	6.3

Table 5—Continued.

CRUSHING.

Number.	Size—inches.	Area—square inches.	Load—pounds.	Stress lb. per sq. in.
4	3¼ x 3	97.7	86400	8900
5	3⅝ x 3¼	11.8	114200	9700
8	3⅝ x 3	10.9	74300	6800
9	3⅝ x 3	10.9	100400	9200
9	3⅝ x 3	10.9	78800	7230
				41830
				Average ..8366

K_9d—POSTON BLOCK, CRAWFORDSVILLE, IND.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Var. from av.	Per cent. var.
1	3.60	3.82	6	9700	1660	2050	—390	19.0
2	3.50	3.85	6	10560	1830	....	—220	10.7
3	3.48	3.88	6	15020	2580	....	+530	25.8
4	3.48	3.95	6	12460	2070	....	+ 20	1.0
5	3.50	3.92	6	10010	1680	....	—370	18.0
6	3.60	3.70	6	11640	2140	....	+ 90	4.4
7	3.50	3.90	6	13510	2280	....	+230	11.2
8	3.50	4.00	6	14420	2320	....	+270	13.2
9	3.55	3.90	6	12450	2070	....	+ 20	1.0
10	3.62	3.90	6	11450	1880	....	—170	8.3
				121220	20510	....		112.6
			Average	12120	2050	....		11.3

ABSORPTION.

NUMBER.	KILOS.			Per cent
	Dry.	Wet.	Gain.	
$d_1$1	3.38	3.482	.102	3.0
2	3.51	3.622	.112	3.2
3	3 70	3.79	.09	2.4
$d_2$1	3.675	3.76	.085	2.3
2	3.82	3.872	.052	1.4
				12.3
			Average..	2.5

Table 5—Continued.

CRUSHING.

Number.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lbs. per sq. inch.
1	3½ x 3½	12.2	97800	8020
2	3½ x 2¾	9.6	97800	10200
5	3½ x 2½	8.7	79200	9100
9	3½ x 2¾	9.6	95000	9900
10	3½ x 2½	8.7	101200	11600
				48820
				Average 9764

K9e—POSTON BLOCK, CRAWFORDSVILLE, IND.

TRANSVERSE.

No.	Breadth, inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture, pounds per.sq. in	Av. Mod.	Var. from av.	Per cent var.	Remarks.
1	3.50	3.66	6	13100	2520	2050	+470	22.9	
2	3.67	3.55	6	11100	2170	....	+120	5.8	Badly ov'rburn'd and very irregular
3	3.60	3.30	6	10970	2520	....	+470	22.9	
4	3.55	3.68	6	5420	1020	....	—1030	50.2	
5	3.55	3.80	6	11790	2070	....	+20	1.0	
6	3.55	3.60	6	10120	1980	....	—70	3.4	
				62500	12280			106.2	
			Average	10120	2050	....	....	17.7	

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$e_1$1	3.255	3.285	.03	0.9
2	3.41	3.433	.023	.7
3	3.485	3.505	.02	.6
$e_2$1	3.465	3.50	.035	1.0
2	3.665	3.69	.025	.7
				3.9
			Average	0.8

CRUSHING.

NUMBER.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lb. per sq. in.
1	3½ x 2¾	9.6	108400	11300
2	3½ x 2½	8.7	89500	10300
3	3½ x 3	10.5	134000	12800
4	3½ x 2¼	7.8	80500	10300
4	3½ x 2¾	9.6	66000	6900
				15600
			Average	10320

Table 5—Continued.

K$_6$b—PURINGTON BLOCK.

ABSORPTION.

Number.	Kilos.			Per cent.
	Dry.	Wet.	Gain.	
1	....	....	....	6.53
2	....	....	....	5.37
3	....	....	....	5.48
4	....	....	....	5.82
5	....	....	....	8.07
				31.27
			Average	6.25

K$_6$c.

c1	....	....	....	3.75
2	....	....	....	3.76
c1	....	....	....	4.92
2	....	....	....	4.92
3	....	....	....	4.38
				19.97
			Average	3.99

K$_6$d.

d1	....	....	....	0.27
2	....	....	....	0.84
d1	....	....	....	0.28
2	....	....	....	0.57
3	....	....	....	0.00
				1.96
			Average	0 39

K$_6$e.

e1	....	....	....	1.25
2	....	....	....	0.43
3	....	....	....	0.95
4	....	....	....	0.98
5	....	....	....	0.85
				4.46
			Average	0.89

K$_6$b$_2$.

II1	....	....	....	6.48
2	....	....	....	7.55
II1	....	....	....	5.88
2	....	....	....	4.90
3	....	....	....	7.76
				32.57
			Average	6.51

Table 5—Continued.

Purington Block—Concluded.

K_6C_2.

Number.	Kilos.			Per cent.
	Dry.	Wet.	Gain.	
cII_2 1				4.33
2				7.17
cII 1				4.74
2				3.68
3				8.29
				28.21
			Average	5.64

K_4b—SPRINGFIELD, ILL.

TRANSVERSE.

No.	Breadth, inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture, pounds per sq. in.	Av. Mod.	Variation from average.	Per cent variation.
1	2.73	4.20	6	4150	780	980	—200	20.4
2	2.75	4.22	6	5120	945		— 35	3.6
3	2.75	4.10	6	3340	650		—330	33.7
4	2.70	4.15	6	3860	750		—230	23.5
5	2.72	4.20	6	5040	950		— 30	3.1
6	2.72	4.15	6	6150	1180		+200	20.4
7	2.70	4.15	6	6170	1195		+215	21.9
8	2.70	4.10	6	5380	1070		+ 90	9.2
9	2.72	4.10	6	5160	1020		+ 40	4.1
10	2.70	4.18	6	6620	1260		+280	28.6
				50990	9800			168.5
			Average	5100	980			16.8

ABSORPTION.

Number.	Kilos.			Per cent.
	Dry.	Wet.	Gain.	
1	1.415	1.595	.180	12.7
2	1.625	1.825	.2	12.3
3	1.93	2.155	.225	11.7
4	1.93	2.165	.235	12.2
5	1.86	2.085	.225	12.1
				61.0
			Average	12.2

Table 5—Continued.

CRUSHING.

Number.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lb. per sq. in.
2	2¾ x 3¼	8.9	10200	1150
5	2¾ x 3¾	10.3	15700	1520
6	2¾ x 3¼	8.9	19100	2150
6	2¾ x 3	8.2	23200	2840
9	2¾ x 4	11.0	28800	2620
				10280
				Average ..2056

K_4c—SPRINGFIELD, ILL.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Variation from average.	Per cent variation.
1......	2.58	3.95	6	11220	2520	2360	+160	6.8
2......	2.65	3.80	6	10350	2440	....	+ 80	3.4
3......	2.60	3.85	6	12630	2960	....	+600	25.4
4......	2.55	3.90	6	8260	1920	....	—440	18.7
5......	2.62	4.00	6	10510	2260	....	—100	4.2
6......	2.62	3.95	6	9400	2080	....	—320	13.6
				62370	14180			72.1
			Average	10395	2360	....	....	8.0

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
1	2.52	2.67	.15	5.95
2	2.51	2.61	.10	4.00
3	2.54	2.67	.13	5.12
4	2.425	2.56	.135	5.57
5	2.54	2.645	.105	4.14
				24.78
			Average	5.00

Table 5—Continued.

CRUSHING.

NUMBER.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lb. per sq. in.
1	2⅝ x 4	10.5	55400	5280
5	2⅝ x 3¾	9.8	52000	5300
5	2⅝ x 3½	9.2	56700	6170
6	⅝ x 3¾	9.8	40200	4100
6	2⅝ x 3½	8.5	41700	4900
				25750
			Average	5150

K_4d—SPRINGFIELD, ILL

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av.Mod.	Variation from average.	Per cent variation.
1	2.68	2.65	6	9120	2300	2250	+ 50	2.2
2	2.62	3.85	6	10770	2490	....	+240	10.7
3	2.58	3.88	6	11290	2610	....	+360	16.0
4	2.60	3.80	6	8350	2000	....	—250	11.1
5	2.62	3.82	6	10690	2520	....	+270	12.0
6	2.62	3.78	6	7470	1800	....	—450	20 0
7	2.62	3.90	6	10290	2330	....	+ 80	3.6
8	2.65	3.70	6	7850	1950	....	—300	13.3
9	2.65	3.70	6	11360	2820	....	+570	25.3
10	2.68	3.70	6	8170	2010	....	—240	10.7
11	2.55	3.90	6	8350	1940	....	—310	13.8
12	2.65	3.80	6	9410	2220	....	-- 30	1.3
				113120	26990			140.0
			Average	9430	2250	....	....	11.7

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$D_1$1	2.69	2.72	.03	1.1
2	2.76	2.794	.034	1.2
$D_2$1	2.645	2.675	.03	1.1
2	2.79	2.82	.03	1.1
3	2.565	2.593	.028	1.1
				5.6
			Average	1.1

Table 5—Continued.

K_4e—SPRINGFIELD, ILL.

TRANSVERSE TEST.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Variation from average.	Per cent variation.
1....	2.60	3.98	6	16150	3530	1890	+1640	86.7
2....	2.63	4.03	6	3000	635	....	—1255	66.4
3....	2.65	4.10	6	9140	2000	....	+ 110	5.8
4....	2.70	4.08	6	8800	1760	....	— 130	6.9
5....	2.70	4.05	6	12260	2490	....	+ 600	31.8
6....	2.63	4.10	6	4430	905	....	— 985	52.2
				53780	11320			249.8
			Average	8960	1890	....		41.6

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
1	1.69	1.702	.012	0.6
2	1.625	1.642	.017	.7
3	1.64	1.655	.015	.6
4	2.37	2.392	.022	.5
5	2.635	2.665	.030	.5
				2.9
			Average	0.6

CRUSHING.

NUMBER.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lb. per sq. in.
1.....................	2⅝ x 3⅜	8.8	33200	3780
3.....................	2⅝ x 4	10.5	31800	3020
3.....................	2⅝ x 4	10.5	31600	3000
4.....................	2⅝ x 2¾	7.2	34600	4800
6.....................	2⅝ x 3	7.9	26300	3340
				17940
			Average	3588

Table 5—Continued.

V8c—STREATOR PAVING BRICK COMPANY.

ABSORPTION.

Number.	Kilos. Dry.	Wet.	Gain.	Per cent.
$c_2$1				0.89
2				3.96
c 1				5.05
2				4.24
3				3.41
				17.55
			Average	3.51

V8d.

d 1				0.47
2				0.50
$d_2$1				0.46
2				0.48
3				0.46
				2.37
			Average	.49

V8e.

$e_2$1				0.00
2				0.50
e 1				0.47
2				0.49
3				0.50
				1.96
			Average	.39

K_{10}b—TERRE HAUTE BLOCK, TERRE HAUTE, IND.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of rupture,—pounds per sq. in.	Av. Mod.	Var. from av.	Per cent var.
1	3.40	4.00	6	8510	1410	1375	+ 35	2.5
2	3.20	4.10	6	7960	1330		— 45	3.3
3	3.35	4.05	6	8560	1410		+ 35	2.5
4	3.25	3.95	6	9170	1630		+255	18.6
5	3.25	3.98	6	8030	1410		+ 35	2.5
6	3.22	3.90	6	4480	825		—550	40.0
7	3.35	3.95	6	8520	1470		+ 95	6.9
8	3.42	4.10	6	12060	1890		+515	37.5
9	3.25	3.90	6	5560	1010		—365	21.6
				72850	12385			135.4
			Average	8090	1375			15.0

Table 5—Continued.

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$b_1$1	2.69	2.948	.258	9.6
2	2.758	3.04	.282	10.2
3	2.39	2.565	.175	7.3
$b_2$1	2.42	2.64	.22	9.1
2	2.625	2.872	.247	9.4
				45.6
			Average	9.1

$K_{10}c$—TERRE HAUTE BLOCK, TERRA HAUTE, IND.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of rupture,—pounds per sq. in.	Av. Mod.	Var. from av.	Per cent var.
1	3.15	3.71	6	11100	2300	1910	+ 390	20.4
2	3.30	3.72	6	4330	855		—1055	55.2
3	3.30	3.65	6	11730	2410		+ 500	26.2
4	3.25	3.80	6	4750	910		—1000	52.4
5	3.22	3.88	6	10560	1960		+ 50	2.6
6	3.30	3.75	6	12160	2360		+ 450	23.5
7	3.20	3.80	6	8540	1660		— 250	13.1
8	3.20	3.80	6	10360	1950		+ 40	2.1
9	3.22	3.94	6	14480	2600		+ 690	36.1
10	3.35	3.85	6	11660	2110		+ 200	10.5
				99670	19110			242.1
			Average	9667	1910			24.2

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$c_1$1	2.865	2.97	.105	3.7
2	3.33	3.37	.04	1.2
3	2.615	2.658	.043	1.6
$c_2$1	2.91	2.968	.058	2.0
2	3.065	3.105	.04	1.3
				9.8
			Average	2.0

Table 5—Continued.

$K_{10}d$—TERRE HAUTE BLOCK, TERRE HAUTE, IND.

TRANSVERSE.

No.	Breadth, inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture, pounds per sq. in.	Av. Mod.	Var. from av.	Per cent var.
1	3.20	3.75	6	14300	2870	2340	+530	22.6
2	3.25	3.75	6	11680	2300	....	— 40	1.7
3	3.15	3.75	6	13300	2710	....	+370	15.8
4	3.20	3.90	6	9680	1800	....	—540	23.1
5	3.20	3.80	6	11280	2210	....	—130	5.5
6	3.23	3.88	6	12290	2290	....	— 50	2.1
7	3.20	3.85	6	11750	2230	....	—110	4.7
				84260	16410	....		75.5
			Average	12040	2340	....		10.8

ABSORPTION.

Number.	Kilos.			Per cent.
	Dry.	Wet.	Gain.	
$d_1$1	2.843	2.868	.025	0.9
2	2.61	2.625	.015	0.6
3	2.69	2.718	.028	1.0
$d_2$1	2.68	2.718	.038	1.4
2	2.51	2.538	.028	1.1
				5.0
			Average	1.0

CRUSHING.

Number.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lbs. per sq. in.
2	3¼ x 3¼	10.6	76700	7250
4	3¼ x 4	13.	76800	5900
4	3¼ x 3	9.7	34700	3580
5	3¼ x 3½	11.4	71500	6250
6	3¼ x 3⅛	10.1	70000	6940
				29920
			Average	5984

Table 5—Continued.

K10e TERRE HAUTE BLOCK, TERRE HAUTE, IND.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Variation from average.	Per cent variation.
1	3.25	4.00	6	18010	3130	1880	+1250	66.5
2	3.33	3.88	6	12260	2200	....	+320	17.0
3	3.45	4.15	6	7250	1100	....	—780	41.5
4	3.40	4.10	6	13200	2080	....	+200	10.6
5	3.25	3.85	6	8020	1500	....	—380	20.2
6	3.32	4.22	6	10020	1530	....	—350	18.6
7	3.30	4.00	6	10100	1720	....	—160	8.5
8	3.30	4.00	6	7930	1350	....	—530	28.2
9	3.35	3.85	6	12670	2290	....	+410	21.8
				99460	16900	....	....	232.9
			Average	11050	1880			25.9

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$c_1$1	2.74	2.765	.025	0.9
2	3.03	3.048	.018	.6
3	2.80	2.82	.02	.7
$c_2$1	2.74	2.762	.022	.8
2	2.578	2.605	.027	1.0
				4.0
			Average	0.8

CRUSHING.

NUMBER.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lb. per sq. in.
7	3¼ x 3⅜	11.	24300	2200
8	3¼ x 3¾	12.2	43000	3520
9	3¼ x 4⅛	13.4	21000	1570
9	3¼ x 3½	11.4	21400	1880
10	3¼ x 4⅜	14.2	41500	2920
				12090
			Average	2418

Table 5—Continued.

H_2b

TOPEKA, KAN.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av.Mod.	Variation from average.	Per cent variation.
2	2.58	3.90	6	8840	2030	2300	— 270	11.7
3	2.34	3.84	6	10540	2750	....	+ 450	19.6
4	2.46	3.90	6	12610	3040	....	+ 740	32.2
5	2.46	3.88	6	10360	2520	....	+ 220	9.6
6	2.52	3.84	6	8280	2020	....	— 280	12.2
7	2.46	4.02	6	11250	2550	....	+ 250	10.9
8	2.28	4.02	6	10160	2480	....	+ 180	7.8
9	2.44	3.90	6	8950	2180	....	— 120	5.2
10	2.46	3.96	6	9740	2270	....	— 30	1.3
11	2.52	3.84	6	9090	2220	....	— 80	3.5
12	2.46	3.96	6	9500	2220	....	— 80	3.5
13	2.44	3.90	6	5520	1340	....	— 960	41.8
				114840	27620	....	....	159.3
			Average	9570	2300	....	....	13.3

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$b_1$1	2.235	2.315	.02	0.9
2	2.19	2.225	.035	1.6
3	2.098	2.118	.02	1.0
$b_2$1	2.092	2.115	.023	1.0
2	2.182	2.215	.033	1.5
				6.0
			Average	1.2

K_8b—WABASH CLAY CO., WEEDERSBURG, IND.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq.in.	Av.Mod.	Variation from average.	Per cent variation.
1	3.62	3.90	6	1730	285	585	—300	51.3
2	3.60	3.95	6	4170	670	....	+ 85	14.5
3	3.50	4.05	6	4380	690	....	+105	17.9
4	3.50	4.05	6	4860	765	....	+180	30.8
5	3.60	3.90	6	4530	745	....	+160	27.3
6	3.55	4.00	6	2740	435	....	—150	25.6
7	3.60	3.95	6	3260	520	....	+ 65	11.1
8	3.50	4.09	6	3630	585	....	0	.0
				29300	4695			178.5
			Average	3660	585	....	....	22.3

Table 5—Continued.

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
$b_1$1	3.128	3.43	.302	9.7
2	3.055	3.338	.283	9.3
3	3.135	3.47	.335	10.7
$b_2$1	2.712	2.98	.268	9.9
2	3.192	3.485	.293	9.7
				49.3
			Average	9.9

CRUSHING.

Number.	Size—square inches.	Area—square inches.	Load—pounds.	Stress—lb. per sq. in.
1	3½ x 3⅝	12.7	56900	4500
3	3½ x 3 ⅝	12.7	34300	2700
4	3½ x 4	14.	26500	1890
4	3½ x 3⅛	10.9	27000	2480
8	3½ x 4¼	14.9	31800	2140
				13710
				Average 2742

K_8c—WABASH CLAY CO., VEEDERSBURG, IND.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modluus of Rupture—pounds per sq. in.	Av.Mod.	Variations from Average.	Per cent Variation.
1	3.50	3.90	6	5530	940	1035	— 95	9.2
2	3.50	3.95	6	6730	1110	....	+ 75	7.2
3	3.50	3.90	6	5120	870	....	—165	16.0
4	3.52	3.88	6	7620	1300	....	+265	25.6
5	3.50	3.90	6	4470	755	....	—280	27.1
6	3.50	3.98	6	6040	980	....	— 55	5.3
7	3.55	3.92	6	7810	1290	....	+255	24.7
				43320	7245	....	....	115.1
			Average	6190	1035	....	....	16.4

Table 5—Continued.

ABSORPTION.

Number.	Kilos. Dry.	Wet.	Gain.	Per cent.
$c_1$1	3.135	3.38	.245	7.8
2	3.130	3.34	.21	6.7
3	3 098	3.375	.277	8.9
$c_2$1	3.085	3.345	.26	8.4
2	3.202	3.444	.242	7.6
				39.4
			Average	7.9

CRUSHING.

Number.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lbs. per sq. in.
1	3½ x 4⅜	15.3	83200	5440
2	3½ x 4	14.0	61400	4380
2	3½ x 5	17.5	65900	3760
3	3½ x 4½	15.7	47500	3020
4	3½ x 4½	15.7	107400	6800
5	3½ x 2⅝	9.2	37200	4040
6	3½ x 4⅝	16.2	72040	4450
7	3½ x 4⅜	15.3	46500	3040
7	3½ x 4¼	14.8	64400	4320
				39250
			Average........	4361

K8d—WABASH CLAY CO., VEEDERSBURG, IND.

TRANSVERSE.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av. Mod.	Variation from average.	Per cent variation.
1	3.48	3.80	6	10350	1860	1440	+420	29.2
2	3.38	3.90	6	5760	1010	....	—430	29.8
3	3.35	3.90	6	10960	1940	....	+500	34.7
4	3.45	3.80	6	10990	1990	....	+550	38.2
5	3.40	3.85	6	7750	1390	....	— 50	3.5
6	3.35	3.88	6	7190	1290	....	—150	10.4
7	3.40	3.80	6	3110	570	....	—870	60.3
8	3.40	3.80	6	9060	1660	....	+220	15.3
9	3.40	3.83	6	7050	1280	....	—160	11.1
				72220	12990			232.5
			Average	8020	1440	....	....	25.8

Table 5—Continued.

ABSORPTION.

NUMBER.	KILOS.			Per cent.
	Dry.	Wet.	Gain.	
d_1	3 285	3.40	.115	3.5
2	3.22	3.355	.135	4.2
3	3.312	3.445	.133	4.0
$d_1$1	3.362	3.488	.126	3.8
2	3.362	3.40	.138	4.2
				19.7

CRUSHING.

Number.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lb. per sq. in.
1	3½ x 3¼	11.4	57800	5060
2	3½ x 3⅝	12.7	35900	2820
5	3½ x 3	10.7	26100	2480
7	3½ x 3¼	11.4	61500	5400
8	3½ x 3¼	11.4	71000	6230
				21990
				Average ... 4398

K_8e—WABASH CLAY CO., VEEDERSBURG, IND.

TRANSVERSE TEST.

No.	Breadth—inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture—pounds per sq. in.	Av.Mod.	Variation from average.	Per cent variation.
1	3.50	3.84	6	4350	760	810	— 50	6.2
2	3.50	4.00	6	6590	1060	....	+250	30.8
3	3.50	3.95	6	4050	670	....	—140	17.3
4	3.50	4.00	6	4900	790	....	— 20	2.5
5	3.50	3.90	6	2200	370	....	—440	54.3
6	3.55	3.80	6	2700	475	....	—335	41.3
7	3.50	3.80	6	1880	335	....	—475	58.6
8	3.50	3.90	6	1900	320	....	—490	60.5
9	3.52	4.00	6	11000	1760	....	+950	117.4
10	3.52	4.00	6	9750	1560	....	+750	92.5
				49320	8090			481.4
			Average	4930	810	....	....	48.1

Table 5—Continued.

ABSORPTION.

Number.	Kilos.			Per cent.
	Dry.	Wet.	Gain.	
	2.11	2.13	.02	1.0
2	2.725	2.77	.045	1.6
3	3.76	3.815	.055	1.5
4	2.495	2.54	.045	1.8
5	3.6	3.67	.07	1.9
				7.8
			Average	1.6

CRUSHING.

Number.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lb. per sq. in.
1	3½ x 3½	12.2	89300	7300
2	3½ x 3	10.5	70600	6730
5	3½ x 3⅛	10.9	100000	9160
7	3½ x 3½	12.2	115000	9450
10	3½ x 3¾	13.1	70100	5350
				37990
				Average 7598

$K_{14}b$—WESTERN PAVER, DANVILLE, ILL,

TRANSVERSE.

	Breadth-inches.	Depth—inches.	Span—inches.	Load—pounds.	Modulus of Rupture, pounds per sq. in.	Av. Mod.	Var. from av.	Per cent var.	Remarks
1	3.48	4.08	6	9180	1424	1617	—193	11.9	
2	3.54	4.06	6	9820	1515		—102	6.3	
3	3.48	4.02	6	11220	1795		+178	11.0	
4	3.58	3.96	6	9610	1541		— 76	4.7	
5	3.46	4.08	6	9260	1447		—170	10.5	
6	3.60	4.02	6	10510	1625		+ 8	0.5	
7	3.48	4.02	6	10330	1653		+ 36	2.2	
8	3.48	3.96	6	10310	1700		+ 83	5.1	
9	3.46	4.02	6	10120	1629		+ 12	0.7	
10	3.60	3.90	6	8300	1364		—253	15.6	Irregular shape caused eccentric load.
11	3.42	4.02	6	12860	2094		+477	29.5	
12	3.58	4.02	6	10370	1613		— 4	0.2	
				121890	19400			98.2	
			Average	10160	1167			8.2	

Table 5—Concluded.

ABSORPTION.

Number.	Kilos.			Per cent.
	Dry.	Wet.	Gain.	
$b_1$1	3.512	3.676	.164	4.7
2	3.810	3.975	.165	4.3
3	3.725	3.875	.150	4.0
$b_2$1	3.505	3.675	.170	3.9
2	3.700	3.855	.155	4.2
				21.1
			Average	4.2

CRUSHING.

Number.	Size—inches.	Area—square inches.	Load—pounds.	Stress—lb. per sq. in.
5	3½ x 4	14.	50000	3580
7	3½ x 4	14.	94500	6750
9	3½ x 3¾	13.1	86800	6640
10	3½ x 3½	12.2	51200	4200
11	3½ x 3½	12.2	60400	4950
				26120
			Average	5224