DEPARTMENT OF COMMERCE

CIRCULAR

OF THE

BUREAU OF STANDARDS

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No. 109

SAND-LIME BRICK—DESCRIPTION AND SPECIFICATION

JANUARY 3, 1921

PRICE 5 CENTS

Sold only by the Superintendent of Documents, Government Printing Office
Washington, D. C.

WASHINGTON
GOVERNMENT PRINTING OFFICE
1921

SAND-LIME BRICK—DESCRIPTION AND SPECIFICATION

ABSTRACT

This article contains a very brief history of the sand-lime brick industry, and a very general description of the process of manufacture and the properties of the brick. For greater detail in these matters, see Bureau of Standards Technologic Paper No. 85.

The Bureau, in cooperation with the Sand-Lime Brick Association, is conducting research work on the subject.

Recommended specifications for building brick (including both sand-lime and clay) are given in full.

CONTENTS

1. DEFINITION

Sand-lime brick is a building material in brick form, which is composed of grains of sand bound together by a hydrated calcium silicate.

2. HISTORY

The process used in making sand-lime brick was covered by German patent No. 14195, granted to Dr. William Michaelis, October 5, 1880. The patent expired without its having been exploited, so that the process is now free for the use of the public.

The first sand-lime brick produced in the United States was made at Michigan City, Ind., in 1901. Since then, the industry has passed through those vicissitudes which seem to be the necessary accompaniment of any new and worth-while development. To-day sand-lime brick has an established position as a satisfactory building material. It is being made in some 80 plants, widely scattered throughout the country.

3. MANUFACTURING PROCESS

Sand-lime brick is made by mixing sand with slaked lime, pressing the mixture into brick form, and curing it in steam. The steam brings about a chemical reaction between the lime and the sand, forming the "hydrated calcium silicate," which is the bonding material of the brick.

Any good clean siliceous sand may be used, provided only that it contains enough fine material to combine with the lime, say, about 15 per cent through a No. 100 sieve. The lime must be nearly pure and must be thoroughly slaked. The proportions of materials used are 90 per cent sand to 10 per cent slaked lime. Enough water is added to make the mixture damp enough to hold its shape when pressed. The mixture is then run through a press, where it is molded into brick form, using a pressure of 5 000 to 10 000 pounds per square inch. The green bricks are piled on small cars, holding about 1000 bricks each. When a car is loaded it is run into the hardening cylinder. This is a long horizontal cylinder made of boiler plate. It is large enough to hold a day's run from one press, say, 10 cars of 1000 bricks each. At night, when the cylinder is full, the front end is bolted in place, and live steam is turned in. The steam pressure in the cylinder is brought up to about 120 pounds and is held there all night. In the morning the cylinder is opened and the brick removed. They are ready for market immediately.

While the above is a description of a typical process of manufacture, it must be understood that each plant has introduced special modifications to meet its particular conditions.

4. PROPERTIES OF THE BRICK

Most sand-lime bricks on the market to-day will qualify as "medium;" some few as "hard." The terms "medium" and "hard" are completely defined in the specification for building brick given below, and correspond pretty closely to the more generally used terms "first common" and "face." This classification defines the strength of the brick and its ability to absorb water.

A characteristic of sand-lime brick is its regular shape; the edges are straight; the sides are parallel and nearly smooth; the angles are true; the individual bricks are uniform in size. That these things should be so is obvious from a consideration of the method of manufacture.

Most sand-lime bricks are nearly white. Occasionally the use of a crushed colored sandstone instead of sand results in the production of a colored brick. Attempts to make colored brick by the addition of pigments have been fairly successful. Buff, red, and gray sand-lime bricks have been on the market, but the tendency of the times is opposed to such specialties.

The addition of Portland cement, or some other ingredient, to give certain properties to the brick has also been tried commercially. The use of such materials has been pretty generally abandoned, usually for economic reasons.

The largest development of the sand-lime brick industry has taken place in northern latitudes—New York, Michigan, Wisconsin, and Minnesota. The satisfactory use of the material in these States and in Canada, over a period of years, is a definite indication of its ability to withstand the action of the weather.

Sand-lime brick is used for building chimneys for small dwelling houses. It is not in any sense a refractory material, and should not be used in places where it may be subjected to a red heat.

It is quite customary to use two kinds of brick for building a wall; the outside of the wall is made of "hard" or "face" brick, the inside of "common," or "backing-up" brick. Since the bricks in this inner course are not exposed to the weather, they may be of inferior quality. Face brick are of extra fine quality to start with, and they are handled with extreme care to prevent chipping the corners and edges. It would seem a more economical proposition to order only one kind of sand-lime brick—the medium, or first common grade—select those which have perfect edges and corners for face brick, and use the rest for "backing up."

Not every market in the United States can be supplied with locally made clay brick. It does not take many miles between producer and consumer for the freight bill to be greater than the cost of the brick. If, in such localities, a deposit of sand can be found available, the establishment of a sand-lime brick factory there would be an economic benefit to the community.

5. WORK OF THE BUREAU

The sand-lime brick manufacturers have a national association, which holds an annual meeting. The Bureau has been represented at each of these meetings since 1910. The representative has reported on the previous year's work, has learned from the

manufacturers the problems before them, and with this knowledge as a basis has laid the plans for the next year's work.

The problems investigated are of two types: Those having to do with the manufacture of the brick, as, for example, the effect of the duration of the hardening treatment on the properties of the brick; and those having to do with the use, such as a discussion of how brick piers fail.

Bureau of Standards Technologic Paper No. 85 can be obtained from the Superintendent of Public Documents, Washington, D. C., at 10 cents per copy, or it can be consulted in any one of many public libraries. It contains a historical sketch and description of sand-lime brick as a common building material. The process of manufacture and the properties of the resultant product are described in detail. The tests suitable for sand-lime brick are outlined, and in the appendix is given a description of various plants. It is shown that where sand of good quality is abundant, the ability to make brick of the sand is placed within the reach of the user, furnishing a cheap, durable, noncombustible building material which is a home product, with reasonable transportation costs.

In cooperation with the American Society for Testing Materials the Bureau of Standards has assisted in the preparation of the specification for building brick, as printed in section 6.

The specification for building brick was adopted as standard by the American Society for Testing Materials in 1920, and is recommended by the Bureau. This specification was developed from new data obtained from many sources, such as State universities and private and public laboratories, including the Bureau of Standards.

To get sand-lime brick suitable for general purposes, specify "Sand-lime brick, medium grade, according to A. S. T. M. specification C21–20."

6. STANDARD SPECIFICATION FOR BUILDING BRICK

I. STANDARD SIZE

1. The standard size of building brick shall be 2¼ by 3¾ by 8 inches.

II. SAMPLING

2. For the purpose of tests, bricks shall be selected by an experienced person so as to represent the commercial product. All bricks shall be carefully examined and their condition noted before

being subjected to any kind of test. For the purpose of the tests 10 bricks will be required; they shall be thoroughly dried to constant weight in a suitable oven at a temperature of from 225° F (107° C) to 250° F (121° C).

III. PHYSICAL TESTS

3. ABSORPTION.—(*a*) At least five dry bricks shall be weighed and completely submerged in water at a temperature between 60 and 80° F, the water heated to boiling within one hour, boiled continuously for five hours, and then allowed to cool in the water to a temperature between 60 and 80° F. They shall then be removed, the surface water wiped off with a damp cloth, and the brick quickly weighed.

(*b*) The percentage of absorption shall be computed on the dry weight, according to the relation:

$$\text{Percentage of absorption} = \frac{100\ (B - A)}{A}$$

where A = weight of dry brick, and B = weight of saturated brick.

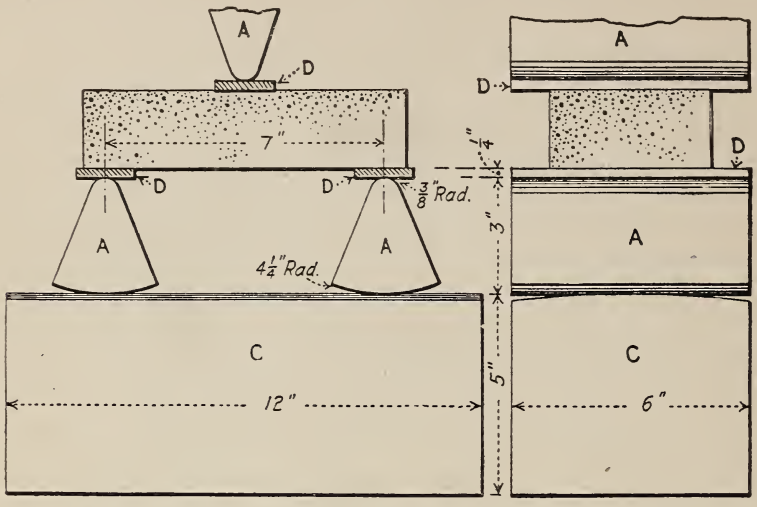
4. COMPRESSION TESTS.—(*a*) Compression tests shall be made on at least five half bricks, previously dried, each taken from a different brick. The half brick shall be prepared either by sawing or cutting upon a yielding bed with a sharp mason's chisel, which shall be the full width of the brick. The specimens shall be tested on edge. To secure a uniform bearing in the testing machine the edge surfaces shall be bedded in a thin coat of plaster of Paris spread upon plate glass previously coated with a film of oil. Before applying the plaster of Paris, the bearing surface of the brick shall receive a coating of shellac. The brick shall be pressed firmly upon the surface, making the layer as thin as possible, and remain undisturbed until set. The depression of recessed or paneled bricks shall be filled with neat Portland-cement mortar, which shall stand at least 24 hours before testing.

(*b*) The machine used for the compression tests shall be equipped with a spherical bearing block kept thoroughly lubricated to insure accurate adjustment, which should be made by hand under a small initial load. During the test the beam of the testing machine shall be kept constantly in a floating position.

(*c*) The breaking load shall be divided by the area in compression and the results reported in pounds per square inch.

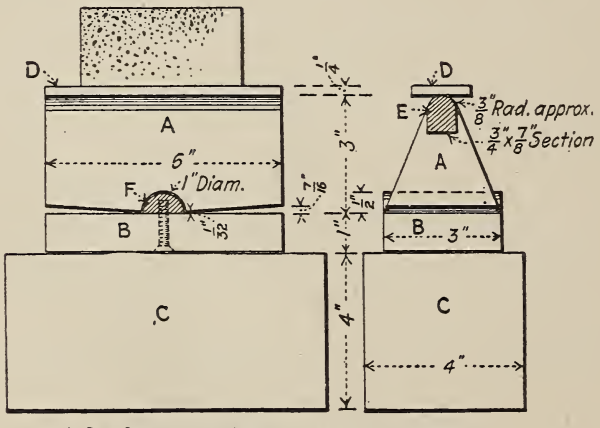
5. TRANSVERSE TESTS.—(*a*) At least five bricks, previously dried, shall be tested, laid flatwise, with a span of 7 inches, and

with the load applied at midspan. The knife-edges shall be slightly curved in the direction of their length. Steel bearing plates, about ¼ inch thick by 1½ inches wide, may be placed between



A = Cast-Iron Wedges; C = Soft Wood Block; D = Cold-Rolled Steel Plates.

FIG. 1.—*Knife-edge bearings for making transverse tests*



A, B = Cast-Iron Wedges; C = Soft Wood Block;
D, E, F = Cold-Rolled Steel.

FIG. 2.—*Alternative style of knife-edge bearings*

the knife-edges and the brick. The use of a wooden base block, slightly rounded transversely across its top, upon which to rest the lower knife-edges (see Fig. 1), or the form of lower knife-edge

shown in Fig. 2, is recommended. If the knife-edges shown in Fig. 2 are used, they should rest upon smooth-plane blocks of wood at least 2 inches thick.

(*b*) The modulus of rupture shall be computed in pounds per square inch by the following formula:

$$R = \frac{3}{2}\frac{Wl}{bd^2}$$

in which l = the distance between supports in inches, b = the breadth and d = depth of the brick in inches, and W = the load in pounds at which the brick failed.

6. RECORD OF TEST RESULTS.—In recording the results of the test the type of brick shall be defined, whether stiff mud, soft mud, dry pressed, repressed, sand-lime, or other types. It is recommended that the data obtained be recorded as indicated on the accompanying "Laboratory Record."

IV. CLASSIFICATION OF BRICKS

7. (*a*) According to the results of the physical tests, the bricks shall be classified as vitrified, hard, medium, and soft bricks, on the basis of the following requirements:

Name of grade	Absorption limits		Compressive strength (on edge)		Modulus of rupture	
	Mean of 5 tests	Individual maximum	Mean of 5 tests	Individual minimum	Mean of 5 tests	Individual minimum
	Per cent	Per cent	Lbs./in.^{2}	Lbs./in.^{2}	Lbs./in.^{2}	Lbs./in.^{2}
Vitrified brick	5 or less	6.0	5000 or over	4000	1200 or over	800
Hard brick	5 to 12	15.0	3500 or over	2500	600 or over	400
Medium brick	12 to 20	24.0	2000 or over	1500	450 or over	300
Soft brick	20 or over	No limit.	1000 or over	800	300 or over	200

(*b*) The standing of any set of bricks shall be determined by that one of the three requirements in which it is lowest.

WASHINGTON, November 5, 1920.