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Master
Specification
No. 1a

DEPARTMENT OF COMMERCE

BUREAU OF STANDARDS

George K. Burgess, Director

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UNITED STATES GOVERNMENT MASTER SPECIFICATION FOR CEMENT, PORTLAND

FEDERAL SPECIFICATIONS BOARD SPECIFICATION No. 1a

[Revised June 10, 1927]

This specification was officially promulgated by the Federal Specifications Board on February 3, 1922, for the use of the departments and independent establishments of the Government in the purchase of Portland cement.

[The latest date on which the technical requirements of this revision of this specification shall become mandatory for all departments and independent establishments of the Government is September 10, 1927. They may be put into effect, however, at any earlier date after promulgation.]

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I. DEFINITION

Portland cement is the product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum.

II. CHEMICAL PROPERTIES

1. CHEMICAL LIMITS

The following limits shall not be exceeded:

	Per cent
Loss on ignition	4.00
Insoluble residue	.85
Sulphuric anhydride (SO_3)	2.00
Magnesia (MgO)	5.00

III. PHYSICAL PROPERTIES

1. FINENESS

The residue on a standard No. 200 sieve shall not exceed 22 per cent by weight.

2. SOUNDNESS

A pat of neat cement shall remain firm and hard, and show no signs of distortion, cracking, checking, or disintegration in the steam test for soundness.

3. TIME OF SETTING

The cement shall not develop initial set in less than 45 minutes when the Vicat needle is used or 60 minutes when the Gillmore needle is used. Final set shall be attained within 10 hours.

4. TENSILE STRENGTH

The average tensile strength in pounds per square inch of not less than three standard mortar briquets (see Section VII, 8, (a)) composed of 1 part of cement and 3 parts of standard sand, by weight, shall be equal to or higher than the following:

Age at test, days	Storage of briquets	Tensile strength
		Lbs./in.²
7	1 day in moist air, 6 days in water	225
28	1 day in moist air, 27 days in water	325

The average tensile strength of standard mortar at 28 days shall be higher than the strength at 7 days.

IV. PACKING, MARKING, AND STORAGE

1. PACKAGES AND MARKING

The cement shall be delivered in packages as specified with the brand and name of the manufacturer plainly marked thereon, unless shipped in bulk. When shipped in bulk, this information shall be contained in the shipping advices accompanying the shipment. A bag shall contain 94 pounds net. A barrel shall contain 376 pounds net. All packages shall be in good condition at the time of inspection.

2. STORAGE

The cement shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment, and in a suitable weather-tight building which will protect the cement from dampness.

V. INSPECTION

Every facility shall be provided the purchaser for careful sampling and inspection at either the mill or at the site of the work, as may be specified by the purchaser. At least 12 days from the time of sampling shall be allowed for the completion of the 7-day test, and at least 33 days shall be allowed for the completion of the 28-day test. The cement shall be tested in accordance with the methods hereinafter prescribed. The 28-day test need not be made if waived by the purchaser.

VI. REJECTION

The cement shall be rejected if it fails to meet any of the requirements of these specifications.

Cement remaining in storage prior to shipment for a period greater than six months after test shall be retested and shall be rejected if it fails to meet any of the requirements of these specifications.

Cement shall not be rejected on account of failure to meet the fineness requirement if upon retest after drying at 100° C. for one hour it meets this requirement.

Cement failing to meet the test for soundness in steam may be accepted if it passes a retest using a new sample at any time within

28 days thereafter. The provisional acceptance of the cement at the mill shall not deprive the purchaser of the right of rejection on a retest of soundness and time of setting at the time of delivery of cement to the purchaser.

Packages varying more than 5 per cent from the specified weight may be rejected; and if the average weight of packages in any shipment, as shown by weighing 50 packages taken at random, is less than that specified, the entire shipment may be rejected.

VII. TESTS

1. SAMPLING

(*a*) Number of Samples.—Tests may be made on individual or composite samples as may be ordered. Each test sample should weigh at least 4 pounds.

(1) *Individual sample.*—If sampled in cars, one test sample shall be taken from each 50 barrels or fraction thereof. If sampled in bins one sample shall represent each 200 barrels unless otherwise specified by the purchaser.

(2) *Composite sample.*—If sampled in cars, one sample shall be taken from one sack in each 40 sacks (or 1 barrel in each 10 barrels) and combined to form one test sample. If sampled in bins or warehouses one test sample shall represent not more than 200 barrels unless otherwise specified by the purchaser.

(*b*) Method of Sampling.—Cement may be sampled at the mill by any of the following methods that may be practicable, as specified:

(1) *From the conveyor delivering to the bin.*—At least 4 pounds of cement shall be taken from approximately each 100 barrels passing over the conveyor. This may be secured by taking the entire test sample at a single operation, known as the "grab method," or by combining several portions taken at regular intervals, known as the "composite method."

(2) *From filled bins by means of proper sampling tubes.*—Tubes inserted vertically may be used for sampling cement to a maximum depth of 10 feet. Tubes inserted horizontally may be used where the construction of the bin permits. Samples shall be taken from points well distributed over the face of the bin.

(3) *From filled bins at points of discharge.*—Sufficient cement shall be drawn from the discharge openings to obtain samples representative of the cement contained in the bin, as determined by the appearance at the discharge openings of indicators placed on the surface of the cement directly above these openings before drawing of the cement is started.

The sampling shall be done by or under the direction of a responsible representative of the purchaser.

(*c*) Treatment of Sample.—Samples preferably shall be shipped and stored in moisture-proof, air-tight containers. Samples shall be passed through a sieve having 20 meshes per linear inch in order to thoroughly mix the sample, break up lumps, and remove foreign materials.

2. CHEMICAL ANALYSIS

(*a*) Loss on Ignition—(1) *Method.*—One gram of cement shall be heated in a weighed covered platinum crucible, of 20 to 25 cc capacity, as follows, using either method (*a*) or (*b*) as specified:

Method (*a*).—The crucible shall be placed in a hole in an asbestos board, clamped horizontally so that about three-fifths of the crucible projects below, and blasted at a full red heat for 15 minutes with an inclined flame; the loss in weight shall be checked by a second blasting for 5 minutes. Care shall be taken to wipe off particles of asbestos that may adhere to the crucible when withdrawn from the hole in the board. Greater neatness and shortening of the time of heating are secured by making a hole to fit the crucible in a circular disk of sheet platinum and placing this disk over a somewhat larger hole in an asbestos board.

Method (*b*).—The crucible shall be placed in a muffle at any temperature between 900 and 1,000° C. for 15 minutes and the loss in weight shall be checked by a second heating for 5 minutes.

(2) *Permissible variation.*—A permissible variation of 0.25 per cent will be allowed, and all results in excess of the specified limit, but within this permissible variation, shall be reported as 4 per cent.

(*b*) Insoluble Residue—(1) *Method.*—To a 1 g sample of cement shall be added 25 cc of water and 5 cc of concentrated hydrochloric acid (specific gravity 1.19). Material shall be ground with the flattened end of a glass rod until it is evident that the decomposition of the cement is complete. The solution shall then be diluted to 50 cc and digested on a steam bath for 15 minutes. The residue shall be filtered, washed with cold water, and the filter paper and contents digested in about 30 cc of a 5 per cent solution of sodium carbonate, the liquid being held at a temperature just short of boiling for 15 minutes. The remaining residue shall be filtered, washed with hot water, then with a few drops of hot hydrochloric acid (1:9), and finally with hot water, then ignited at a red heat and weighed as the insoluble residue.

(2) *Permissible variation.*—A permissible variation of 0.15 per cent will be allowed, and all results in excess of the specified limit but within this permissible variation shall be reported as 0.85 per cent.

(*c*) Sulphuric Anhydride—(1) *Method.*—To a 1 g sample of cement shall be added 25 cc of water and 5 cc of concentrated hydrochloric acid (specific gravity 1.19). Material shall be ground with

the flattened end of a glass rod until it is evident that decomposition of the cement is complete. The solution shall be diluted to 50 cc and digested on a steam bath for 15 minutes, filtered, and the residue washed thoroughly with hot water. The solution shall be diluted to 250 cc, heated to boiling, and 10 cc of a hot 10 per cent solution of barium chloride shall be added slowly, drop by drop, from a pipette and the boiling continued until the precipitate is well formed. The solution shall then be digested on the steam bath at least three hours, preferably overnight. The precipitate shall be filtered, washed, and the paper and contents placed in a weighed platinum crucible and the paper slowly charred and consumed without flaming. The barium sulphate shall then be ignited and weighed. The weight obtained multiplied by 34.3 gives the percentage of sulphuric anhydride. The acid filtrate obtained in the determination of the insoluble residue may be used for the estimation of sulphuric anhydride instead of using a separate sample.

(2) *Permissible variation.*—A permissible variation of 0.10 per cent will be allowed, and all results in excess of the specified limit but within this permissible variation shall be reported as 2.00 per cent.

(*d*) MAGNESIA—(1) *Method.*—To 0.5 g of the cement in an evaporating dish shall be added 10 cc of water to prevent lumping and then 10 cc of concentrated hydrochloric acid (specific gravity 1.19). The material shall be ground with the flattened end of a glass rod until attack is complete. The solution shall then be evaporated to complete dryness on a steam or water bath. To hasten dehydration, the residue may be heated to 150° C. or even 200° C. for one-half to one hour. The residue shall be treated with 10 cc of hydrochloric acid diluted with an equal amount of water. The dish shall be covered, and the solution digested for 10 minutes on a steam bath or water bath. The solution shall be diluted to 75 cc, filtered into a beaker, and the separated silica washed thoroughly with hot water (note 1). Five cubic centimeters of concentrated hydrochloric acid and two drops of methyl red indicator (0.2 per cent alcoholic solution) shall be added to the filtrate (about 250 cc) (note 2).

NOTE 1.—Since this procedure does not involve the determination of silica, a second evaporation is unnecessary.

NOTE 2.—Manganese, if present, is distributed between the precipitates of iron and alumina, calcium and magnesium. In the amounts usually present in Portland cement, it may be neglected. If it is desired to determine the small amount of manganese that may be present in the magnesium pyrophosphate, this may be done colorimetrically as described in the United States Geological Survey Bulletin No. 700, page 153. If present in larger amounts, manganese should be precipitated with the iron and alumina, preferably by the persulphate method (United States Geological Survey Bulletin No. 700, p. 112). If this method is used, more aluminum passes into solution than in the method above described.

Dilute ammonium hydroxide shall be added dropwise until the color of the solution changes to a distinct yellow. The solution shall be boiled for one or two minutes and filtered at once. The beaker and precipitate shall be washed slightly with a hot 2 per cent solution of ammonium chloride (or ammonium nitrate). Setting aside the filtrate, the precipitate shall be transferred by a jet of hot water to the precipitating vessel and dissolved in 10 cc of hot hydrochloric acid. The paper shall then be extracted with acid, the solution and washings being added to the solution of the precipitate. The aluminum and iron shall then be reprecipitated at boiling heat by ammonium hydroxide as before in a volume of about 100 cc and the second precipitate shall be collected and washed with a hot 2 per cent solution of ammonium chloride (or ammonium nitrate) on the filter used in the first instance, if this is still intact. To the combined filtrates from the hydroxides of iron and aluminum, reduced in volume if need be, 1 cc of ammonium hydroxides shall be added, the solution brought to boiling, 25 cc of a saturated solution of boiling ammonium oxalate added, and the boiling continued until the precipitated calcium oxalate has assumed a well-defined granular form. The precipitate after one hour shall be filtered and washed, and the filtrate set aside. The filter shall be placed wet in a platinum crucible, and the paper burned off over a small flame of a Bunsen burner; after ignition it shall be cautiously moistened with water, redissolved in hydrochloric acid, and the solution diluted to 100 cc; ammonia shall be added in slight excess, the liquid boiled, and filtered if a precipitate appears. The lime shall then be reprecipitated by ammonium oxalate, allowed to stand till settled, filtered, and washed. The combined filtrates from the calcium precipitates shall be acidified with hydrochloric acid, concentrated on the steam bath to about 150 cc and made slightly alkaline with ammonium hydroxide boiled and filtered (to remove a little iron and aluminum, and perhaps calcium). When cool, the solution shall be acidified with hydrochloric acid, 10 cc of saturated solution of sodium-ammonium-hydrogen phosphate added, and ammonia, drop by drop, with constant stirring. When the crystallin ammonium-magnesium orthophosphate has formed, 5 cc excess ammonia shall be added. The solution shall be set aside for not less than four hours, preferably over night, in a cool place, filtered and washed with water containing 2.5 per cent NH_3. The precipitate shall be dissolved in a small quantity of hot hydrochloric acid, the solution diluted to about 100 cc, 1 cc of a saturated solution of sodium-ammonium-hydrogen phosphate added, and ammonia, drop by drop, with constant stirring, until the precipitate is again formed as described and the ammonia is in moderate excess. The precipitate shall then be allowed to stand about two hours, filtered, and washed as before. The paper and contents shall be placed in a weighed platinum crucible, the paper slowly charred,

and the resulting carbon carefully burned off. The precipitate shall then be ignited to constant weight over a Meeker burner, or a blast not strong enough to soften or melt the pyrophosphate. The weight of magnesium pyrophosphate obtained multiplied by 72.5 gives the percentage of magnesia. The precipitate so obtained always contains some calcium and usually small quantities of iron, aluminum, and manganese as phosphates.

(2) *Permissible variation.*—A permissible variation of 0.4 per cent will be allowed, and all results in excess of the specified limit, but within this permissible variation, shall be reported as 5 per cent.

3. DETERMINATION OF FINENESS

(*a*) Apparatus.—Wire cloth for standard sieves for cement shall be woven (not twilled) from brass, bronze, or other suitable wire, and mounted without distortion on frames about 2 inches below the top of the frame. The joint between the cloth and frame shall be smoothly filled with solder to prevent lodging of the cement. The sieve frames shall be circular, approximately 8 inches in diameter, and may be provided with a pan and cover.

A standard No. 200 sieve is one having nominally a 0.0029-inch opening, certified by the National Bureau of Standards, and conforming to the specifications for this sieve in the Standard Specifications for Sieves for Testing Purposes (serial designation: E 11) of the American Society for Testing Materials.[1] The correction to the sieving value of the sieve shall be determined by sieving tests made in conformity with the standard specifications for these tests on a standardized cement which gives a residue of about 20 per cent on the No. 200 sieve.

(*b*) Method.—The test shall be made with 50 g of cement. The sieve shall be thoroughly clean and dry. The cement shall be placed on the No. 200 sieve, with pan and cover attached, if desired, and shall be held in one hand in a slightly inclined position so that the sample will be well distributed over the sieve, at the same time gently striking the side about 150 times per minute against the palm of the other hand on the up stroke. The sieve shall be turned every 25 strokes about one-sixth of a revolution in the same direction. The operation shall continue until not more than 0.05 g passes through in one minute of continuous sieving (note 1). The fineness shall be determined from the weight of the residue on the sieve expressed as a percentage of the weight of the original sample, applying the sieve correction (note 2).

Note 1.—The essential points in the sieving operation may be summarized as follows:

(1) Rotation of the sieve throughout the process.

(2) Guarding against loss of material. Sieve over white paper and always tap the sieve gently.

[1] A.S.T.M. Standards Adopted in 1926.

(3) Use of a balance which will give results correct within 5 mg and sufficiently sensitive so that the rest point will be deflected at least two divisions of the scale for an added load of 5 mg.

(4) Washers, shot and slugs should never be used on the sieve.

(5) Excessive humidity interferes with good sieving. It tends to decrease the percentage of cement passing the sieve, and in general to produce irregular results.

NOTE 2.—A plus (+) sieve correction indicates the amount to be added to and a minus (−) sieve correction the amount to be subtracted from the per cent passing the sieve to obtain the true fineness. The per cent passing is the amount obtained by subtracting the per cent residue from 100. The corrections are used in the reverse order when applied to the residues direct.

Mechanical sieving devices may be used, but the cement shall not be rejected if it meets the fineness requirement when tested by the hand method described in Section VII, 3, (*b*).

4. MIXING CEMENT PASTES AND MORTARS

(*a*) METHOD.—The quantities of dry materials to be mixed at one time shall be 500 g for neat cement mixtures and 1,000 g for mortar mixtures. The proportions of cement or cement and sand shall be stated by weight in grams of the dry materials; the quantity of water shall be expressed in cubic centimeters (1 cc of water = 1 g). The dry materials shall be weighed, placed upon a nonabsorbent surface, thoroughly mixed dry if sand is used, and a crater formed in the center, into which the proper percentage of clean water shall be poured; the material on the outer edge shall be turned into the crater by the aid of a trowel. After an interval of one-half minute for the absorption of the water the operation shall be completed by continuous, vigorous mixing, squeezing and kneading with the hands for at least one minute. During the operation of mixing, the hands shall be protected by rubber gloves.

NOTE.—In order to secure uniformity in the results of tests for the time of setting and tensile strength the manner of mixing above described shall be carefully followed. At least one minute is necessary to obtain the desired plasticity which is not appreciably affected by continuing the mixing for several minutes. The exact time necessary is dependent upon the personal equation of the operator. The error in mixing shall be on the side of overmixing.

The temperature of the room, the materials, the mixing water, the moist closet, and storage-tank water shall be maintained as nearly as practicable at 21° C. (70° F.) and the mixing water, moist closet, and the water in the storage tank shall not vary from this temperature by more than 3° C. (5° F.).

5. NORMAL CONSISTENCY

(*a*) APPARATUS.—The Vicat apparatus consists of a frame *A* (fig. 1) bearing a movable rod, *B*, weighing 300 g, one end *C* being 1 cm in diameter for a distance of 6 cm, the other having a removable

needle *D*, 1 mm in diameter, 6 cm long. The rod is reversible, and can be held in any desired position by a screw *E*, and has midway between the ends a mark *F* which moves under a scale (graduated to millimeters) attached to the frame *A*. The paste is held in a rigid conical ring, resting on a glass plate about 10 cm square. The ring shall be made of a noncorroding, nonabsorbent material, and shall have an inside diameter of 7 cm at the base, 6 cm at the top, and a height of 4 cm.

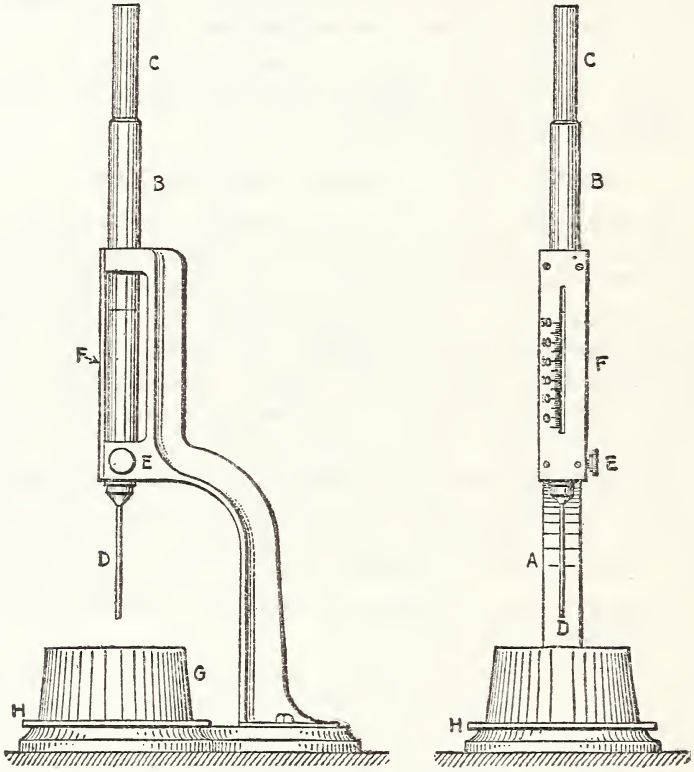


FIG. 1.—*Vicat apparatus*

(*b*) METHOD.—In making the determination, 500 g of cement, with a measured quantity of water, shall be kneaded into a paste, as described in Section VII, 4 (*a*), and quickly formed into a ball with the hands, completing the operation by tossing it six times from one hand to the other, maintained about 6 inches apart; the ball resting in the palm of one hand shall be pressed into the larger end of the conical ring held in the other hand, completely filling the ring with paste; the excess at the larger end shall then be removed by a single movement of the palm of the hand; the ring shall then be placed on its larger end on a glass plate and the excess paste at the smaller end sliced off at the

top of the ring by a single oblique stroke of a trowel held at a slight angle with the top of the ring, and the top smoothed, if necessary, with a few light touches of the pointed end of the trowel. During these operations care shall be taken not to compress the paste. The paste confined in the ring, resting on the plate, shall be placed under the rod, the larger end of which shall be brought in contact with the surface of the paste; the scale shall then be read, and the rod quickly released. The paste shall be of normal consistency when the rod settles to a point 10 mm below the original surface in one-half minute after being released. The apparatus shall be free from all vibrations during the test. Trial pastes shall be made with varying percentages of water until the normal consistency is obtained. Each trial shall be made with fresh cement. The amount of water required shall be expressed in percentage by weight of the dry cement.

The consistency of standard mortar shall depend on the amount of water required to produce a paste of normal consistency from the same sample of cement. Having determined the normal consistency of the sample, the consistency of standard mortar made from the same sample shall be as indicated in Table 1, the values being in percentage of the combined dry weights of the cement and standard sand.

TABLE 1.—*Percentage of water for standard mortars*

Percentage of water for neat cement, paste of normal consistency	Percentage of water for one cement, three standard Ottawa sand	Percentage of water for neat cement, paste of normal consistency	Percentage of water for one cement, three standard Ottawa sand
15	9.0	23	10.3
16	9.2	24	10.5
17	9.3	25	10.7
18	9.5	26	10.8
19	9.7	27	11.0
20	9.8	28	11.2
21	10.0	29	11.3
22	10.2	30	11.5

6. DETERMINATION OF SOUNDNESS

NOTE.—Unsoundness is usually manifested by change in volume which causes distortion, cracking, checking, or disintegration.

Pats improperly made or exposed to drying may develop what are known as shrinkage cracks within the first 24 hours and are not an indication of unsoundness. These conditions are illustrated in Figure 2.

The failure of the pats to remain on the glass or the cracking of the glass to which the pats are attached does not necessarily indicate unsoundness.

(*a*) APPARATUS.—A steam apparatus, which can be maintained at a temperature between 98 and 100° C., or one similar to that shown in Figure 3, is recommended. The capacity of this apparatus may be increased by using a rack for holding the pats in a vertical or inclined position.

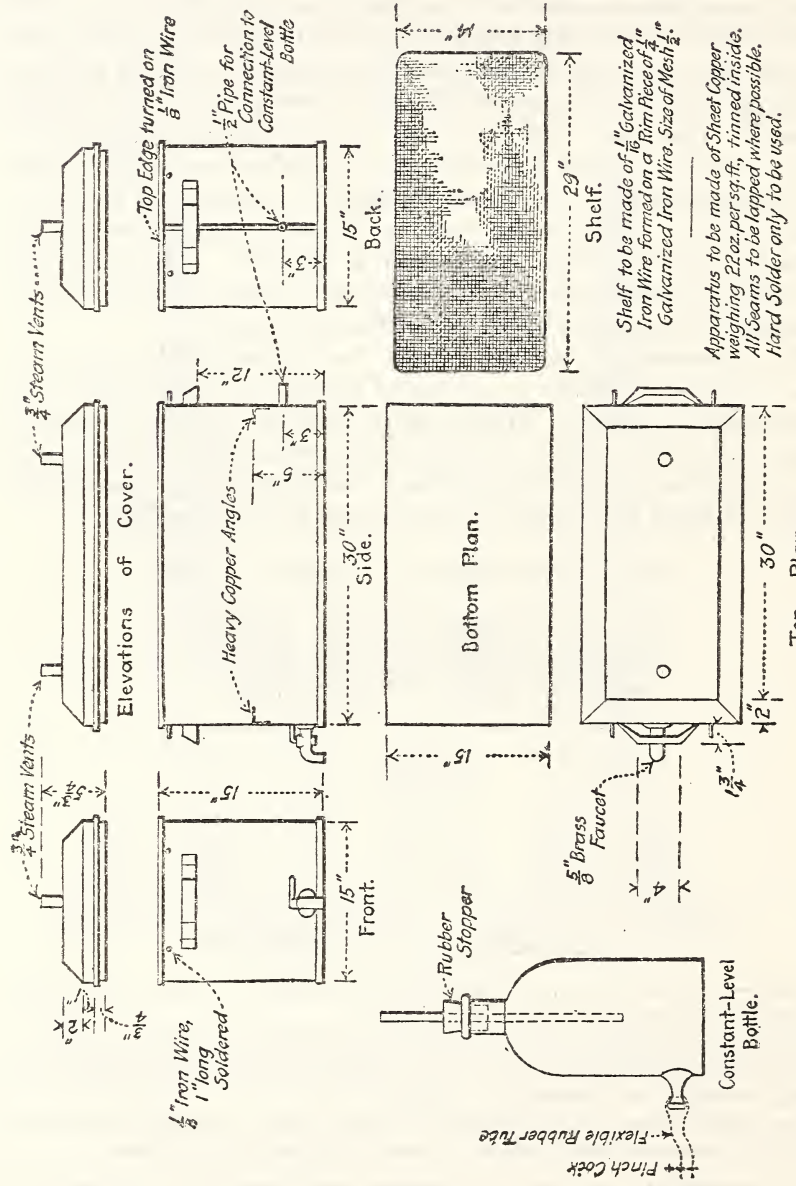
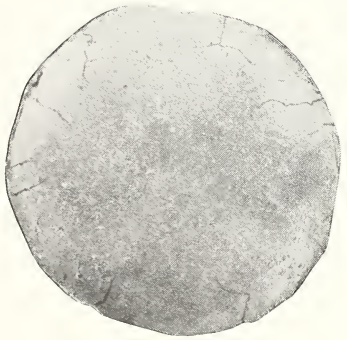


FIG. 3.—*Apparatus for making soundness test of cement*

Shrinkage.

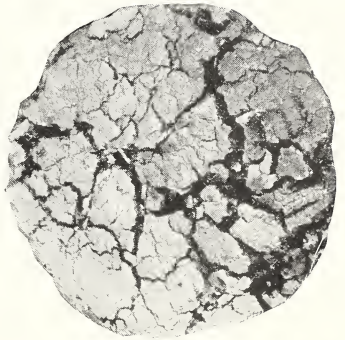
Shrinkage.

Distortion.



Cracking.

Checking.



Disintegration.

FIG. 2.—*Typical failures in soundness test*

(*b*) METHOD.—A pat from cement paste of normal consistency about 3 inches in diameter, one-half inch thick at the center, and tapering to a thin edge, shall be made on flat clean glass plates about 4 inches square, and stored in moist air for 24 hours. In molding the pat, the cement paste shall first be flattened on the glass and the pat then formed by drawing the trowel from the outer edge toward the center, then flattening the top. The pats used for the time of setting tests by the Gillmore method may be used for soundness tests.

The pat shall then be placed in an atmosphere of steam at a temperature between 98 and 100° C., upon a suitable support 1 inch above boiling water for five hours.

NOTE.—It is important that the specimens be 24 hours old when placed in steam, since variations in their age will produce differences in the results of the steam tests. Particularly noticeable are the effects of steaming pats too soon, for many specimens steamed when only 10 or 12 hours old give apparently satisfactory results, while failure would be observed if they were not placed in steam until 24 hours old.

Should the pat leave the plate, distortion may be detected best with a straightedge applied to the surface which was in contact with the plate.

7. DETERMINATION OF TIME OF SETTING

The following are alternate methods, either of which may be used as specified:

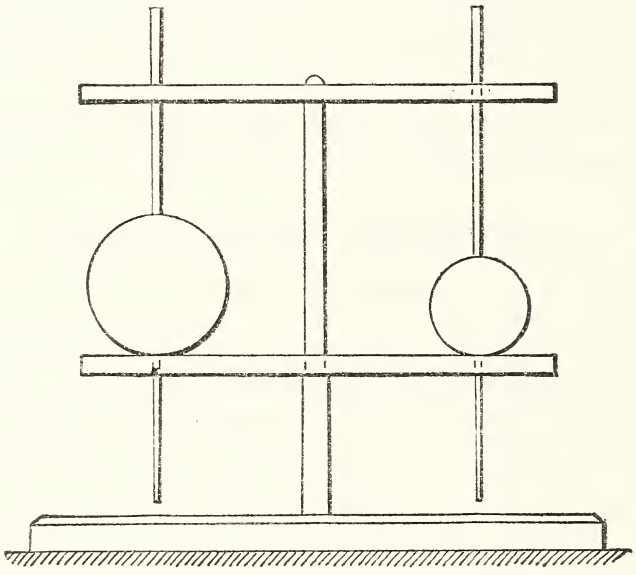
(*a*) VICAT APPARATUS.—The time of setting shall be determined with the Vicat apparatus described in Section VII, 5, (*a*). (See fig. 1.)

(*b*) VICAT METHOD.—A paste of normal consistency shall be molded in the ring *G* as described in Section VII, 5, (*a*), and placed under the rod *B*, the smaller end of which shall then be carefully brought in contact with the surface of the paste, and the rod quickly released. The initial set shall be said to have occurred when the needle ceases to pass a point 5 mm above the glass plate in one-half minute after being released; and the final set, when the needle does not sink visibly into the paste. The test pieces shall be kept in moist air during the test. This may be accomplished by placing them on a rack over water contained in a pan and covered by a damp cloth, kept from contact with them by means of a wire screen; or they may be stored in a moist closet. Care shall be taken to keep the needle clean, as the collection of cement on the sides of the needle retards the penetration, while cement on the point may increase the penetration. The time of setting is affected not only by the percentage and temperature of the water used and the amount of kneading the paste received, but by the temperature and humidity of the air, and its determination is therefore only approximate.

(*c*) GILLMORE NEEDLES.—The time of setting shall be determined by the Gillmore needles. The Gillmore needles should preferably be mounted as shown in Figure 4 (*b*), and the needle ends shall be maintained in a clean condition and shall be plane and at right angles to the axis of the rod.

(*d*) GILLMORE METHOD.—The time of setting shall be determined as follows: A pat of neat cement paste about 3 inches in diameter and

(*a*) Pat with Top Surface Flattened for Determining Time of Setting by Gillmore Method.



(*b*) Gillmore Needles.

FIG. 4

one-half inch in thickness with a flat top (figure 4 (*a*)), mixed to a normal consistency, shall be kept in moist air at a temperature maintained as nearly as practicable at 21° C. (70° F.). The cement shall be considered to have acquired its initial set when the pat will bear, without appreciable indentation, the Gillmore needle one-twelfth inch in diameter, loaded to weigh one-fourth pound. The final set has been acquired when the pat will bear, without appreciable indentation, the Gillmore needle one-twenty-fourth inch in diameter, loaded to weigh 1 pound. In making the test, the needles shall be held in a vertical position and applied lightly to the surface of the pat.

8. TENSION TESTS

(*a*) Form of Test Piece.—The form of test piece shown in Figure 5 shall be used. The molds shall be made of noncorroding metal and have sufficient material in the sides to prevent spreading during molding. Gang molds when used shall be of the type shown in Figure 6. Molds shall be oiled with a mineral oil.

(*b*) Standard Sand.—The sand to be used shall be natural sand from Ottawa, Ill., screened to pass a No. 20 sieve and retained on a No.

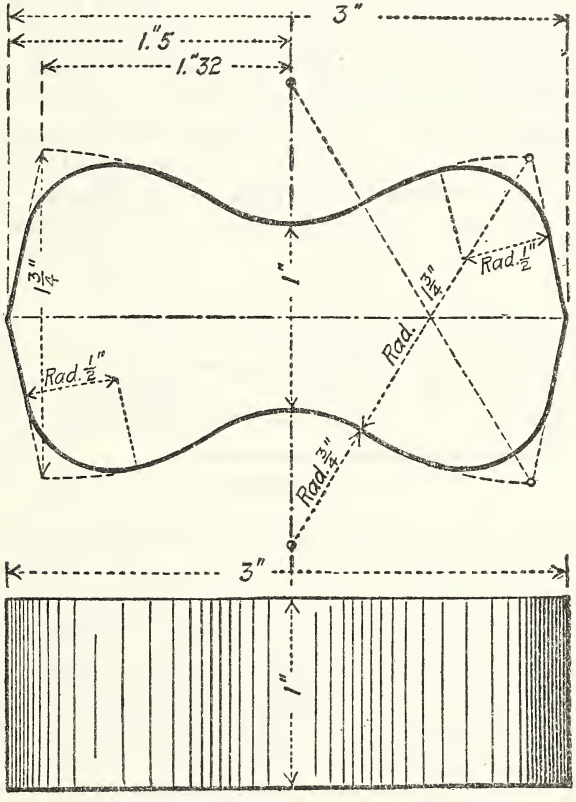


Fig. 5.—*Dimensions of briquet*

30 sieve. This sand may be obtained from the Ottawa Silica Co., Ottawa, Ill.

This sand shall be considered standard when not more than 5 g are retained on the No. 20 sieve, and not more than 5 g pass the No. 30 sieve, after one minute continuous sieving of a 100 g sample, in the manner specified for sieving cement on the No. 200 sieve (see Section VII, 3 (*b*)).

The Nos. 20 and 30 sieves shall conform to the requirements for these sieves as given in the Standard Specifications for Sieves for

Testing Purposes (serial designation: E 11) of the American Society for Testing Materials.

(*c*) Molding.—Immediately after mixing the standard mortar in accordance with the methods for mixing cement pastes and mortars the molds shall be filled heaping full without compacting. Then the mortar shall be pressed in firmly with the thumbs, applying pressure 12 times to each briquet, at points to include the entire surface. The pressure shall be such that the simultaneous application of both thumbs will register a pressure of between 15 and 20 pounds. Each application of the thumbs shall be maintained not longer than sufficient to attain the specified pressure. Then the mortar shall be heaped above the mold and smoothed off with a trowel. The trowel shall be drawn over the mold in such a manner as to exert a pressure of not more than 4 pounds. The mold shall then be turned over upon a plane plate oiled with mineral oil, and the operation of heaping, thumbing, and smoothing off repeated. No ramming or tamping shall be used, nor any troweling in excess of that required to smooth off the specimen.

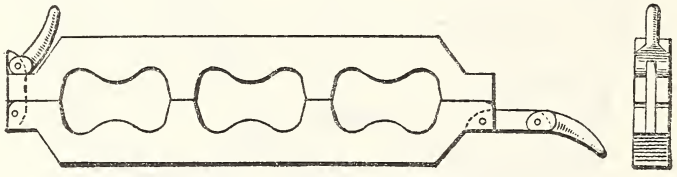


Fig. 6.—*Briquet gang mold*

(*d*) Testing.—The briquets shall be tested as soon as they are removed from the water. Tests may be made with any machine meeting the following requirements: The machine shall be capable of weighing the applied load within 0.5 per cent of the nominal value. The sensibility reciprocal (the weight required to be added to the load to move the beam from a horizontal position of equilibrium to a position of equilibrium at the top of the trig loop) shall not exceed 1 pound at the full capacity of the machine or at any lesser load. The clips for holding the tension test specimens shall be in accordance with Figure 7. The bearing surfaces of the clips and briquets shall be free from sand or dirt, and the roller bearings shall be well oiled and maintained so as to insure freedom of turning. The briquets shall be carefully centered in the clips and the load applied continuously at the rate of 600 pounds per minute.

Testing machines shall be frequently calibrated in order to determine their accuracy.

(*e*) Faulty Briquets.—Briquets that are manifestly faulty, or which give strengths differing more than 15 per cent from the average

value of all test specimens made from the same sample and tested at the same period, shall not be considered in determining the tensile strength.

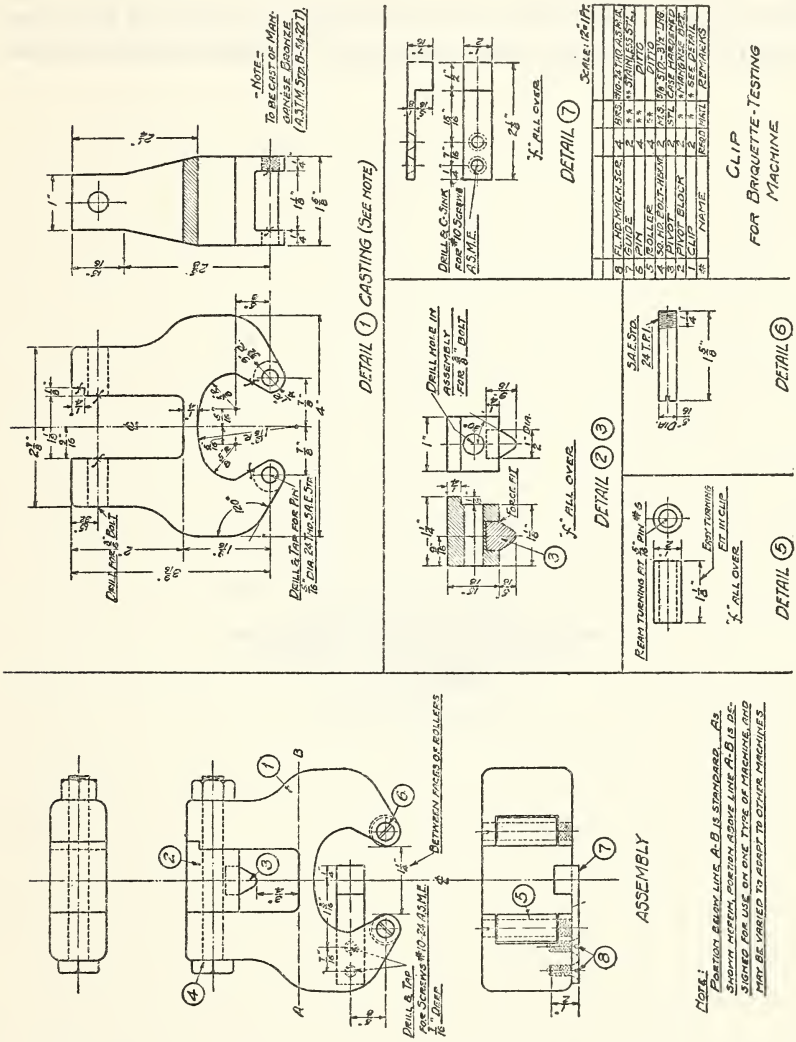


FIG. 7.—*Clip for briquet testing machine*

9. STORAGE OF TEST SPECIMENS

(*a*) APPARATUS.—The moist closet may consist of a soapstone, slate or concrete box, or a wooden box lined with metal. The interior wall surfaces of all closets shall be covered with felt or broad wicking kept wet. The bottom of the moist closet shall be covered with water to a depth of at least 2 inches.

(*b*) METHOD.—All test specimens, immediately after molding, shall be kept in the molds on plane plates in the moist closet for from 20 to 24 hours in such manner that the upper surfaces shall be exposed to the moist air.

The briquets shall then be removed from the molds and immersed in clean water in storage tanks constructed of noncorroding material.

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