

Proportioning
Concrete Mixtures
and
Mixing and Placing
Concrete



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What Concrete Is

Concrete is an artificial stone prepared by mixing Portland cement, sand, and pebbles or broken stone in certain proportions, depending upon the nature of the work for which the concrete is to be used. When this mixture is allowed to remain undisturbed, it will become as hard as stone and will assume the shape of the form or mold in which placed.

Almost every one has more or less knowledge of the possible uses of concrete, yet a great many persons who know of its numerous applications in building construction, fail to appreciate the fact that success in the use of concrete depends very largely upon the qualities of the sand and pebbles or broken stone of which the concrete is largely composed.

Factors Governing the Quality of Concrete

Many people believe that the quality of concrete depends entirely upon the Portland cement. While good Portland cement is necessary if good concrete is to result, nevertheless, Portland cement as manufactured today is a very reliable product. It is manufactured to meet exacting specifications that have been made as the result of very extensive engineering studies and experiments. When dissatisfaction results from concrete work—as happens occasionally—the fault can almost invariably be traced, not to the cement, but to failure to observe some of the well-established rules or methods for the selection of sand and pebbles or broken stone, neglect of proper proportioning of materials, too much or too little water used for mixing, dirty water, too little mixing of materials, or lack of care used to place the concrete properly and protect it while hardening.

How Portland Cement Is Packed

No cement should be used in concrete construction except Portland cement of standard manufacture, such as is produced by all of the well-known cement manufacturers. All mills now pack Portland cement in standard packages (cloth sacks and paper bags) weighing 94 pounds net and considered as 1 cubic foot when proportioning mixtures by volume, which is the common method. Four of such sacks or bags make a barrel. Cloth sacks are billed to the cement purchaser at 10 cents each, or 40 cents to the barrel. When emptied, they may be returned to the dealer from whom the cement was purchased or to the mill, and the manufacturer will buy them back at 10 cents each if they are in good condition and suitable for further use as cement containers. A cement sack which has been wet, torn or otherwise rendered unfit for use, will not be redeemed. Although cement is sometimes packed in paper bags, this practice is growing less common. A charge of 10 cents per barrel (2½ cents per bag) is made for packing cement in paper bags. These, of course, are not redeemable.

Storing Portland Cement

Portland cement should be kept in a dry place until used. It should never be piled directly on the ground nor in any place where it will be subject to the effect of moisture. A dry, tight shed having a floor raised from the ground so that dampness will be avoided and good circulation of air secured

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beneath the floor, are requirements of storage accommodations. It is also well to avoid piling sacked cement directly against the side of the shed, as dampness may pass through the side walls. A properly built concrete storage shed or warehouse, will be air and moisture-proof, and is best for cement storage. Cement which has become caked or hardened as a result of absorbing moisture must not be used in concrete mixtures. If the lumps may be crushed readily under slight pressure between one's fingers, the cement has not been damaged. Such lumpiness is usually the result of what is called "storage caking" and is common in the lower sacks of piles owing to the weight of the sacks above.

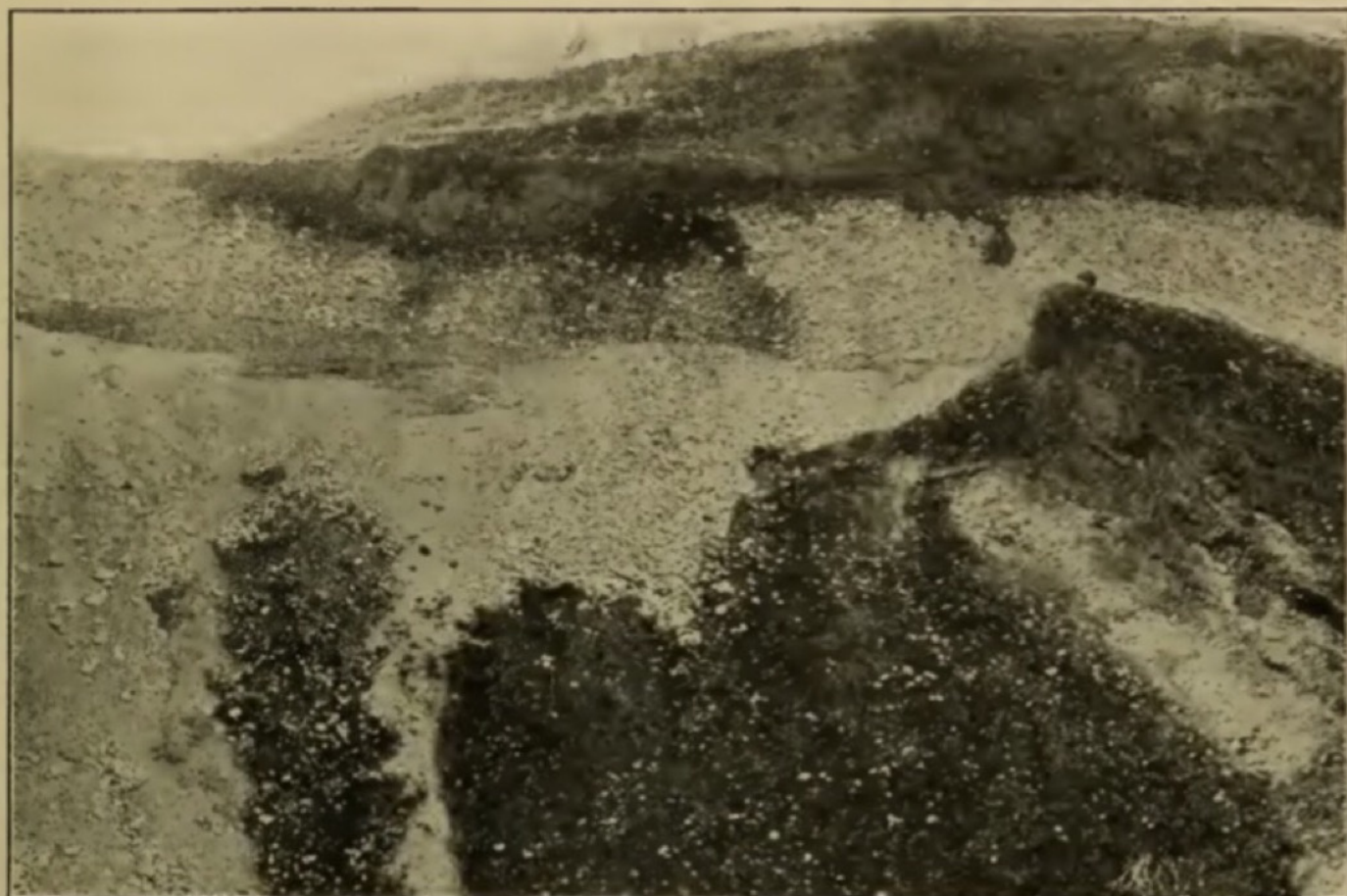


Most gravel banks present an appearance like shown in this view. The fine material (sand) and coarse material (pebbles) lie in layers, usually with the sand greatly in excess of the pebbles.

Aggregates

Many persons disregard the importance of carefully selecting the sand, pebbles, and broken stone, or other materials which are sometimes used in their place, when preparing concrete mixtures. Sand and pebbles or broken stone, when used in concrete, are referred to as "aggregates." Sand is known as "fine aggregate," while the pebbles and broken stone are called "coarse aggregate." Sometimes clean stone screenings below a certain maximum size, that is, ranging from $\frac{1}{4}$ inch downward and free from dust, are used as fine aggregate instead of sand.

In order to distinguish between sand and pebbles, that is, between the fine and the coarse aggregate, it is necessary to fix a maximum size for the material that is to be called sand and a minimum size for the pebbles or broken stone. In concrete work, sand is the material that ranges in size downward from $\frac{1}{4}$ inch in greatest dimension, while pebbles or broken stone range in size from $\frac{1}{4}$ inch upward.



Many gravel banks are not properly stripped of overlying soil, hence loam and vegetable matter become mixed with the bank material.



This pit is largely fine material, in addition to which vegetable matter has drifted down across the face of the pit, thus mixing objectionable foreign material with the sand.

Both sand and pebbles or broken stone must be clean and well graded from fine to coarse, with the coarser particles predominating. They must also be hard and tough. Sand and pebbles may be hard, yet brittle—and in the latter case would not correspond to the idea of toughness.

Bank-Run Material

Bank-run gravel, that is, the natural mixture of sand and pebbles (usually containing more or less foreign material also) as it comes from the ordinary gravel bank, is not suitable for concrete mixtures. No doubt some concrete failures have resulted from the practice of using bank-run gravel without screening it so that well-graded sand and pebbles could be mixed in definite proportions.

Most natural deposits of so-called gravel contain nearly twice as much sand as is desirable in a concrete mixture, and to produce strength approaching that resulting from a concrete made by using properly proportioned sand and pebbles, much more cement would be necessary with the un-screened bank-run material. Therefore, true economy results when the bank-run material is screened and the sand and pebbles correctly proportioned.

Voids, or air spaces, contained in any given bulk or volume of pebbles are about 45 per cent of the mass. In order to fill these air spaces and make a dense concrete, the amount of sand should be approximately half the volume of pebbles. If un-screened bank-run material is used, a greater quantity of cement is required to fill the voids or air spaces. The amount of cement used in a 1 : 2 : 4 mixture, for instance, provided the 2 cubic feet of sand and 4 cubic feet of pebbles are well graded is 1 sack (1 cubic foot), and this is sufficient, when thoroughly mixed with the 2 cubic feet of sand and 4 cubic feet of pebbles, to coat every particle of sand and form a sand-cement mortar which will fill all of the air spaces in the pebbles. If, however, these proportions were changed and twice as much sand as gravel used, the 1 sack of Portland cement would be far less than necessary to thoroughly coat the increased number of sand grains and fill the air spaces between them. So weak and porous concrete would result.

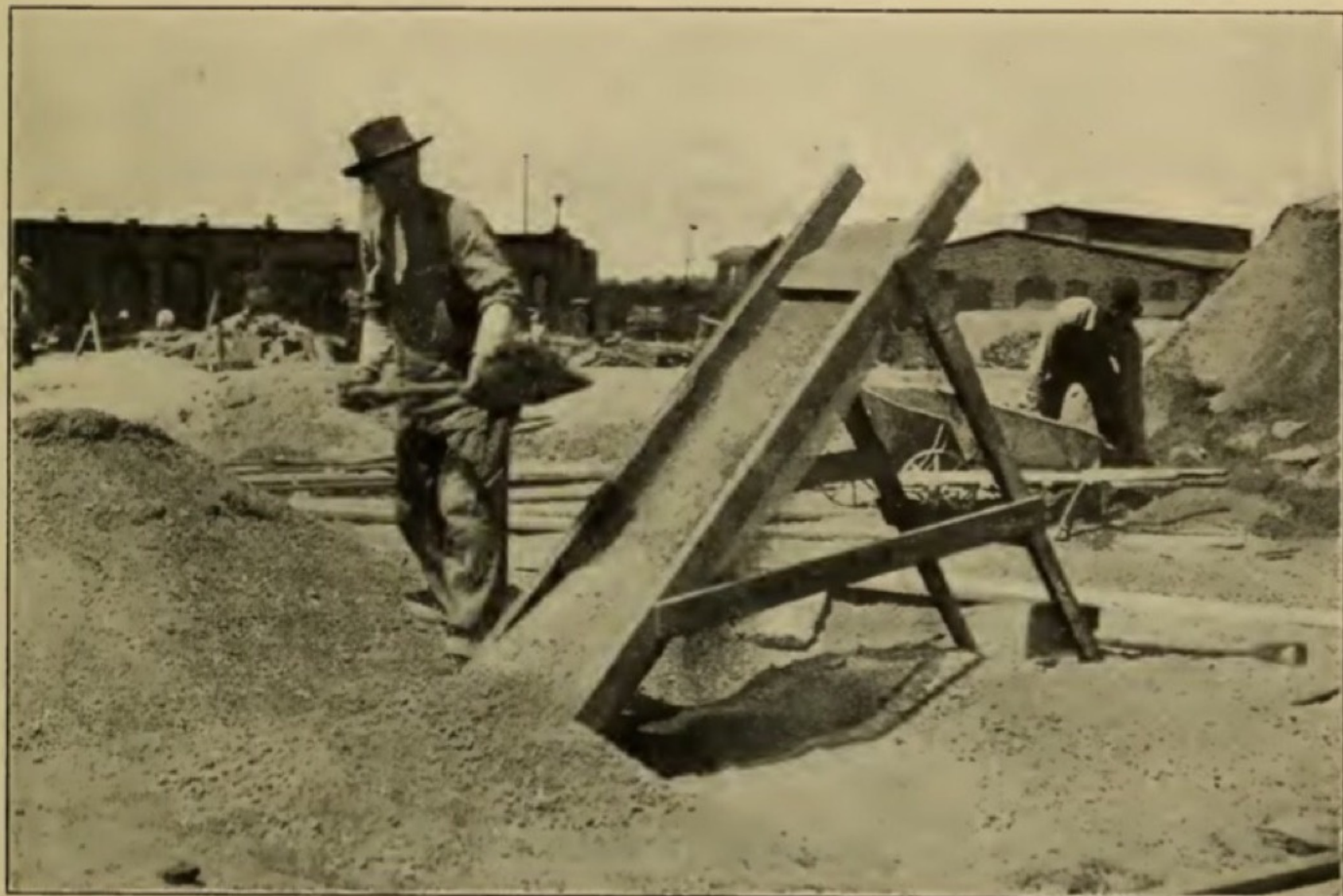
Watertight Concrete

Watertight concrete may be secured for all practical purposes even where there is a considerable "head" or pressure of water, by using well-graded, correctly-proportioned materials, with enough sand and cement (sand-cement mortar) to overfill the air spaces or voids between the pebbles. No two loads of bank-run material from the same pit contain the same relative proportions of sand and pebbles, consequently, concrete made from such material is not uniform, dense nor watertight, nor so strong as it should be.

Screening Bank Run Material

Bank-run material must be screened by separating it into at least two volumes, the sand being that material which will pass through a screen having four meshes to the linear inch (16 meshes to the square inch), the

pebbles or the material usually referred to as gravel, being that which will not pass a screen having $\frac{1}{4}$ -inch meshes and consisting of particles ranging in size from $\frac{1}{4}$ -inch up to as large as proper to use in the class of construction to be performed. For foundation work, for example, 2 inches is often an allowable maximum size for pebbles or broken stone, while for concrete fence posts and other concrete products the maximum size may be fixed at $\frac{3}{4}$ inch for fence posts, silo staves, concrete block, large concrete pipe and tile, and $1\frac{1}{4}$ or $1\frac{1}{2}$ inches for other work.



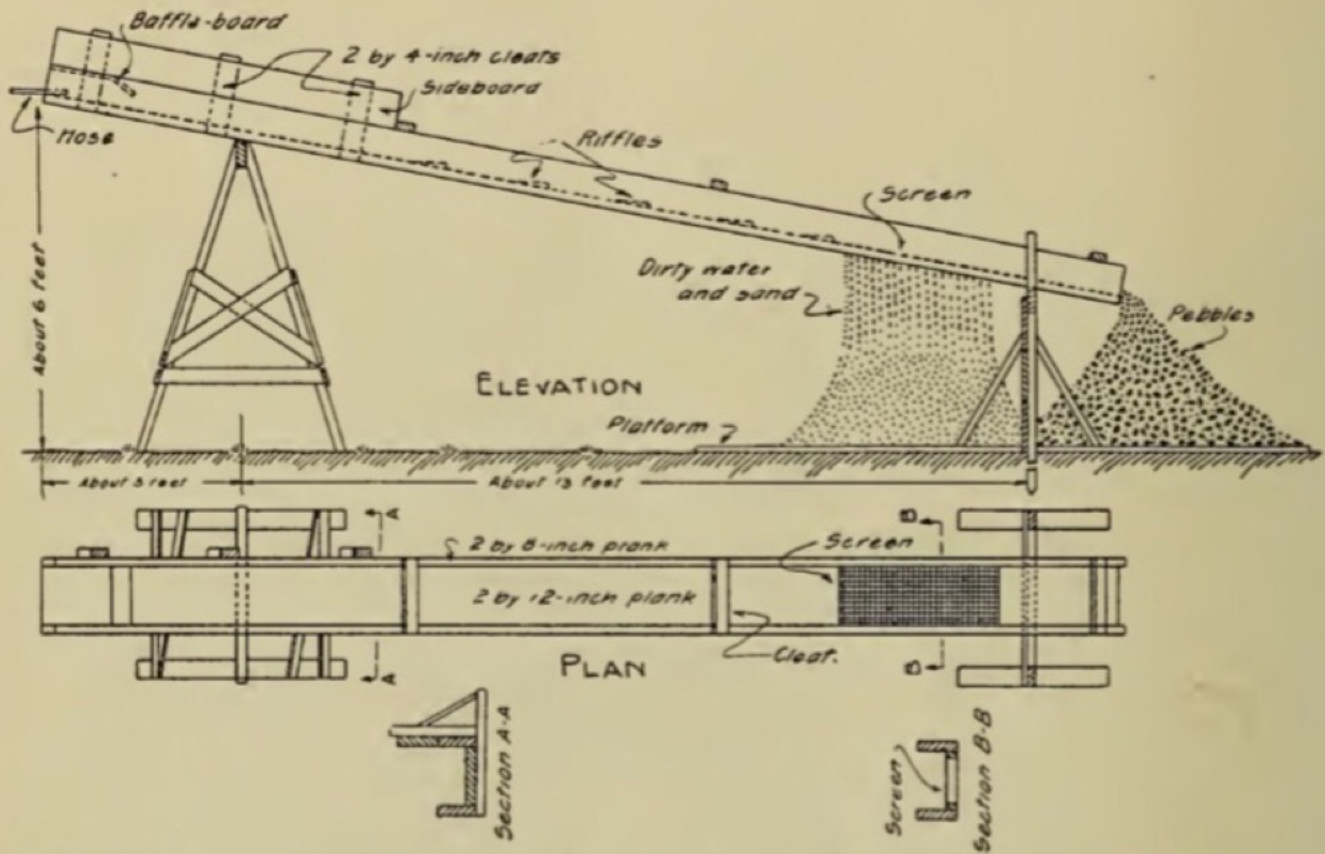
Bank-run material should always be screened before using in a concrete mixture.

A common rule in concrete construction is that no pebble or particle of broken stone used in a concrete mixture shall exceed in greatest dimension, one-half the thickness of the concrete section in which it is to be used. This refers more particularly to concrete products such as pipe and tile, but does not mean, however, that such a maximum size may always be used.

Clay or Other Foreign Material in Aggregates

Many conflicting and sometimes confusing opinions are advanced as to the effect produced on concrete by the presence of a small amount of clay, loam or other foreign material. Certain principles, however, are fairly well agreed upon. When clay exists as a coating on the particles of sand or pebbles, it is undoubtedly injurious, as it will prevent a proper adhesion or bond between the cement and the sand or pebbles. For this reason, one should be careful to use only clean sand and pebbles. Rotted vegetable matter, usually spoken of either as loam or organic matter, is also injurious. A very small quantity of such material tends to prevent the cement from performing its bonding or binding action, by keeping

the particles of cement apart. Usually, concrete made with sand containing loam hardens very slowly and sometimes will not harden enough to permit the concrete being put to its intended use. Washing and screening bank-run material is neither a difficult nor an expensive operation and can easily be accomplished wherever there is running water. Any means which will agitate the materials and allow the lighter foreign material to run off with the water, will accomplish the purpose.



A simple washing trough with screen at the lower end, by means of which dirty bank-run material can easily be washed free from clay or other foreign material and the sand separated from the pebbles. The platform on which the sand and pebbles are discharged should be sloped slightly to cause the wash water to flow away freely.

Washing Aggregates

An accompanying illustration shows a washing and screening device which has been successfully used to remove foreign matter from sand and bank-run gravel before using them in a concrete mixture, and at the same time to separate the sand and pebbles from each other. The materials to be washed are shoveled into the trough at the high end, while water is applied through a hose connected to the pipe shown, which causes the materials to be tumbled and rolled about until they reach the lower end of the trough where the screen separates the sand from the pebbles, and the water carries off the foreign material. Wedge-shaped cleats (riffles) are nailed on the bottom of the trough inside to assist in tumbling the materials as they roll down. There are, of course, more elaborate means of washing sand and pebbles; but most of these involve power-operated screens and other machinery, of interest principally to the contractor or commercial sand and gravel producer.

Miscellaneous Aggregates

So far only sand and pebbles or broken stone have been mentioned as possible concrete aggregates. Usually the home worker finds sand and pebbles the materials easiest to obtain. Yet there are many sections of the country where suitable pebbles are not obtainable, and the farms or fields are littered with "rubblestones," or "niggerheads" which are a great hindrance to cultivating land that would naturally be productive if these stones were out of the way. When properly crushed, these will often make a suitable grade of broken stone that can be used as a substitute for pebbles in constructing permanent concrete farm buildings and other structures. Small stone crushers operated by three or four horse-power gasoline engines can now be obtained at relatively low cost, and in this way otherwise useless material may be converted into useful material for concrete, at a cost ranging from 40 to 60 cents per cubic yard. Sometimes the fine screenings from these crushed rubblestones make a better fine aggregate than the only sand that may be available locally. Mine tailings, such as "chats" from zinc smelters, decomposed granite, such as found in sections of Colorado and Wyoming, and similar materials, such as tufa rock, can often be made available for use as concrete aggregate.

Selecting Materials for Fire Resistance

One of concrete's greatest merits is its fire resistance. If this is to be attained to the fullest possible degree, care must be given to selecting the sand and pebbles or broken stone to be used in the concrete mixture. Trap rock, some grades of pebbles, and bank slag are generally to be preferred if the concrete is to possess maximum fire resistance. Sand for this purpose should be of what is known as a silicious nature.

Mixing Water

Water used in concrete mixtures should be clean. Not only should there be no loam, clay or other foreign material in the water, but it should be free from oil and excessive alkali. Water that is fit to drink is best for mixing concrete. Alkali in mixing water may not only be the cause of a whitish deposit on the finished concrete, called efflorescence, but if in excess, may finally affect the strength of the concrete.

Proportioning Mixtures

Strength and density of concrete are dependent upon correct proportioning of all materials. Strength, of course, depends in part on using clean, hard, durable sand and pebbles, while density depends largely upon correct proportioning—yet both strength and density are results of observing the same fundamentals.

Proportioning of materials must be such that the cement will coat every particle of sand, and the sand-cement mortar will coat every pebble or particle of broken stone and be slightly in excess of what is actually required to fill the air spaces or voids in the mass of pebbles. Unless these conditions are secured, the concrete will be porous, hence not watertight, and the sand and pebbles will not be firmly bound together into one mass by the cement. In other words, the amount of sand used should slightly exceed the volume of air spaces in the pebbles or broken stone, while the quantity

of cement used should slightly exceed the voids or air spaces in the sand. If these principles of proportioning are carefully observed, the resulting concrete will be practically free from air spaces, consequently strong, dense and watertight.

Compressive strength of concrete, which is the ability to carry heavy loads placed directly upon it, also increases with an increase in density.

There are a number of ways to determine the volume of air spaces in a given bulk of sand and pebbles or broken stone, so that the materials to be used for any concrete mixture can be accurately proportioned to reduce air spaces to a minimum. But for extreme accuracy, rather complicated methods must be used, and it has therefore become a more or less general practice for the home worker to rely on so-called arbitrary mixtures, which are recommended when the sand and pebbles or broken stone have been selected so as to insure materials of uniform grading from fine to coarse, with the coarser particles predominating.

A table of such arbitrary mixtures follows, with suggestions as to the particular classes of construction or parts of construction to which they are suited. In this table the figures stand for the volumes of the cement, sand, and pebbles or broken stone used. For example: A 1:2:3 mixture means 1 sack (1 cubic foot) of Portland cement, 2 cubic feet of sand, and 3 cubic feet of pebbles or broken stone.

A 1:2 mixture means 1 sack (1 cubic foot) of Portland cement and 2 cubic feet of sand.

TABLE OF RECOMMENDED MIXTURES

1 : 1 : 1 Mixture for

The wearing course of two-course floors subject to heavy trucking, such as occurs in factories, warehouses, on loading platforms, etc.

1 : 1 : 1½ Mixture for

The wearing course of two-course pavements, in which case the pebbles or crushed stone is graded from $\frac{1}{4}$ to $\frac{1}{2}$ inch.

1 : 2 : 3 Mixture for

Reinforced concrete roof slabs.

One-course concrete road, street, and alley pavements.

One-course walks and barnyard pavements.

One-course concrete floors.

Fence posts.

Sills and lintels without mortar surface.

Watering troughs and tanks.

Reinforced concrete columns.

Mine timbers.

Construction subjected to water pressure, such as reservoirs, swimming pools, storage tanks, cisterns, elevator pits, vats, etc.

1 : 2 : 4 Mixture for

Reinforced concrete walls, floors, beams, columns and other concrete members designed in combination with steel reinforcing.

Concrete for the arch ring of arch bridges and culverts; foundations for large engines causing heavy loading, some impact and vibration. Concrete work in general subject to vibration.
Reinforced concrete sewer pipe.

1 : 2½ : 4 Mixture for

Silo walls, grain bins, coal bins, elevators and similar structures.
Building walls above foundation, when stucco finish will not be applied.
Walls of pits or basements, subject to considerable exposure to moisture, but practically no direct water pressure.
Manure pits, dipping vats, hog wallows.
Backing of concrete block.
Base of two-course road, street and alley pavements.

1 : 2½ : 5 Mixture for

Walls above ground which are to have stucco finish.
Base of two-course sidewalks, feeding floors, barnyard pavements and two-course plain concrete floors.
Abutments and wing walls of bridges and culverts, dams, small retaining walls.
Basement walls and foundations for ordinary conditions where watertightness is not essential.
Foundations for small engines.

1 : 3 : 6 Mixture for

Mass concrete such as large gravity retaining walls, heavy foundations and footings.

1 : 1½ Mixture for

Inside plastering of water tanks, silos, and bin walls, where required, and for facing walls below ground when necessary to afford additional protection against the entrance of moisture.
Back plastering of gravity retaining walls.

1 : 2 Mixture for

Scratch coat of exterior plaster (cement and stucco).
Facing block and similar concrete products.
Wearing course of two-course walks, floors subjected only to light loads, barnyard pavements, etc.

1 : 2½ Mixture for

Intermediate and finish stucco coats.
Fence posts when coarse aggregate is not used.

1 : 3 Mixture for

Concrete block when coarse aggregate is not used.
Concrete brick.
Concrete drain tile and pipe when coarse aggregate is not used.
Ornamental concrete products.

QUANTITIES OF MATERIALS REQUIRED FOR VARIOUS MIXTURES OF MORTAR AND CONCRETE

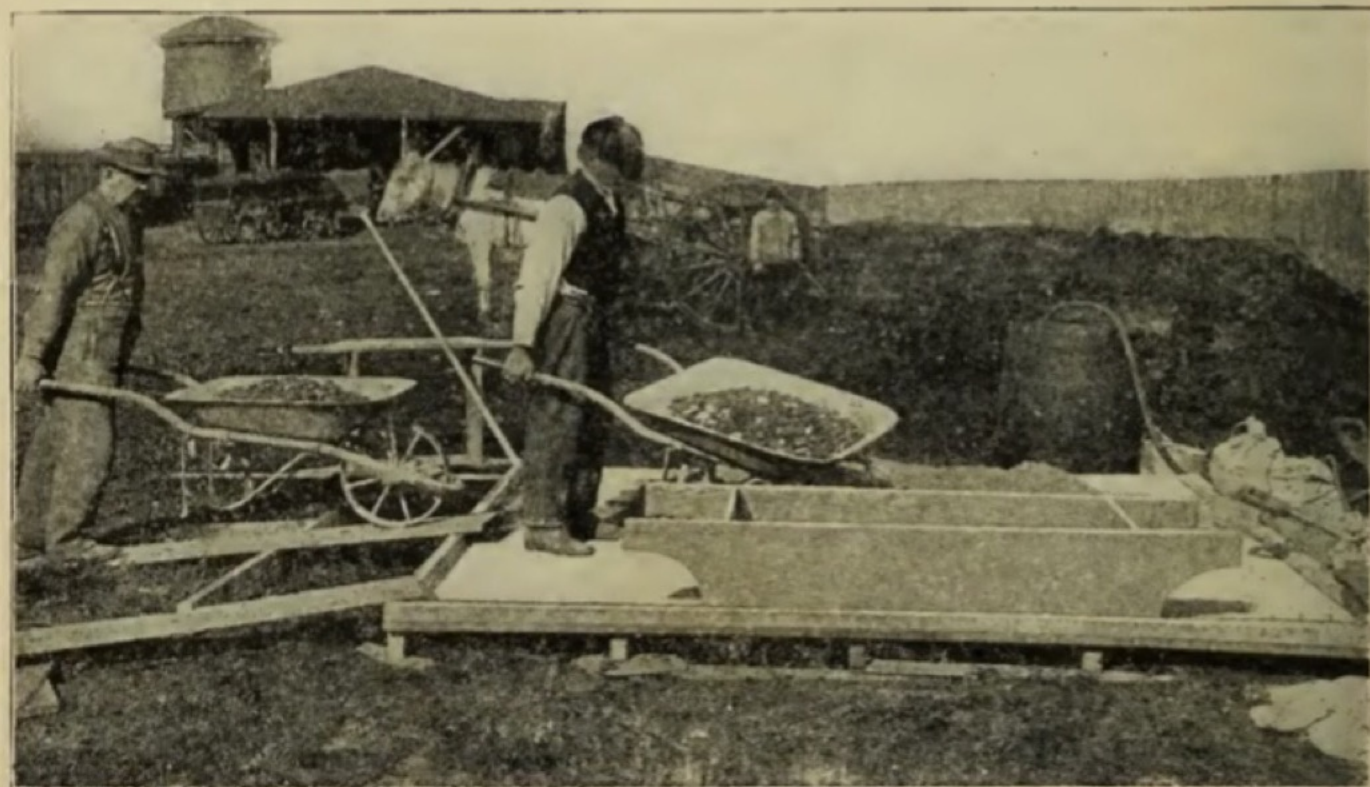
MIXTURE MATERIALS FOR ONE BAG BATCH				RESULTING VOLUME IN CUBIC FEET		QUANTITIES OF CEMENT, SAND, AND PEBBLES OR STONE REQUIRED FOR ONE CUBIC YARD OF COMPACTED MORTAR OR CONCRETE				
	Cement in Sacks	Sand cu. ft.	Pebbles or Stone cu. ft.	Mortar	Concrete	Cement in Sacks	Sand		Stone or Pebbles	
							Cu. Ft.	Cu. Yd.	Cu. Ft.	Cu. Yd.
1:1½	1	1.5		1.75		15.5	23.2	.86		
1:2	1	2.0		2.1		12.8	25.6	.95		
1:2½	1	2.5		2.5		11.0	27.5	1.02		
1:3	1	3.0		2.8		9.6	28.8	1.07		
1:2:3	1	2.0	3.0		3.9	7.0	14.0	.52	21.0	.78
1:2:4	1	2.0	4.0		4.5	6.0	12.0	.44	24.0	.89
1:2½:4	1	2.5	4.0		4.8	5.6	14.0	.52	22.4	.83
1:2½:5	1	2.5	5.0		5.4	5.0	12.5	.46	25.0	.92
1:3:6	1	3.0	6.0		6.4	4.2	12.6	.47	25.2	.94

(Based on tables in "Concrete, Plain and Reinforced," by Taylor & Thompson)

MIXING CONCRETE

Hand Mixing

If concrete is to be mixed by hand, a watertight mixing platform, large enough so that two men using shovels can work upon it at one time, is needed. This platform should be made preferably of 2 by 6-inch plank, tongued and grooved so that tight joints will be formed to prevent the loss of cement carried away when adding mixing water to the materials. These planks may be nailed to three 2 by 4's set on edge. The two outside ones may have holes bored near the end so that if necessary to move



Mixing platform with bottomless box for measuring materials. This box should be marked on the inside to show capacities of 1, 2, and 3 cubic feet. When level full, the box holds 4 cubic feet.

the platform from place to place, clevises and a chain may be attached so a horse can be hitched to the platform to drag it. Two sides and one end of the platform should have a strip nailed along the edge, projecting about 2 inches above the top of the platform to prevent materials from being washed or shoveled off the platform while mixing.

Whether concrete is mixed by hand or machine, a measuring box is necessary so that the sand and pebbles or broken stone can be properly proportioned. Such a device is really a bottomless box, and can be made of 1 or 4 cubic feet capacity; in the latter case, marks should be made at proper levels on the inside to indicate capacities of 1, 2 and 3 cubic feet. When used, the measuring box is set on the mixing platform and after the required amount of sand has been shoveled in and measured, the box is raised and the sand spread about in an even layer on the mixing platform. (Wheelbarrows of different capacities are also made for measuring aggregates. These are generally used when concrete is mixed by machine, because the materials can readily be dumped from wheelbarrows into the mixer hopper or loading skip. Otherwise a measuring box of 1 cubic foot capacity is set in an ordinary wheelbarrow and filled in the usual way.)

Next the cement, which need not be measured, as each sack may be considered 1 cubic foot, is spread in an even layer on top of the sand. Square-pointed shovels are used to turn the cement and sand two or three times, or more if necessary, until the streaks of brown and gray have merged into a uniform color, indicating thorough mixing of the two materials.

Pebbles or broken stone (first thoroughly wet) are then measured and spread in a layer on top of the cement and sand and all of the materials again mixed by turning with shovels. Then a depression or hollow is shoveled in the center of the pile and water added gently, preferably by a spray from a hose, while two or more men turn the materials with square-pointed shovels, adding water while this is being done, until the cement, sand and pebbles have been thoroughly and uniformly mixed and the desired consistency obtained.

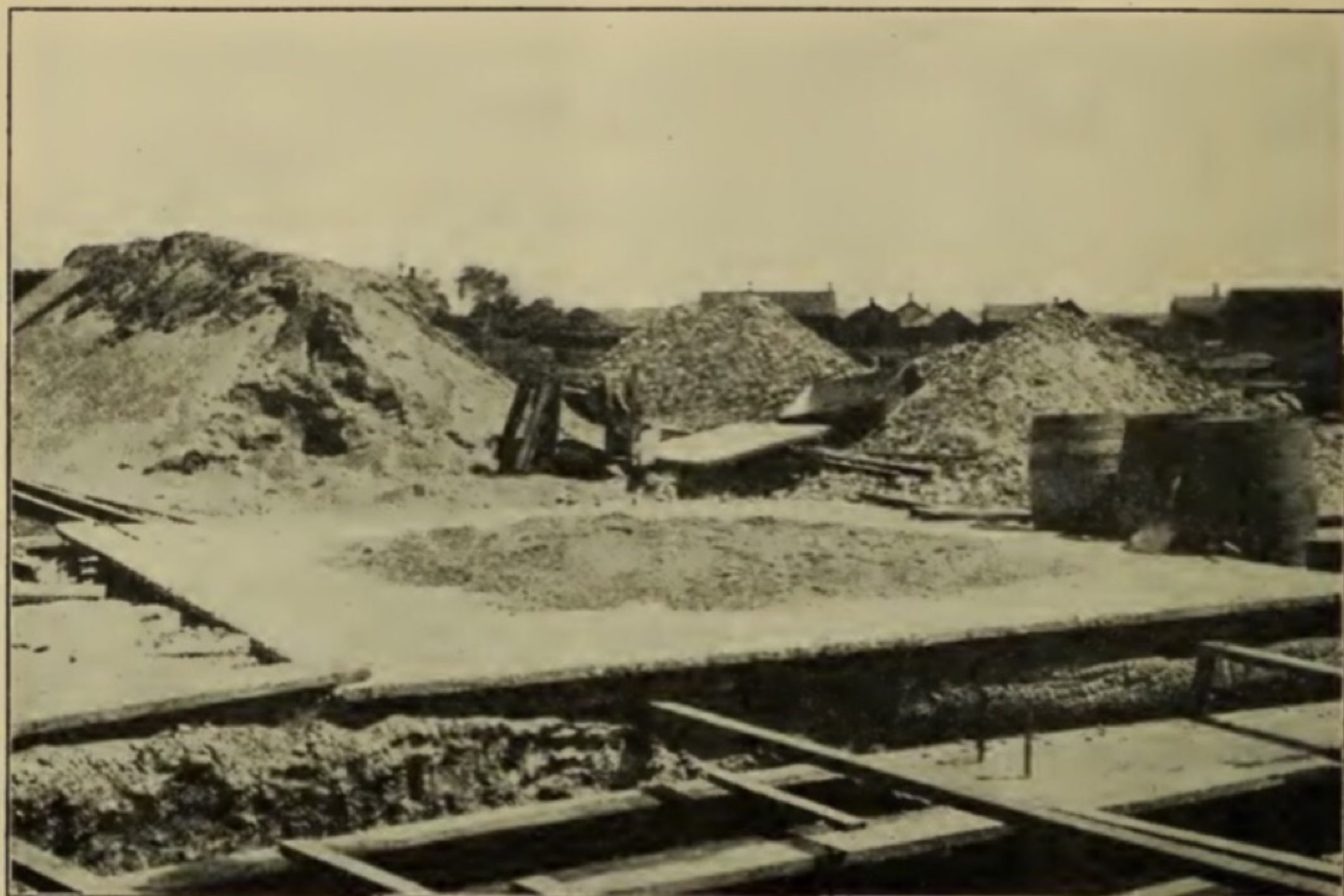
Quantity of Water Used

If much concrete is to be mixed, it is well to determine when preparing the first batch, the amount of water necessary to produce the required consistency, so that the same measured quantity of water can be used for subsequent batches of the same size, thus always producing concrete of the same consistency.

For most classes of construction, the correct amount of water is that which will make a concrete of quaky or jelly-like consistency. Less water is sometimes used for foundation concrete where the wall is not to enclose a cellar or basement, that is, need not be watertight; but the "quaky" consistency is preferable wherever possible to use it.

In hand mixing, batches should not be larger than can conveniently be mixed on the platform, nor larger than will represent an amount of concrete which can be placed within thirty minutes after mixing.

Quaky mixtures are made to settle to all parts of the form by spading the concrete rather than by tamping it when placing. Spading makes



A measured quantity of sand and cement is spread in a thin layer on the platform preparatory to mixing in the dry state.



Men using square-pointed shovels turn the sand and cement thoroughly several times until the streaks of brown and gray have merged into a uniform color.



The previously wetted broken stone or pebbles are then added to the sand-cement mixture and thoroughly incorporated with it, after which a depression or hollow is shoveled in the pile and the required amount of water added.



The entire mass is then turned thoroughly several times until every pebble or particle of broken stone is covered with sand-cement mortar and the whole mass is of uniform consistency.

quaky concrete settle to greatest density and releases any air that may be entrapped in the mixture. If concrete containing less water than would produce a quaky mixture is being placed, then it is tamped in the forms, but such concrete should be wet enough to cause water to flush to the surface under moderate tamping or compacting.

Experience has proved that where sand is only moderately damp when combined with the other materials in a concrete mixture, that the quaky or jelly-like consistency can usually be produced by using water in the proportion of 1 gallon to 1 cubic foot of concrete in place. This figure is not intended to represent a fixed rule, but rather an approximation of the amount required. If the sand is dry, then it is necessary to increase the amount of water to obtain the desired consistency. Certain kinds of broken stone are somewhat porous, and if used, would take up some of the mixing water and necessitate more water to produce a quaky mixture. When the sand contains a large amount of moisture, naturally less water is required.

Some classes of concrete work require wetter concrete mixtures than are described by the word "quaky." Take, for instance, concrete fence posts. In such work it is necessary to use a slightly wetter mixture so that when stirring the concrete in the molds or agitating the molds to compact the concrete and release entrapped air, reinforcing metal will everywhere be thoroughly surrounded and the concrete be enabled perfectly to bond with (adhere to) the steel. In all concrete work one must be careful to avoid using so much water as to make the concrete sloppy or soupy, thus causing the sand-cement mortar and pebbles or broken stone to separate.

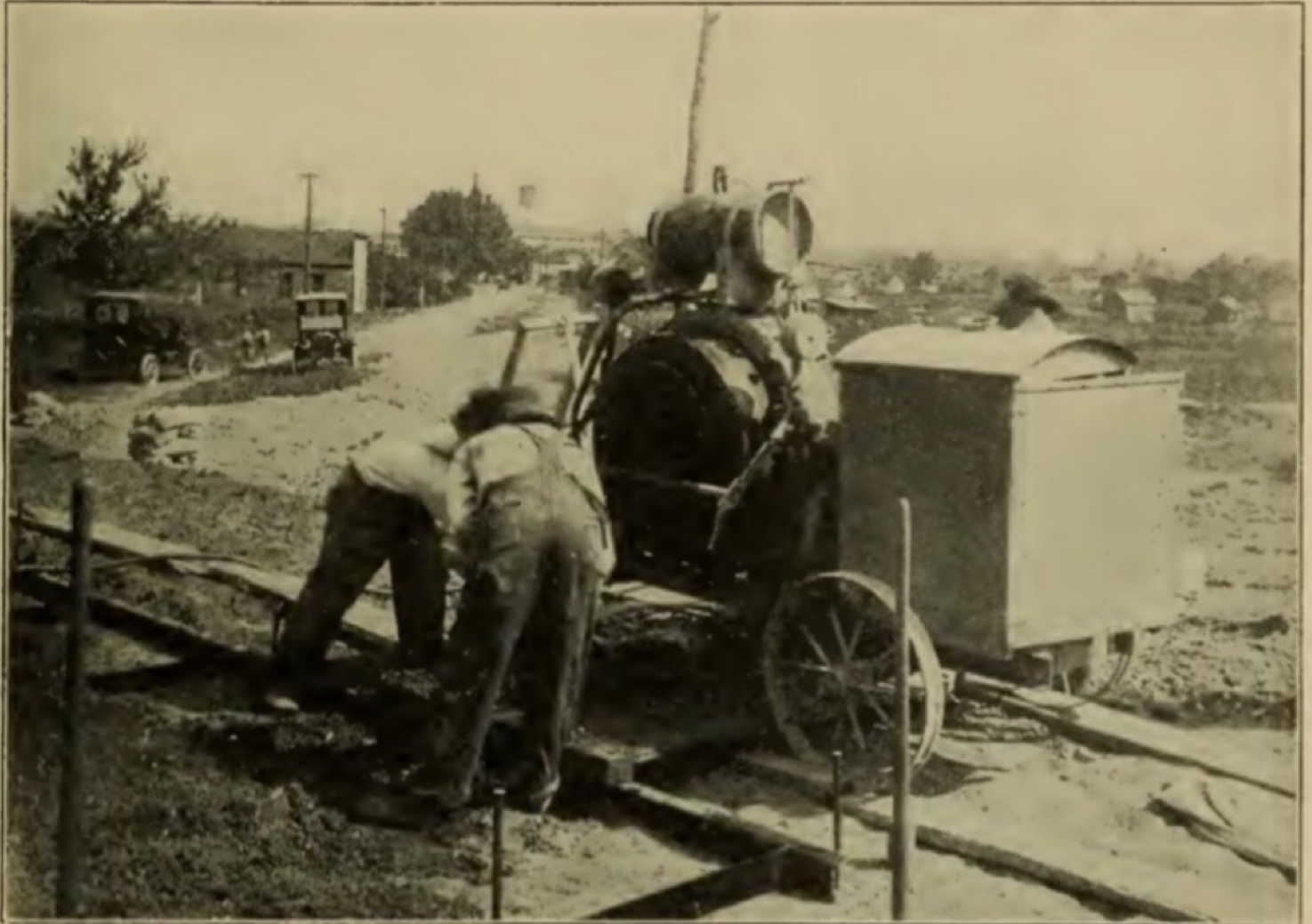
Even though concrete mixtures may have been proportioned so that the combined materials contain the lowest possible volume of air spaces or voids and also represent a mixture rich enough for strength, yet unless the proper amount of water is used the resulting concrete will not be watertight; therefore, the correct amount of water is very important when one desires to secure watertight construction—just as important, in a way, as having the sand and pebbles properly proportioned and well graded, and using the necessary quantity of cement.

The sand and cement should not be combined very far in advance of adding the required amount of pebbles or broken stone, because the moisture which the sand contains will cause the cement to commence hardening and this will affect the final strength of the concrete. Just as soon as the cement and sand for a batch of concrete are mixed, the pebbles or broken stone and water should be added, and mixing continue without interruption, followed immediately by placing of the concrete.

Machine Mixing

At the present time there are many types of power-operated concrete mixers on the market. These range in size from small and inexpensive machines, complete with self-containing gasoline engine, representing an outfit such as well meets the home worker's requirements, up to the large self-propelling machines that are used in concrete road building. The

smaller machines range in price from \$75 or \$80 upward, and if one has any considerable amount of concreting to do, such machines represent a profitable investment and reduce the labor cost of mixing, to say nothing of insuring well-mixed concrete. Only a mixer of the batch type should be used, that is, one having a revolving drum in which all of the materials are placed at one time, the drum being revolved until mixing is complete.



A small self-contained mixer-engine outfit at work on a job of mixing concrete for a concrete walk. Such an outfit is a profitable, labor-saving and efficient piece of equipment.

Before water is added the mixer drum should be given a few revolutions to thoroughly mix the materials in the dry state, then the required amount of water should be added and the drum revolved for a specified time or a specified number of revolutions, either of which should represent a period of mixing of at least one minute. Some mixers have attached to them a water tank by means of which a measured quantity of water for each batch may be added to the dry materials. Care should be taken not to place more materials in the drum than recommended by the manufacturer, otherwise thorough mixing cannot be accomplished, nor should the mixer drum be revolved too rapidly, for that would cause the materials to cling to the inner surface of the drum rather than be tumbled about and thoroughly mixed. The materials for a batch should not exceed in volume one-third of the full capacity of the mixer drum.

In making concrete products such as are usually formed by machines with iron molds, that is, concrete block, brick and tile, a somewhat dryer mixture must be used so that the molds can be removed immediately after

forming the products. In such work it is a general rule to use as much water as possible without interfering with the quick removal of the mold or having the product so wet that it will not retain its shape after the mold is removed.

PLACING CONCRETE

General

As the hardening action resulting from the combination of cement and water begins very soon after a batch of concrete is mixed, concrete should be deposited as quickly after mixing as possible. For convenience in placing concrete the mixing platform (if concrete is being mixed by hand) or the mixer (if machine mixing is being done) should be placed near where the concrete is to be deposited. When the concrete is placed in a trench without using forms, boards or planks should be laid along and across the trench for the workers to stand upon when dumping and tamping concrete so as to prevent knocking down earth from the sides of the trench into the freshly placed concrete.

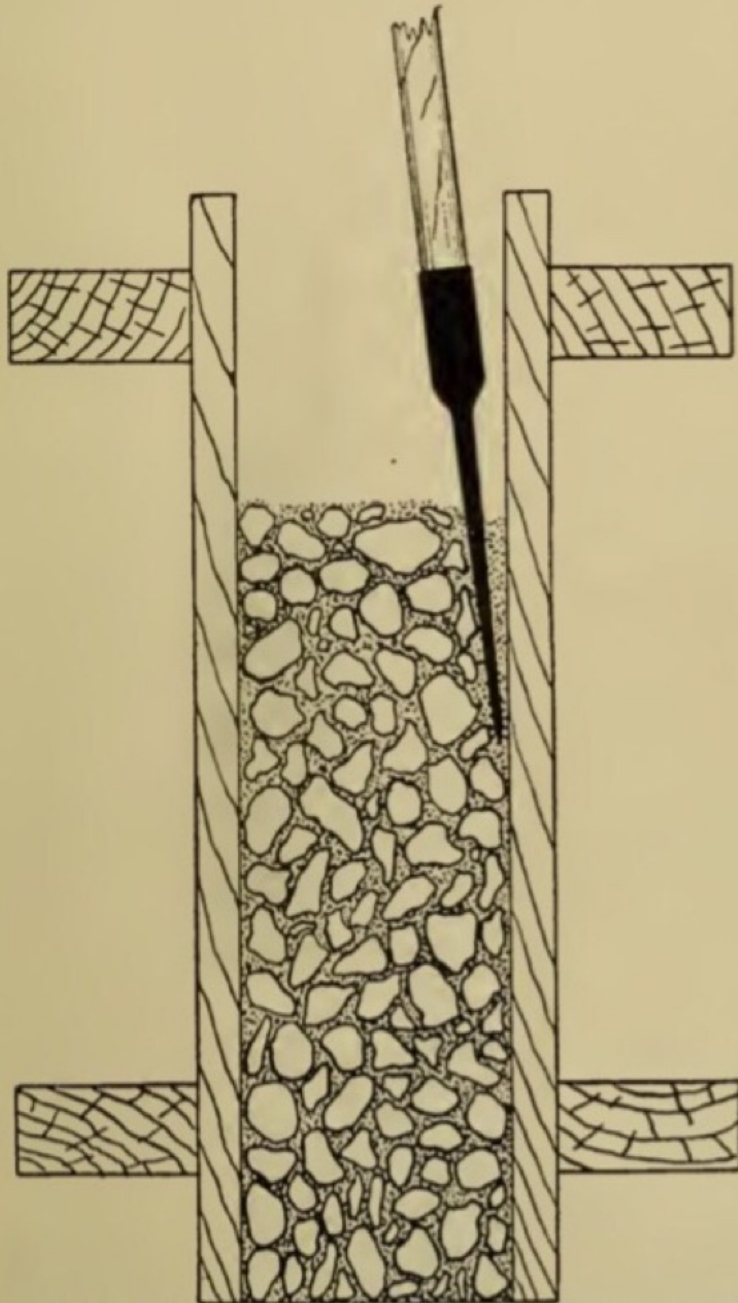


If the mixing platform can be placed near where concrete is to be deposited, the concrete may be shoveled directly from the platform into the forms.

Concreting work should be planned so that the quantity of concrete that will be placed during a working day or whatever time is to be devoted to concreting, can be estimated with reasonable accuracy, to enable leaving the work in suitable condition for resuming concreting later. Concrete should be deposited in a layer or layers of uniform depth all around the enclosure, that is, between forms, unless it is desired to complete the work in sections to full height of forms, when a vertical joint is arranged for.

As already mentioned, concrete for some foundation work is mixed to a consistency produced by using less water than would be required for a quaky mixture. Such concrete is tamped in the forms. Quaky concrete instead of being tamped is spaded thoroughly between form faces and next to form faces so as to secure the greatest possible density and to release air that may be in the mixture.

Spading next to form faces also forces back the coarser particles and allows the sand-cement mortar to come next to the forms, thus increasing density and watertightness of the surface, and producing a smooth finish free from pebble pockets. An old hoe straightened out, or a flattened garden spade with slots in it, makes a convenient spading tool. Narrower spading tools are needed sometimes to thoroughly work the concrete around reinforcing rods.



An old hoe straightened out, or a flattened garden spade or similar tool, makes a convenient device for spading concrete in the forms, as shown in this illustration.

Methods of Placing

Methods of placing concrete necessarily vary in accordance with certain working conditions and the nature of the construction. Concrete for feeding floors and barnyard pavements, for example, is dumped from wheelbarrows upon a previously prepared foundation, and as rapidly as the forms for alternate slabs are filled, the concrete is struck off level by using a straightedge resting upon side forms and moved back and forth across them with a saw-like motion,

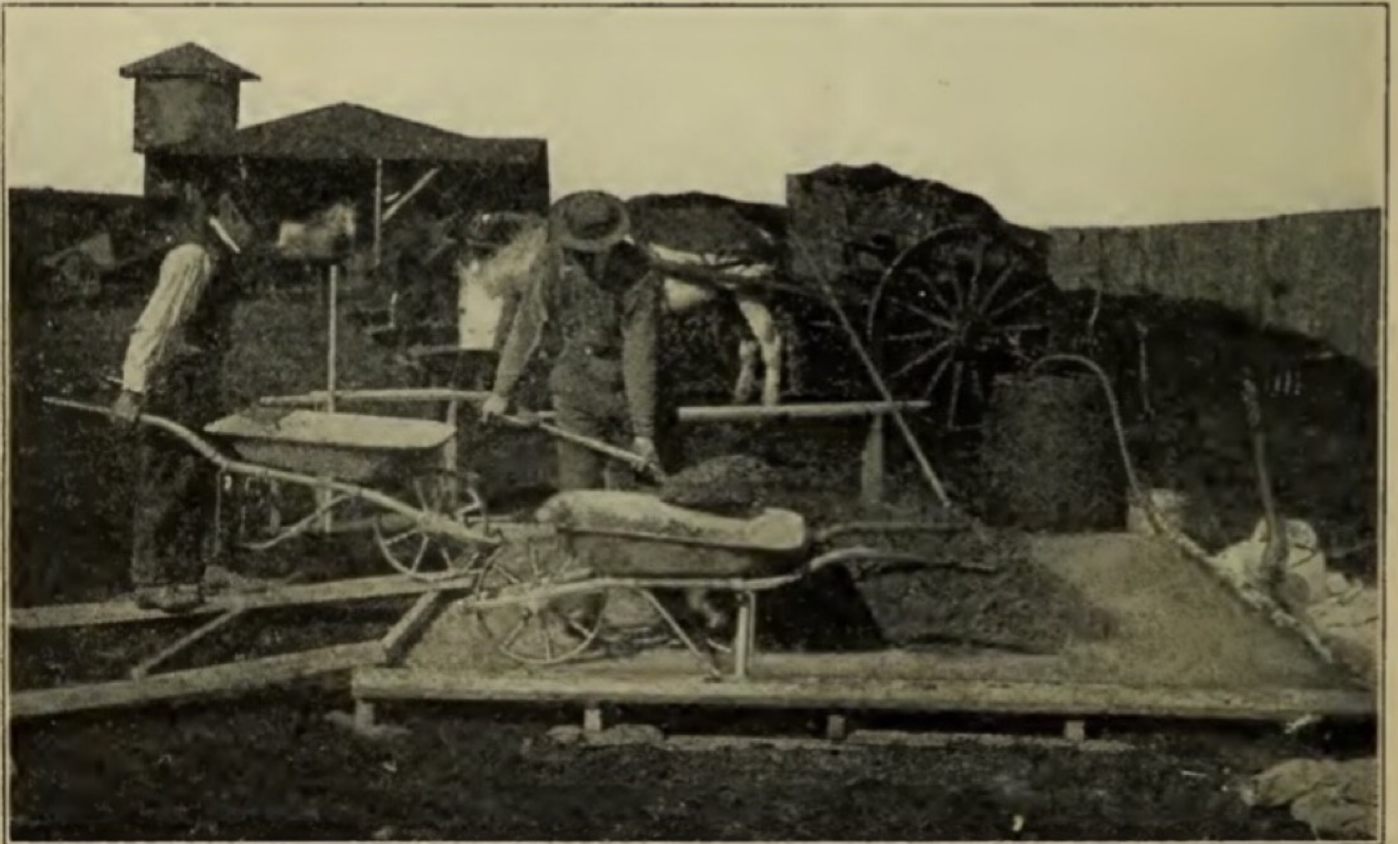
after which the surface is finished by using a wood float. In the case of troughs and stock-watering tanks, necessary reinforcement having been previously placed in the forms and secured in proper position, concrete for the floor or bottom of the trough or tank is placed, the inside form is then quickly set in position supported from the top of the outside form and concrete for side walls immediately placed so as to make certain that it will unite perfectly with that forming the floor.

Concrete should not be placed in layers deeper than will permit compacting it firmly and causing it to unite or bond with the concrete previously placed. If a mixture containing less water than a quaky one is being placed, layers no deeper (thicker) than 6 inches should be deposited, while

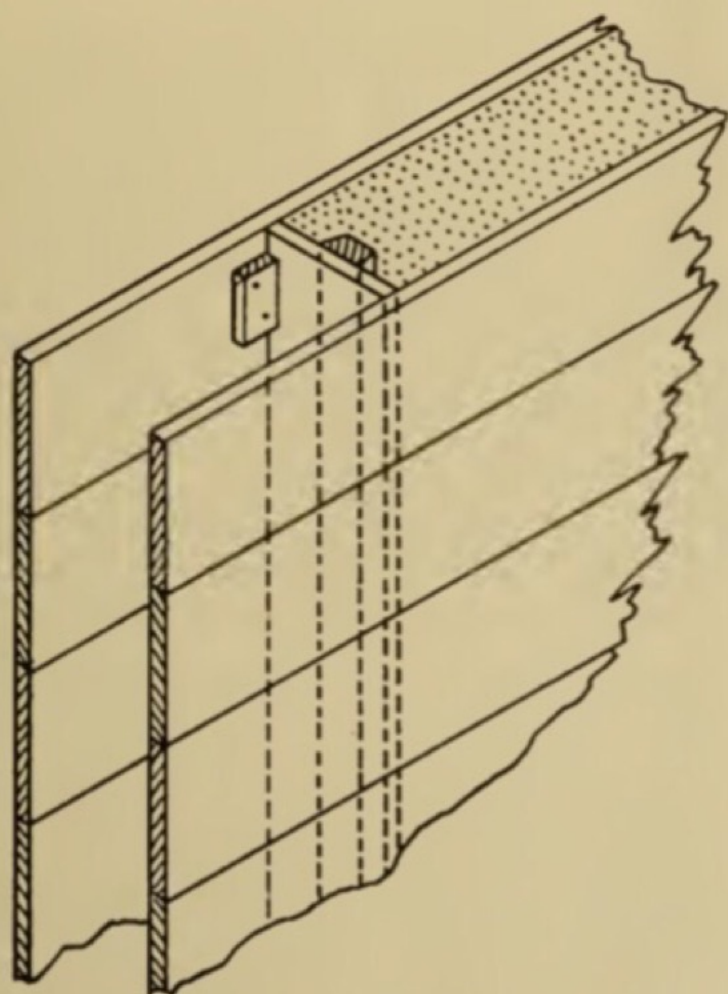
for a quaky mixture the layers should not be deeper than the length of the blade of the spading tool being used.

In constructing walls for milkhouses, smokehouses, icehouses and similar small buildings, wall forms are filled as just described, yet for thin wall sections one should be careful not to board up the forms so high on one side as to prevent effective use of the spading tool. For instance, if the wall being laid is only 6 inches thick the space between forms makes it difficult to properly spade the concrete if both forms are boarded up to a height of 8 or 10 feet. Another objection to placing concrete in forms that have been carried up too far, is that the concrete has to drop through such a distance when dumped or shoveled into the forms, that there is likely to be some separation of the sand-cement mortar from the pebbles or broken stone, thus resulting in a lack of uniform density in the wall because of the formation of pebble pockets.

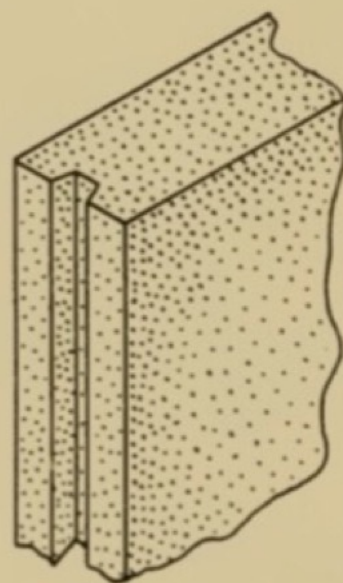
If necessary that a certain section be finished complete to the top of the forms within a stated time, arrangement must be made to provide a vertical joint in the work by blocking a board in the forms, with a beveled 2 by 4 or similar strip nailed to the face against which concrete is being placed so that this vertical joint will have a mortise face, as shown in the illustration on next page. Then when concrete is placed in the next section the board stop is taken out and the hardened concrete acts as an end form against which the fresh concrete is placed, a tenon being formed in the mortise of the concrete previously deposited. Before resuming concreting against this section, the face of the hardened concrete should be thoroughly painted with thick hot tar just in advance of placing the various layers of concrete so that the joint will be effectively sealed against leakage.



Sometimes wheelbarrows are used to wheel concrete from the mixing platform to where it is to be placed.



*Form showing
stop board in place.*



*Wall with form
removed.*

If necessary or desirable to finish some section of concreting to the full height of the forms, a vertical joint may be provided for as shown in this illustration.

Stopping Work for the Day

When necessary to discontinue concreting before forms are filled, as at the close of the day, for instance, the top of the concrete last placed in the form should be roughened by scratching it with a stick to prepare for a good bond with fresh concrete that is to be placed the next day or when concreting is resumed. Immediately before resuming concreting, however, the surface of the old concrete should be well washed off and painted with a mixture of cement and water, mixed to the consistency of thick cream and applied just in advance of placing the fresh concrete.

Protecting the Finished Work

Proper protection of concrete after placing is of utmost importance. Although a concrete mixture begins to harden within a short time after all of the materials have been combined, the complete changes which result in thorough hardening take place rather slowly and are accomplished best only in the presence of moisture. If concrete, after placing, is left exposed to sun and wind, much of the water which was mixed with it will evaporate, and instead of hardening properly, the concrete will simply dry out. Many people believe that drying out is the natural and only process concluding the work of concreting. The finished concrete must be so protected that it will retain the water already in it until complete hardening has been accomplished.

Concrete floors, for example, should be covered with straw, sand, earth or some other protective covering and this be kept wet by sprinkling for a period varying from several days to two weeks or more, depending upon the nature of the work and weather conditions. Concrete hardens more rapidly in hot than in cool weather. Building walls, which cannot be covered with straw or sand, may be protected by hanging burlap, old canvas or similar material over and around them and keeping this covering wet. It is well also to sprinkle the concrete several times daily for the first few days after placing. Forms left in place provide good protection, but even then the work should be wet down daily.

Care should be taken not to remove forms from concrete that is to sustain any load other than its own weight until all possibility of collapse shall have passed.



Tennis Courts of Concrete
Concrete Septic Tanks
Concrete Fence Posts
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Are new publications which may interest you. If you would like any of these booklets, write the Portland Cement Association, 111 West Washington Street, Chicago.

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