

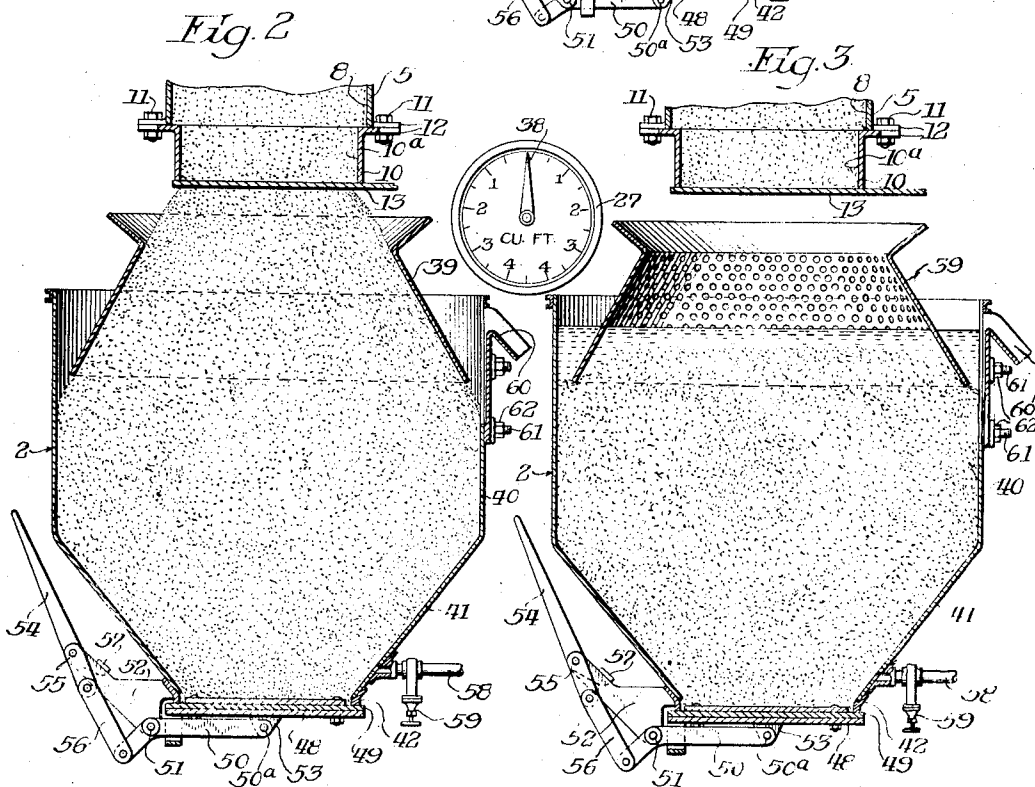
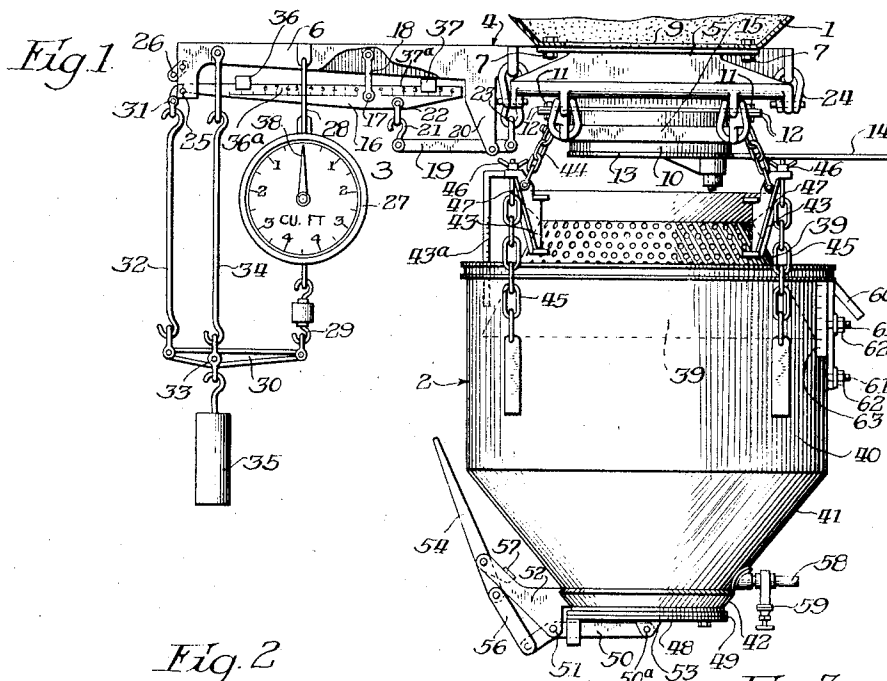
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METHOD OF PROPORTIONING AGGREGATES AND WATER FOR CONCRETE

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METHOD OF PROPORTIONING AGGREGATES AND WATER FOR CONCRETE

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The invention relates generally to the art of making concrete and more particularly to a method of accurately proportioning the amount of total water in the mix independently of the amount of moisture contained in the aggregates.

It is well recognized that the strength of concrete depends largely upon the total amount of water in the mix. If the amount of water is just sufficient fully to react with the cement, the resulting mix gives the maximum strength, but the mix is too stiff for most practical purposes. With a lesser amount of water the strength of the concrete decreases rapidly in proportion to the amount of water while with an excess of water the strength of the concrete also decreases rapidly with increasing quantities of water so that with 100% excess water the strength of the concrete is about 20% of the maximum obtainable with no excess water. It follows that the accurate determination of the quantity of water included in each mix is highly essential to obtain concrete of uniform and predetermined strength.

It is the object of the invention to provide an improved method of accurately proportioning the total water in a concrete mix.

In the processes used heretofore wherein the normally moist aggregates are measured by volume and then introduced into a concrete mix with separately proportioned units of water, variations in the moisture content of the aggregates have caused variations in the total water in the mix. These variations in total water content in concrete mixtures change the consistency of the mixed concrete, increase the placing expense due to changes in workability, cause changes in the strength of the concrete, all other factors being held constant, and may cause "honey combed" concrete.

Loose dry sand is subject to density changes or changes in compaction by jarring or tamping, these changes depending in part upon the gradation. (The term sand will hereinafter be used instead of aggregate, it being understood that the invention is applicable to aggregates generally, i. e., those coarser than sand such as gravel or stone, as

well as to sand.) Moist sand is also subject to such changes of density or compaction. If the sand be submerged it is still subject to density changes or changes in compaction when jarred or tamped or allowed to stand undisturbed, these changes again depending in part upon the gradation. Thus these prior processes wherein the quantity of sand has been measured by volume have been unsatisfactory in that they do not provide an accurate means to determine the total quantity of water in the mix. This error has been due largely to the fact that the gradation and voids of commercial sand vary, and that the density changes.

The specific gravity of commercial sand, however, is a quality that cannot be altered by handling, jarring, tamping, gradation or standing undisturbed, and tests have shown that commercial building sand coming from many separated sources is remarkably uniform in its specific gravity. If therefore water is combined with sand until the total weight of the water and sand equals a predetermined amount at a predetermined volume, the total amount of water in the mix may be accurately determined. Furthermore, changes in the moisture content in commercial sand alter the apparent volume of the sand due to the resulting changes in bulk- ing, but do not alter the total absolute volume of the sand particles. The changes in apparent volume are not directly proportional to the changes in moisture content throughout the full range of possible moisture content in the sand. However, an analysis of the bulking characteristics of commercial sand has disclosed that the absolute volume of sand in equal apparent volumes of moist sand is quite constant within a certain range of moisture variation, and records disclose that in commercial sand the moisture content holds quite closely within the limits of this range.

Thus the variation in absolute volume of sand measured by apparent volume is practically negligible in commercial work, and sand measured by apparent volume will give practically uniform absolute volumes independent of the moisture content within this range.

I utilize these facts in providing a process for proportioning the total amount of water for a concrete mix, the process consisting generally of measuring a predetermined volume of moist commercial sand and then combining with that sand a quantity of water such that the combined sand and water equals a predetermined volume. The weight of the combined sand and water is then checked against the weight of a like volume of sand and water having a predetermined weight.

For the purpose of more clearly illustrating and disclosing the invention, I have shown in the drawing the preferred form of an apparatus which is adapted to utilize the process, together with diagrammatic sectional views of the apparatus at various stages of the process. However, it is to be clearly understood that the form of the apparatus may be varied and altered at will without departing from the spirit and scope of the invention as defined in the appended claims.

As shown in the drawings:

Figure 1 is an elevational view of the preferred form of the apparatus.

Figs. 2 and 3 are sectional views thereof at different stages of progress of the process.

Referring to the drawings, the apparatus as illustrated comprises a bin 1, an adjustable measuring hopper 2 and a weighing mechanism designated generally as 3. The bin may be supported by any suitable means (not shown) and the hopper and weighing device are herein shown as suspended from the bin. The weighing device in the preferred form of the invention comprises an adapter frame or bracket 4 having an annular ring portion 5 and an arm-like extension 6. The ring portion may be secured to the bin 1 as by means of bolts 7 and has an aperture 8 therein which coincides with a discharge opening 9 in the bin. An annular valve frame 10 is clamped against the annular portion 5 of the bracket 6 by means of bolts 11 which are entered through apertures in lugs 12 on said parts. This valve frame has an opening 10^a there-through coinciding with the apertures 9 and 8 in the bin 1 and bracket 4 thereby to form a discharge pipe for the bin which may be opened and closed by means of a gate 13. This gate is pivotally mounted on the valve frame 10 and is operable by means of a handle 14.

A load supporting member or scale ring 15 is positioned surrounding the annular valve frame 10 and serves as the scales for the weighing device. A beam 16 is fulcrumed intermediate its ends at 17 by means of a link 18 which is suspended from the arm 6. This beam is connected to the scale ring 15 by means including a lever 19 pivoted intermediate its ends to a depending portion 20 of the arm 6, a linkage 21 connecting the outer end of this lever with a pivot 22 on the beam, and linkage 23 between the inner end

of the lever 19 and a suitable leverage system of a well known construction designated generally as 24 which latter provides a suspension means for the scale ring (not shown in detail). The outer end of the beam 16 passes through an end opening in the arm 6 and may be locked against a stop pin 25 by means of the usual beam lock 26.

A spring scale having an indicating dial 27 is suspended from the arm 6 by means of a link 28 and has its scale hook 29 connected to one end of a lever 30, the other end of which is connected to the free end 31 of the beam 16 by means of a link 32. The lever 30 is fulcrumed intermediate its end on a pivot 33 which is suspended from the arm 6 by means of a linkage 34 and has a weight 35 suspended therefrom.

The beam 16 is provided with two sliding poises 36 and 37, one positioned upon each side of the fulcrum 17 and has graduations 36^a and 37^a thereon reading both ways from the said fulcrum, as hereinafter more fully set forth. The pointer 38 of the dial 27 will register the amount off-balance between the setting of the poises on the beam and the weight of the measuring hopper and its contents which is suspended from the scale ring 15. With the poises set at zero the pointer also indicates zero, the spring scale then balancing the weight of the hopper empty.

The measuring hopper 2 as illustrated herein, comprises an upper conical portion or member 39 and a lower container 40. The container is generally cylindrical in form but has inwardly sloping sides 41 at the bottom thereof converging to define a circular discharge port 42, thereby to insure complete discharge of material from the hopper. The upper member 39 is preferably perforated to permit water to flow freely therethrough and is herein shown supported from the scale ring 15 of the weighing device by means of a plurality of brackets 43 secured to the member 39 and chains 44 which are attached at their opposite ends to the said brackets and to the ring 15. The container 40 is adjustable relative to the conical member 39 of the hopper to permit of adjustment of the volumetric content of the hopper. For this purpose the container may be suspended from the brackets 43 by means of chains 45, and adjustable screw devices 46 having hooked portions 47 are provided one on each bracket to receive the free end of a chain. Should it be desired to adjust the volume of the hopper to a greater extent than that provided for by the screw devices, a lower link on each chain may be caught over the hooks 47. The volume of the hopper may be indicated by means of a scale 43^a secured to a bracket 43.

A gate 48 having a water tight gasket 49 is provided to control the discharge port 42 of the hopper. This gate is carried on a

lever 50 pivotally supported intermediate its ends at 51 on a bracket 52 which is secured rigidly to the container 40. The end 50^a of this arm is loosely pivoted to an outstanding lug 53 positioned centrally on the gate. As herein illustrated the lever 50 is operable by means of a hand lever 54 pivoted at 55 on the bracket 52, and a toggle link 56 connecting the adjacent ends of the lever 54 and lever 50. Thus the gate may be opened and closed by means of the hand lever 54 and in its closed position the gate is held locked by the toggle device, a stop lug 57 being provided on the hand lever and arranged to engage the bracket 52. With the force exerted by the lever 50 applied centrally of the gate the pressure of the gasket 49 on the container is equalized and uniform so as to insure an effective seating action throughout its periphery.

In the apparatus illustrated in the drawings means is provided to combine water with the sand in the hopper. For this purpose a pipe 58 leading to a suitable supply of water (not shown) is connected to the lower portion of the container 40. A valve 59 in this pipe line is adapted to control the flow therethrough.

An adjustable overflow 60 is provided on the container 40 and is secured thereto by means including the bolts 61 anchored on the container. By loosening the nuts 62 of these bolts the overflow may be raised or lowered, graduations 63 being preferably provided upon the container adjacent the overflow to indicate the volume of the container to which the overflow is set.

The process when utilized in connection with the apparatus disclosed consists generally in first measuring a predetermined volume of bulk or normally moist aggregate; second, combining water with said aggregate until the combined aggregate and water equals a second predetermined volume, and third, weighing the combined mass to determine the accuracy of the proportioning of the aggregate and water. For purposes of simplicity, I shall continue to refer to aggregates as sand although as mentioned hereinbefore, the invention contemplates coarser aggregates as well.

For purposes of illustration it is desired to proportion 10 cubic feet of sand with 4 cubic feet of water. Assuming that bulk or normally moist sand contains 100 pounds of dry sand per cubic foot, specific gravity of sand is 2.70, and water weighs 62.5 pounds per cubic foot, then the absolute volume of 10 cubic feet of sand equals $10 \times 100 / 2.7 \times 62.5$ or 1000/168.75 or 5.93 cubic feet.

Adding 5.93 to 4 (cubic feet of water) the total absolute volume of the combined mass equals 9.93 cubic feet, to which point on the scale 63 the overflow 60 is then set.

The poises 36 and 37, the moment arms

of these poises about the fulcrum 17, and the leverage between the beam 16 and scale ring 15 are so designed that with the poises adjacent the fulcrum the beam balances the empty hopper and the pointer 38 indicates zero, i. e., a balanced condition. The graduations to the left of the fulcrum indicate "combined volumes" and the graduations to the right of the fulcrum and on the dial 27 indicate "cubic feet of water." Thus by setting the poise 36 at the combined volume (in this instance 9.93), setting the poise 37 at the volume of water (in this instance 4) and adjusting the hopper to measure 10 cubic feet of bulk sand (as shown by the scale 43^a), the apparatus is ready for operation.

The two poises and the graduations on the scale beam are provided in this manner so as to facilitate setting-up the apparatus for various "combined volumes" and "volumes of water" to be contained therein. To obtain these results the poise 36 is such that its weight multiplied by its moment arm equals the "combined volume" (in this instance 9.93 cubic feet) of solid sand, i. e., sand without voids.

Thus with the overflow 60 and the poise 36 both set at 9.93 cubic feet (the poise 37 being set at zero) the beam 16 would balance with the hopper filled with solid sand. Inasmuch as part of this volume, however, is to be filled with water (in this instance 4 cubic feet), the poise 37 must counterbalance the poise 36 to the extent of the difference in weight of that volume of water and a like volume of sand. This difference is equal to the volume of water multiplied by the difference between the specific gravities of the sand and water. Thus the combined or resultant weight indicated by the two poises on the beam equals the weight of the "combined volume" of solid sand minus the volume of water multiplied by the difference between the specific gravities of sand and water.

If:

B = the combined weight of sand and water,
 A = the combined absolute volume of sand and water,

Specific gravity of sand = 2.7,

X = the volume of the water, and

62.5 = weight of a cubic foot of water,

then:

$$B = 2.7 \times 62.5 \times A - (2.7 - 1) \times 62.5 X$$

$$\text{or } B = 168.75 A - 106.25 X.$$

Thus in the example under consideration

$$A = 9.93$$

$$X = 4$$

$A \times 168.75$ must balance the moment effect of poise 36

$X \times 106.25$ must balance the moment effect of poise 37.

With the poises 36 and 37 set at 9.93 and 4 respectively, the overflow 60 set at 9.93 cubic

feet and the volume of the hopper adjusted to 10 cubic feet on the scale 43^a, the preferred operation of the apparatus to utilize the process is as follows:

5 The gate 48 is closed, and the gate 13 is then opened to permit normally moist sand to discharge from the bin into the hopper. As shown in Fig. 2, when the sand stops flow-
10 ing the gate 13 may be closed, thereby striking off the column of sand and leaving the desired quantity of sand (10 cubic feet) in the hopper.

Water is then admitted from the supply line 58 by opening the valve 59, until the
15 water in the hopper reaches the height of the overflow 60 as shown in Fig. 3. This point is generally determined by permitting some water to discharge over the overflow. Inas-
20 much as the conical member of the hopper is perforated the water rising within the cone and that between the cone and the container quickly assume a common level.

If now the pointer 38 indicates zero with the beam 16 unlocked, the water and sand
25 have been combined in the proportion of 5.93 cubic feet absolute volume of sand and 4 cubic feet of water. This indicates that the assumption that one cubic foot of bulk sand contained 100 pounds of dry sand content
30 was correct.

If, however, the pointer does not indicate zero, it is apparent that the bulk sand con-
tained either more or less than 100 pounds of dry sand per cubic foot. Thus, if the pointer
35 indicates to the right of zero (assuming that additional weight in the hopper turns the pointer clockwise) then it is obvious that the bulk sand contained more than 100 pounds
40 of dry sand per cubic foot and that there is too much sand and therefore too little water in the hopper. If the pointer indicates to the left, the opposite is true.

The dial is preferably calibrated to indicate directly in cubic feet the excess or
45 deficiency of water in the combined mass. Inasmuch as one cubic foot of dry sand weighs 168.75 pounds and a cubic foot of water weighs 62.5 pounds, one cubic foot of excess sand adds 168.75 minus 62.5 or
50 106.25 pounds excess weight to the combined mass. If therefore the poises 36, 37 are at the zero points of the scales 36^a, 37^a, and 106.25 pounds weight placed in the empty hopper, the pointer 38 will indicate one cubic
55 foot on the scale of the dial 27. By adding increments of 106.25 pounds to the weight in the hopper, this suggested method can be extended to calibrate the entire scale.

With the dial calibrated in this manner
60 the pointer 38 will indicate in cubic feet the excess or deficiency of water in the combined mass. Should this excess or deficiency be within allowable limits, the contents of the container may be discharged therefrom
65 and used in a concrete mix. Should the point-

er indicate a deficiency of water beyond the allowable limit, this means an excess of sand in the combined mass and to obtain the desired proportioning of sand and water, a second batch is prepared wherein the vol-
70 ume of bulk sand as premeasured is decreased by adjusting the hopper to decrease the volumetric content thereof, as indicated on the scale 43^a. Additional experimental
75 batches may then be combined until the pointer indicates within the allowable limits. If, however, the pointer indicates an excess of water within the allowable limit, the op-
80 posite adjustment of the measuring hopper is effected in the succeeding experimental batches.

It is apparent that by this process the moisture introduced into the container as measured in the sand becomes a part of the
85 total water and that the total water in the container is complementary in volume to the absolute volume of the sand. Inasmuch as the variation in absolute volume of sand measured by apparent or bulk volumes is
90 less than the moisture variation within the range hereinbefore mentioned, it will be apparent that the variation in total water measured by this process will be less than that encountered when water and moist sand are
95 measured by weight or by volume and later combined in a mix.

The process is particularly well adapted for use with apparatus of simple construc-
tion and ready adjustment and because of its
100 ease of operation lends itself particularly to field work. When used with the apparatus disclosed herein, and this apparatus has been calibrated as hereinbefore described, it is
105 merely necessary for an operator to open the gate on the sand bin and thereby discharge sand into the hopper until the sand stops flowing. Then by closing the gate he strikes off the sand to the predetermined
110 volume. The valve 59 in the water line 56 is then opened and water permitted to flow into the hopper until some of it runs out through the overflow 60. The valve is then closed and if the pointer 38 indicates within
115 the allowable limits of water variation, the combined mass is ready to be mixed with the proper proportions of cement and stone and may be discharged through the lower gate on the hopper.

It will be apparent that the pointer on the dial indicates the cubic foot variation
120 in water from the quantity desired and operates as a check on the dry sand content of the premeasured bulk sand as well as upon the water combined therewith and thereby
125 indicates to the operator of the apparatus the necessity for readjustment should such necessity occur.

I claim as my invention:

1. A process for proportioning the total
water in a concrete mix which comprises 130

measuring a predetermined volume of normally moist aggregate, combining water with said measured aggregate so that the moisture in the aggregate combines with the added water until the combined aggregate and water equals a second predetermined volume, and weighing said combined mass.

2. A process for proportioning the water in a concrete mix which comprises placing a pre-measured quantity of moist aggregate in a container, flowing water upwardly through the aggregate to a predetermined level, and weighing the combined aggregate and water.

3. A process of proportioning water and a normally moist aggregate for concrete which consists in measuring by apparent volume a quantity of such aggregate, combining said aggregate with water so that the normal moisture in the aggregate combines with the water to produce a predetermined combined volume, and weighing the combined mass.

4. The process for proportioning water and an aggregate for a concrete mix which consists in placing a measured quantity of bulk aggregate in a hopper having a water outlet located at a predetermined level, admitting water to the hopper from a point below said outlet until a quantity is free to run off through the outlet, and weighing the combined mass of aggregate and water.

In testimony whereof, I have hereunto affixed my signature.

CHARLES S. JOHNSON.