April 16, 1940. T. H. JOHNSON ET AL 2,197,431

METHOD OF LAYING CONCRETE PAVEMENTS

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Fig. 1.

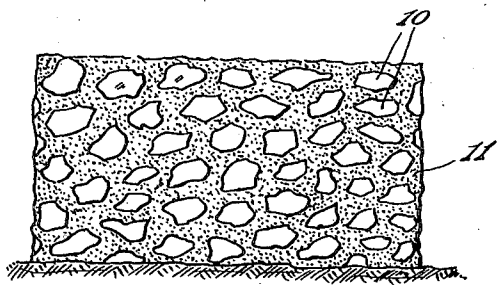


Fig. 2.

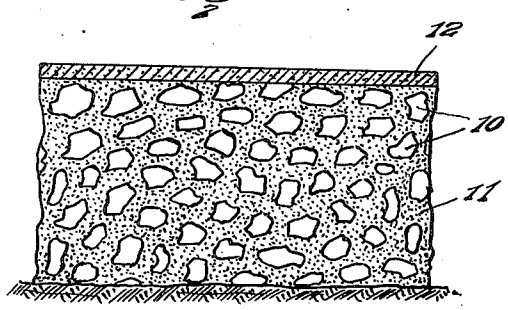
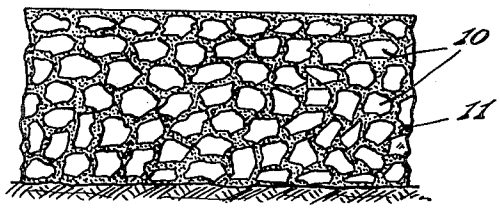


Fig. 3.



Inventors

T. H. Johnson and
M. D. Johnson

By Thos. H. Johnston

Attorney

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METHOD OF LAYING CONCRETE PAVEMENTS

Telemachus H. Johnson and Milburn D. Johnson, Sioux City, Iowa

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4 Claims. (Cl. 94—24)

This invention relates to an improved method of laying concrete pavement or the like, having been developed as an outgrowth of the method set forth in Patent No. 1,314,810 of Telemachus H. Johnson.

In the patented method identified, the mix is poured onto the subgrade and after being struck off, the slab is immediately kneaded or vibrated by rubbing the surface of the slab with heavy floats. It has been discovered, however, that any attempt to mechanically compact the slab immediately after it is poured results in the formation by the coarse aggregate of stress columns and arches within the slab which remain to produce voids and planes of weakness within the finished pavement, it being impossible, after the coarse aggregate bridges or wedges together to form said columns and arches, to entirely remove the entrapped air and water from the pockets thus formed and fill said pockets with mortar. It has also been discovered that under the proper conditions, the detrital content of the fresh mixture will, given proper time undisturbed, settle into a more uniformly compact mass than can be produced by agitating, pressing, vibrating or otherwise mechanically manipulating the freshly poured concrete.

It is therefore our object to provide a method wherein the detrital component of the fresh mixture will be treated much as an alluvial content and will be permitted to settle and compact in much the same manner as an alluvial deposit to thus be subjected to natural forces tending to provide a uniform tightly compacted mass uniquely free of voids. Further, it is our object to provide a method whereby a pavement of increased density, strength, imperviousness and wearing qualities may be produced while also, the cost of production may be cheapened. For the purposes of the present application, the detritus shall be considered to comprise all of the constituents of the concrete mixture except water.

In accordance with the present method, a lean mixture is employed and an abundance of excess water is used to render the mixture highly fluent. Thorough saturation of the cement particles is thus insured while, at the same time, the mobile condition of the mixture necessary for rapid sedimentation of the detrital content of the mixture after the slab is laid is created.

Upon the formation of the pavement slab, the slab is, quickly thereafter, covered with a seal coat excluding the entrance of air to create a partial vacuum within the slab. This partial vacuum will not only lessen the resistance met by excess water ascending to the surface of the slab but will also arrest the downward movement of a large portion of the gravitational water and thereby prolong the highly fluent state of the mixture to afford correspondingly prolonged rapid sedimentation of the detrital content of the mixture after the slab is laid.

The sealed slab is then allowed to rest undisturbed for a period of time while the aggregates and cement particles settle and compact within the slab and until the seal of the seal coat is broken by water ascending to the top surface of the slab, after which the slab is gently floated for accelerating evaporation and intensifying surface tension as well as mixing the materials of the seal coat with the surface materials of the slab, when the slab is again rested undisturbed to secure further sedimentation and compaction within the slab. This alternate floating and resting of the slab is continued as circumstances may require and, in floating the slab, care is taken not to vibrate the slab internally to form voids or arches therein.

Although an abundant excess of water is used, provision is made for the elimination of such proportion thereof as will produce the best results in the finished pavement. Repeated gentle floating of the slab, as previously noted, will, of course, contribute to this end but also, the absorptivity of the subgrade is controlled, either by wetting, if dry, or by scarifying, if wet, to produce a correctly absorptive top layer. The subgrade will, accordingly, absorb a large volume of gravitational water upon the breaking of the seal of the seal coat and the consequent extinguishment of the partial vacuum within the slab releasing the gravitational water for downward movement into the subgrade. Sufficient wetting of the subgrade is thus also accomplished to avoid subsequent warping of the slab.

In the accompanying drawing:

Figure 1 is a fragmentary sectional view through a pavement slab and showing the slab in its initial condition immediately after being laid.

Figure 2 is a similar view showing the slab immediately after being covered with a seal coat.

Figure 3 is a similar view showing the finished pavement.

In accordance with the present improved method, the subgrade is first prepared, graded and crowned and immediately prior to laying the pavement, the subgrade may be made sufficiently

absorptive to take from the wet concrete, at a chosen time after it is poured and prior to the setting of the concrete, up to two gallons of water per square yard or, at the least, so much as is required to produce a substantially uniform water content in the slab for its entire depth without exceeding the plastic limit of the subgrade, and so provide the means of preventing the warping of the slab as well as utilizing the excess of water in the slab that must be eliminated. Furthermore, it is planned to establish a condition of the subgrade which will yield as strong a pavement after a rain as before the rain and thus attain a uniform quality of pavement slab by correcting the absorptivity of the subgrade so as to care for the necessary reduction in water content of the concrete for the greatest strength. If the subgrade is wet, the surface thereof may be scarified or otherwise treated to provide a top layer of loose material sufficiently dry to absorb at least the quantity of water stated, whereas, if the subgrade is too dry, it may be sufficiently wetted.

When the subgrade is ready, the concrete mixture is next prepared and deposited on the subgrade. For most satisfactory results, we preferably employ a mixture consisting, by volume, of one part cement, two and one-half parts fine aggregate and four and one-half parts or more of coarse aggregate, gradings as specified elsewhere herein, together with sufficient water to inundate the mass of materials and render the mortar portion of the mixture highly fluent. As will be perceived, a mixture having the proportions stated will, as has been found to be consistent with maximum hardness and density, contain substantially a maximum quantity of coarse aggregate in proportion to the sand and cement. This condition naturally results in the presence in the mixture of substantially a minimum quantity of mortar lean in cement as consistently producing the greatest strength in the finished pavement together with a maximum of volume stability. Such a mixture will contain substantially five ninety-four pound sacks of cement per cubic yard of concrete as compared with six ninety-four pound sacks or more, as commonly used. Thus, the present method effects a great saving in the quantity of cement employed, as compared with conventional practice, and accordingly makes available a much cheaper pavement. Approximately seven gallons of water are used per each ninety-four pound sack of cement as compared with five to five and one-half gallons under conventional practice. A large excess of water is thus present to render the mortar portion of the mixture highly fluent. The present method uses substantially 40% more water per each ninety-four pound sack of cement than is commonly used.

The fine aggregate preferably consists of evenly graded sand passed by a quarter inch screen. Likewise, the coarse aggregate is evenly graded and preferably ranges in size between a quarter inch and three inches. In preparing the mixture, the ingredients thereof, including the quantity of water stated, are placed in a suitable drum and when the drum is revolved a sufficient length of time, say fifty-five to sixty seconds, the mixture is poured onto the subgrade to form the pavement slab. Figure 1 of the drawing shows the slab in its initial condition, the coarse aggregate being indicated at 10 and the mortar at 11, and, as will be observed, the pieces of coarse aggregate are uniformly dispersed throughout the thickness of the slab.

Upon the formation of the pavement slab, as previously described, the slab is struck off when the entire top surface of the slab is immediately or, at least, while it is substantially free of surface water, sealed for retaining the excess of free water in the slab. Sealing of the slab may be accomplished in any one of a number of different ways. A properly prepared air-proof membrane of paper or fabric may be employed to cover the top surface of the slab, to be held in contact with the slab surface by the surface tension of the wet concrete below, or any appropriate dry material sufficiently finely divided to be, in effect, water-repellant when mixed with enough sand to avoid stickiness. For this purpose we preferably use a seal coat which, in effect, is water-repellant and is composed of a mixture of equal parts, by volume, of sand that has passed a number eight screen, and cement of such fineness that approximately 90% or more passes a number 200 sieve, the sand and cement being thoroughly mixed dry. When the seal coat has been flooded with water forced upward by the sedimentation of the aggregates, the sand acts to give the surface of the slab a gritty texture and to furnish a medium to be tumbled in order to maintain a water film over an increased area to promote evaporation. Figure 2 of the drawing shows the slab immediately after the seal coat has been applied, the seal coat being indicated at 12.

The seal coat 12 is thinly applied evenly over the entire top surface of the slab at the rate of approximately ten pounds of the mixture per square yard of slab surface. This seal coat practically inhibits the entrance of air at the top surface of the slab, enabling the formation by the downward sag of a portion of the gravitational water, of a partial vacuum within the slab. This sealed surface and its resultant partial vacuum not only lessens the resistance met by water ascending within the slab but also retards the downward movement of a large portion of the gravitational water, thereby holding a sufficient portion of the free water in the slab to enable rapid sedimentation. The seal coat will thus preserve, temporarily, the highly fluent consistency of the mortar portion of the concrete mixture and by applying the seal coat shortly after the slab is struck off, the downward drainage of free water from the slab will be checked before the subgrade becomes wetted to any considerable degree.

Upon the application of the seal coat, the factor of time, in carrying out the present method, comes into prominence. As noted, the seal coat will retain the highly fluent consistency of the mortar portion of the concrete mixture to foster rapid sedimentation, and the slab is now subjected to a period of rest from external manipulation lasting from fifteen to twenty minutes or, at the least, until sufficient of the free water has been forced upward by the sedimentation of the coarse aggregate to thoroughly saturate the seal coat, during which time the seal coat remains effective and sedimentation of the detrital content of the mixture proceeds naturally and undisturbed. As the coarse aggregate settles or gravitates downwardly, free water will be displaced and forced upwardly, due to the pressure of the heavier fluent mixture of cement and sand, to the top surface of the slab, the rising water carrying with it any air entrapped at the lower sides of said

aggregate as well as air entrapped between the aggregate. At the same time, the finer particles of the fine aggregate along with saturated particles of cement will infiltrate the small voids in the mortar from which the water and air have been forced toward the surface and also infiltrate the crevices and interstices between the coarse aggregate to form a uniformly dense and compact mass characteristically free of voids or cellular structure. Furthermore, it is to be noted that by sealing the slab and thus retaining therein the excess of water, all particles of the cement will be thoroughly permeated with moisture while also the usual air envelop which surrounds each particle will be penetrated by the permeating moisture and expelled with the free water forced to the top surface of the slab by the gravitating aggregate. Thorough and complete saturation of the cement is thus obtained to produce maximum strength in the finished concrete and, at the same time, the density of the slab is greatly increased by the elimination of the greater portion of air.

During the initial rest period, following the application of the seal coat, the physical structure of the concrete slab has been transformed from an excessively wet, open porous mass that could not support its own weight without a form, into a comparatively dry, dense, compact pavement supporting workmen walking on it freely during subsequent surface manipulations, all accomplished in a few minutes and by natural forces operating entirely unaided by external forces. The density of the slab secured during this period of rest and due to the sedimentation of the detritus, has reduced its capacity for capillary water, converting by the amount of this reduction, a portion of the capillary water into free or gravitational water. A portion of this converted water has also been forced to the surface of the slab by continued sedimentation, where it is mingled in a reduced size of particles with the surface materials. Water so finely divided is not influenced by the attraction of gravitation, but as water has an attraction for water, these small bits of water may by floating be brought together and blended into large drops, in which condition they may be removed by gravitational drainage over the surface of the slab, by subsequent manipulations.

After the completion of the initial sedimentary period of rest, the remaining steps of the method, with the exception of straight-edging and checking for riding quality, are directed to increasing the density and compactness of the slab by removing therefrom as much of the intersticial and capillary water as possible, reducing its volume (the water content of the slab) to the ratio of approximately five or five and one-half gallons per sack of cement, and providing maximum strength and impermeability in the finished concrete. Upon the saturation of the seal coat, the seal formed thereby at the top surface of the slab is rendered inoperative so that remaining gravitational water may freely drain from the slab into the absorptive subgrade and it is for the purpose of more certainly absorbing this portion of the excess water originally introduced in the cement mixture and initially held in the slab by the seal coat, that the subgrade is, if necessary, treated as previously pointed out, to readily absorb approximately two gallons of water per square yard. Thus, the subgrade will, at the desired stage of the method, absorb a large proportion of the free water liberated from the slab.

Following the initial sedimentary period of rest and the complete saturation of the seal coat with consequent liberation of the remaining gravitational water to find its way into the absorptive subgrade, the top surface of the slab is gently floated with a smooth float for the purpose of stirring up the materials of the seal coat and incorporating them with the surface materials of the slab proper, freely releasing at the surface of the slab the water forced upwardly by the settling of the detritus. This initial floating will greatly facilitate the removal of the free water from the surface of the slab and promote evaporation. As stated, a smooth float is used and care is taken to avoid vibration of the slab. By floating the top surface of the slab gently, the seal coat may be thoroughly incorporated with the surface material of the slab without vibrating the slab internally and causing the formation of stress columns and arches therein.

The slab is now straight-edged to check the surface and correct any irregularities, after which the slab is belted to remove free water and tumble the surface material to encourage evaporation and capillary action.

Following the belting operation, the slab is again rested to provide a second undisturbed sedimentary period. This second sedimentary period is preferably somewhat longer than the first, previously described, and will last approximately from fifteen to thirty minutes, or until the water sheen disappears by evaporation from the surface of the slab. The exact time will depend largely upon humidity, air currents and other weather conditions. During this period, the sedimentation of the detrital content of the concrete mixture will continue though at a reduced rate, owing to the partial depletion of the gravitational water.

Following the second sedimentary period of rest, previously described, the top surface of the slab is again floated and belted, after which, should it appear necessary, the slab is again subjected to another undisturbed sedimentary period of rest lasting say from fifteen minutes to one-half hour. This alternate resting of the slab and floating thereof or belting or both belting and floating is continued as above outlined until the surface mortar of the slab attains a consistency such that the float marks therein cease to disappear. The slab is then finally belted or broomed or both belted and broomed as may appear expedient. Figure 3 of the drawing shows the finished pavement slab. As will be observed, the seal coat has been incorporated into the surface material of the slab while also, the thickness of the slab, as compared with its original thickness, has been reduced, due to elimination of water and air as well as the compaction of the aggregates and cement by the settling thereof. In the finished pavement, the physical characteristics of the slab are substantially uniform throughout the slab. Curing of the slab may be accomplished in any generally accepted manner, preferably by alternate wetting and drying. Conventional practice may be followed in the placing of appropriate expansion and contraction joints.

Having thus described the invention, what we claim is:

1. The method of laying a concrete pavement or the like which includes the steps of preparing a highly fluent cementitious mixture containing an abundant excess of water sufficient to afford rapid sedimentation of the detrital con-

tent of the mixture when the mixture is placed in situ, placing the mixture to form a slab, quickly thereafter covering the slab with a dry granular water-repellent seal coat substantially free of uncombined lime and containing a finely comminuted ingredient sealing the slab against the intake of air at the top and thereby suspending the excess of water in the slab and preserving the highly fluent character of the mixture to provide a prolonged period of rapid sedimentation of the detrital content of the mixture within the slab after the mixture is placed, resting the sealed slab undisturbed for a period of time while the detrital content of the mixture settles and compacts within the slab, and gently floating the top surface of the slab to break up the seal coat and mix the seal coat with the surface material of the slab without disrupting the internal structure of the slab.

2. The method of laying a concrete pavement or the like which includes the steps of preparing a highly fluent cementitious mixture containing an abundant excess of water sufficient to afford rapid sedimentation of the detrital content of the mixture when the mixture is placed in situ, placing the mixture to form a slab, quickly thereafter covering the slab with a dry granular water-repellent seal coat substantially free of uncombined lime and containing a finely comminuted ingredient sealing the slab against the intake of air at the top and thereby suspending the excess of water in the slab and preserving the highly fluent character of the mixture to provide a prolonged period of rapid sedimentation of the detrital content of the mixture within the slab after the mixture is placed, and alternately resting the sealed slab for a period of time while the detrital content of the mixture settles and compacts within the slab and gently floating the top surface of the slab to break up the seal coat and mix the seal coat with the surface material of the slab without disrupting the internal structure of the slab.

3. The method of laying a concrete pavement or the like which includes the steps of preparing a subgrade of at least a given absorptive capacity sufficient to take up a predetermined proportion of excess water from a cementitious slab, preparing a highly fluent cementitious mixture containing an abundant excess of water sufficient to afford rapid sedimentation of the detrital content of the mixture when the mixture is placed in situ, placing the mixture on the prepared subgrade to form a slab, and quickly thereafter covering the slab with a dry granular water-repellent seal coat substantially free of uncombined lime and containing a finely comminuted ingredient sealing the slab against the intake of air at the top and thereby suspending the excess of water in the slab and preserving the highly fluent character of the mixture to provide a prolonged period of rapid sedimentation of the detrital content of the mixture within the slab before the excess of water is released for gravitation into the subgrade to be taken up thereby.

4. The method of laying a concrete pavement or the like which includes the steps of preparing a subgrade of at least a given absorptive capacity, depositing a highly fluent cementitious mixture upon the subgrade to form a slab, and quickly thereafter covering the slab with a dry granular water-repellent but slowly absorbent seal coat substantially free of uncombined lime and containing a finely comminuted ingredient sealing the slab against the intake of air at the top and thereby suspending the liquid content of the mixture within the slab and preserving the highly fluent character of the mixture for a time until the seal coat is wetted and the liquid content of the mixture is thereby released for gravitation into the subgrade to be taken up thereby.

TELEMACHUS H. JOHNSON.
MILBURN D. JOHNSON.