STONE ASPHALT ROAD AND METHOD OF PREPARING AND LAYING THE SAME

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My invention relates to bituminous road surfacing materials or compounds and to the manufacture thereof, the said materials being of such character that they can be mixed at the quarry where the stone originates or where the aggregate originates, and can be shipped in railroad cars, or trucks over the highways, and can be laid at the temperature of the air without any further preparation, or may be held in storage to be employed at any future time without further preparation. In accordance with the invention the stone or other aggregate is dried and cleaned and prepared for the storing or absorption of a solvent therein before the aggregate comes into contact with the bitumen which is to be used as a binder. This drying and cleaning is done without substantially heating the stone or aggregate and thereafter the solvent is added. After the solvent has been absorbed by the stone, the latter is mixed with the bitumen. The solvent contained in the stone is then slowly absorbed by the cold bitumen which is by this means maintained in a plastic condition. The thorough drying of the stone by my process gives me ample capacity of storing the amount of solvent required to handle the material at the temperature of the air, and the reabsorption of the solvent from the stone into the bitumen extends over a period of many days or even weeks. The material manufactured by this method can thus be shipped long distances and successfully unloaded and laid in place at the temperature of the air. I have in actual practice shipped the material hundreds of miles, taking 10 days or more in transit, and have experienced no trouble in unloading or laying. The materials permit the road surface to be produced with any finish or texture desired for non-skid surfaces.

In view of the foregoing, it will be understood that one of the principal objects of the invention is to provide a road of improved character.

Another object of the invention is to provide a method of road laying whereby my improved road may be constructed.

Still another object of the invention is to provide a slow setting bituminous stock material for road making or surfacing which material is adapted to be transported and laid at atmospheric temperatures and without any preliminary heating.

A further important object of the invention is to provide an improved method for mixing or manufacturing the improved road surfacing material.

Further objects of my invention will be apparent from the following specification and claims.

In the accompanying drawings, I have shown a road constructed in accordance with my invention, and I have also shown diagrammatically an apparatus whereby my improved method may be carried on. It is to be understood, however, that the drawings are for illustrative purposes only and are not to be construed as defining or limiting the scope of the invention, the claims forming a part of this specification being relied upon for that purpose.

Of the drawings:

Fig. 1 is a transverse sectional view showing the laying of the first course of material to form a road embodying the invention.

Fig. 2 is a view similar to Fig. 1, but showing the laying of the second course of material.

Fig. 3 is a transverse sectional view showing the completed road embodying the invention.

Fig. 4 is an enlarged fragmentary sectional view showing the relation between the stones of the second or wearing course of material and the third or sealing course.

Fig. 5 is a diagrammatic view of an apparatus whereby my improved method of mixing the materials may be carried on.

I preferably and ordinarily prepare my improved road surfacing material in three grades with three different sizes of stone or aggregate, these grades being used respectively for three separate courses in the construction of the road. There are two different sizes of stone for the first two courses, and a coarse sand is used for the third or sealing course.

For the first course I preferably use run of crusher stone which has been screened through a one and one-half inch screen, that is a screen having circular openings one and one-half inches in diameter, and which has been retained in a three-quarter inch screen, that is, a screen with circular
openings three-quarters of an inch in diameter. It is important to select a grade of stone that fractures in cubes or similar shapes and not in flat thin wafers. For the second course I preferably use all sizes that pass through a three-quarter inch screen, and which are retained on a one-quarter inch screen. For the top or sealing course, I use good sharp river or concrete sand which will pass a one-quarter inch screen.

While I do not limit myself to the exact sizes specified, I nevertheless consider it very important that the size limits be properly related. It will be noted that the upper size limit for the first course is twice that for the second course, and approximately this ratio should be maintained, even though the sizes themselves be changed. It will further be observed that the lower size limit for the first course is the same as the upper limit for the second course, and that the lower limit for the second course is the same as the upper limit for the third course.

All of the three grades of material used in my pavement are separately mixed with a bitumen, preferably in accordance with the method to be described, and are then placed on the foundation in three separate courses. As shown in Fig. 1, the base course 12 is placed on the roadway first, about two and one-quarter inches of loose material ordinarily being used, and the material is then rolled or compacted to about one and one-half inches in thickness when thoroughly compacted. The quantity of binder in the first course is such as to avoid any excess thereof.

As shown in Fig. 2, I lay on the base the second course 12 or wearing course 13, which is raked uniformly over the said base course. About one inch of loose material is ordinarily applied which is then compressed to about one-half inch in thickness making a total depth of the material of about two inches. The quantity of binder in the second or wearing course is such that after compacting the stones will project.

The thicknesses of the two main courses, while preferably approximately as given, may vary widely according to circumstances, and somewhat thicker courses are shown in the drawings. The showing of the road roller is entirely diagrammatic and not to scale. Where the pavement is to be laid in city streets the size of the stones in the wearing surface can be changed to a maximum size of five-eighths inch, caught on one-quarter inch screen. When the pavement is to be laid thicker than two inches, the size of the stones in the base course can be correspondingly increased.

I place the third or sealing course 14 on the wearing course, to form the complete pavement as shown in Fig. 3. The quantity of binder in the material for the sealing course is such that the material is granular in character and can be easily spread. A small amount is placed on the surface of the wearing course and then is raked or hoed, with the edge of a board or a back of a rake, over the wearing surface, so that none of the sealing or third course projects above the highest pieces of aggregate in the second course. This is clearly shown in Fig. 4.

When the third or sealing course 14 has been distributed in this manner, the road is opened to traffic without any rolling of the third course. The wheels of the traffic compress the third or sealing course tightly between the small pieces of aggregate of the wearing course and seal the roadway tightly together, making the same waterproof. In this way the road is sealed without covering up the grain or texture produced by the second course, and the second or wearing course is left exposed in its best non-skid condition. Thus by my novel method of sealing and water-proofing the road, I have added a sealing coat without destroying the non-skid surface of the wearing course.

In all asphaltic concrete mixtures or sheet asphalt mixtures, the sand is carefully graded and a certain definite amount of fines passing a two hundred mesh screen are absolutely essential for the proper mixture. In my process I purposely keep the fines out of the first and second course material—having no material finer than three-quarter inch in the base course and no material finer than one-quarter inch in the wearing surface. It will be seen that my improved road composition is not an asphalt concrete nor a sheet asphalt nor a bituminous macadam, being radically different from all of these. It includes only stones or other pieces of aggregate of selected and restricted sizes and is entirely free from fines.

A road constructed in accordance with my invention is rigid and stable to an unusual degree. This is due in large part to the fact that each of the two main courses comprises stones of a considerable size range without, however, including the small fines and chips. The stones in each layer intermingle and pack when coated with a heavy coat of bitumen and when properly rolled or compressed together. Thus I have proper stability for supporting the wheels of traffic without the aid of a hard bitumen cement. The road is also wave proof and roll proof. A characteristic not obtained in any other type of pavement, where all the voids are not completely filled with smaller sizes of aggregate and bitumen. Although my pavement contains a plastic cement, it will not sweat in hot weather or crack in cold weather. Temperature changes do not affect it.
A further advantage of my improved road construction is that the peculiar surface provided entirely eliminates the humming or singing noise that frequently occurs with some types of tires.

I do not necessarily limit myself to all three courses, as under some circumstances one or even two of them may be omitted. For example, I find in actual practice where the road to be surfaced is of the rigid type, such as concrete, etc., that it is necessary to apply only two courses. The wearing surface and sealing course can be used exactly in the manner described above, except that the wearing surface is to be placed one inch thick when compressed. The sealing coat is to be added exactly as described above. In other cases the sealing coat may be entirely omitted.

Before further discussing the advantageous features of my improved pavement, I will further describe the materials or compositions that are preferably used and the method of mixing the same.

Referring to Fig. 5 of the drawings, 1 represents a revolving drum which is adapted to serve as a cleaner and dryer for the crushed rock or other aggregate which is to be used. As illustrated this drum is inclined to enable the material to progress through it. Suitable means, such as a motor 2, is provided for rotating the drum.

An elevating conveyor 3 is provided for delivering the crushed rock or aggregate to the receiving end of the drum. Before being delivered to the conveyor the rock or other aggregate is suitably graded as to size by screens or other devices which are not shown.

From the drum 1 the aggregate is discharged through a chute 4 into a weighing hopper 5. From the weighing hopper the aggregate is discharged into a suitable mixer 6 which may be provided with a steam-jacket 7. From the mixer the material can be discharged into a suitable transporting means, such as a railway car 8.

Air can be supplied to the lower end of the drum 1 by means of a suitable fan 9. For heating the air delivered by the fan, or at least some of the air, I provide a suitable heater which is shown as being an oil burner 10. Preferably I heat only a portion of the air supplied to the fan and I, therefore, provide a funnel 11 through which the heated air is delivered, other air being drawn into the fan around the funnel.

In practicing my improved method, the stone is suitably graded as to size as already stated, and is then delivered by the conveyor 3 into the drum 1. By reason of the rotation of the drum, the aggregate is caused to slowly progress downward through the drum, and on doing so it is acted upon by the air delivered by the fan 9. In practice I have found that a large fan is desirable, and for a drum four feet in diameter I prefer a fan having a capacity of approximately 140,000 cubic feet of air per minute. This large volume of air flowing through the drum in opposition to the movement of the aggregate removes all dust and small particles from the aggregate thus thoroughly cleaning it.

The air is used as a drying medium for the aggregate as well as a cleaning medium therefore, and to facilitate the drying action the air is or may be slightly heated. The heating means for the air has already been described, and it will be understood that the fan serves to draw in a large volume of air directly from the atmosphere, and also serves to draw in a smaller volume of highly heated air through the funnel 11. In ordinary practice I have found that approximately one cubic foot of heated air should be drawn through the funnel for each twenty cubic feet of air drawn directly from the atmosphere. The heated air and the atmospheric air are thoroughly mixed by the fan with the result that the air mixture delivered into the drum is at a temperature only slightly above that of the atmosphere. I prefer to so control the temperature of the air delivered to the drum that the aggregate will not be raised more than six or seven degrees above the atmospheric temperature. I have found that in dry clear summer weather I can eliminate the burner for artificially heating the air, the required drying of the stone being effected by the atmospheric air without heating.

By means of the weighing hopper definite batches of the aggregate of predetermined weight can be delivered to the mixer 6, and from the foregoing description it will be seen that the aggregate thus delivered has been thoroughly cleaned and thoroughly dried without, however, having the temperature thereof raised much above the atmospheric temperature. This avoidance of any substantial increase in the temperature of the aggregate is important for a reason which will presently appear.

As soon as a batch of the aggregate is delivered into the mixer, which in operation, I add to the aggregate a suitable material which is adapted to serve as a solvent for the asphalt or other bitumen which is to be subsequently added. This solvent should be a slowly volatile one such as kerosene or other oil having a flash test, or evaporating temperature, ranging from 120 degrees F. to 150 degrees F. It will be seen that I select a solvent which will not rapidly evaporate at atmospheric temperature, and which, therefore, will not within a reasonable time be caused to evaporate to any appreciable extent by reason of the contact with the aggregate which, as already stated, is at only a few degrees above the
atmospheric temperature. The amount of solvent which is added is carefully predetermined by test so that there will be no excess beyond what can be retained and absorbed by the thoroughly dried and slightly porous surfaces of the stone. I have found that when the stone is thoroughly dried, as described, a considerable amount of solvent can be absorbed thereby, and the operation of the mixer is continued until all of the surfaces of the aggregate are thoroughly saturated with the solvent and until the solvent is completely absorbed.

After the solvent has been absorbed, I then preferably add a substance which serves to thicken and thicken the bitumen. This substance is preferably hydrated lime and I add from one-half to one percent by actual weight. The mixing is continued until a thoroughly homogeneous mass is produced, with the lime uniformly distributed as a surface coating over the pieces of stone or aggregate. I have found by actual practice that either caustic lime or hydrated lime will produce the same results, but, inasmuch as the caustic lime is harder to handle, I prefer to use the hydrated lime.

I then add the required quantity of the bituminous binder which has been previously heated to a temperature of approximately 250 degrees F. or more. Preferably I use from 7/8 to 8% by weight of bitumen for the base course material; 9 to 10% for the wearing course material; and 3/4 to 4% for the sealing course material. The mixing of the bitumen with the aggregate is continued until all pieces of the aggregate have been thoroughly coated. It will be understood that the heating of the bitumen is primarily for the purpose of more easily securing the required uniformity of mixture and the required uniformity of the distribution of the bitumen over the surfaces of the pieces of stone or aggregate. This heating is not for the purpose of facilitating the subsequent laying of the material, as the material is allowed to become cold before being laid.

The steam-jacket may be used for the purpose of maintaining the heat of the bitumen during the final mixing operation, but is not used during the preliminary mixing operations when the solvent and the lime are added. After the mixing with the bitumen has been completed the mixture is then discharged from the mixer into the railway car 8 or other transporting means.

The hydrated lime which I add to the mixture of my material is used to thicken the binder, particularly at the points of contact with the stone. This also increases the thickness of the bitumen on the individual stones of the aggregate, a result that is very beneficial and desirable. The lime, being added before the bitumen is added to the mix, is very uniformly distributed throughout the entire mass.

According to prior practice, there are three methods of establishing a bond between the aggregate and the bitumen: first, the emulsion method in which the bitumen is emulsified with water; second, the heating of both the aggregate and the bitumen to about 275 degrees F.; and third, the cold methods of combining the aggregate and bitumen by thinning the latter with a solvent. In the emulsifying method, the aggregate absorbs a large quantity of the water or, in other words, becomes saturated. As the result of this method a comparatively thin coat of bitumen is left on the aggregate, and the mixture has a very temporary life, with a relatively poor bond between the bitumen and the aggregate. By the hot mix method the heat, which is applied to both the aggregate and the bitumen, is used as a distributing agent to keep the material plastic; and the result is that the material must be placed and compacted in the pavement at a high temperature. By the method wherein the solvent is added to the asphalt as a distributing agent, sufficient solvent must be added to handle the asphalt cold. This results in too thin a coat on each individual stone in the aggregate.

From the foregoing it will be apparent that any improved process differs radically from prior practice in that I neither apply heat to the entire mass to effect distribution nor add a liquefier to effect distribution. I apply heat only to the bitumen, and mix this heated bitumen with cold aggregate in order to obtain a thick coat of bitumen which is chilled in coming into contact with the aggregate. This gives me a thicker coating of asphalt on the individual pieces of aggregate than could be obtained with hot stone. I store the solvent in the stone so that it is not used at all as a coating material or liquefier to aid in coating the stone. The solvent having been stored or absorbed in the aggregate before coating and the asphalt having been chilled when coated on the stone, I have a physical condition of the bitumen that holds the heavy coating on the stone. This bitumen, now being cold and far below the melting point thereof, is slowly attacked by the solvent and, due to the fact that the bitumen and stone are cold, the action of the solvent is retarded and this facilitates the unloading and laying of the material days after the material has been mixed. I find in actual practice that the slow absorbing of the solvent by the bitumen tends to draw the bitumen further into the surface of the stone. Any solvent that is absorbed by the bitumen must be replaced by the bitumen penetrating the pores of the stone occupied by the solvent. This not only retards the
action of the solvent but also increases the bond between the stone and the bitumen.
In case additional heat is needed in the final mixing to produce a uniform coating of the bitumen on the aggregate, the steam-jacket of the mixer is used. By this method the bitumen absorbs the heat first and the minimum amount required is used, so as not to defeat the advantage gained by using the cold aggregate. In this way I get a thorough coating without the use of a liquefer in the bitumen or heat in the aggregate.

Referring again to my improved pavement it will be understood that the base is rolled or compressed first, and that the wearing surface is rolled next. As the material is all laid at the temperature of the air, uniform compression is obtained throughout the entire mass. As admitted by experienced pavement engineers, no road rolling in a short space of time by a mechanical roller having a wide contact with the pavement can roll a pavement material to ultimate compression. With my method of manufacture, advantage is taken of the traffic over the road to compact the road and bring it to ultimate compression, as the material is in its original cold and plastic condition so that it can benefit by the compression of traffic.

As to some of its subject matter this application constitutes a continuation in part of my co-pending application for road surfacing material and method of manufacturing and laying, Serial No. 11,367, filed February 24, 1926.

What I claim is:

1. The method of forming a roadway, which consists in adding to a stone aggregate a slowly volatile bitumen solvent which is stored therein, the quantity of such solvent being limited to that which can be absorbed by the surfaces of the stones, mixing with the aggregate bitumen in sufficient quantity to completely coat the stones thereof, laying the mixture on the roadbed to form a wearing surface, and compacting the said mixture upon the roadbed.

2. The method of forming a roadway, which consists in adding to a stone aggregate a slowly volatile bitumen solvent which is stored therein, the quantity of such solvent being limited to that which can be absorbed by the surfaces of the stones, maintaining the aggregate at approximately atmospheric temperature, mixing with the aggregate heated bitumen in sufficient quantity to completely coat the stones thereof, laying the mixture on the roadbed to form a wearing surface, and compacting the said mixture upon the roadbed.

3. The method of forming a roadway, which consists in adding to a stone aggregate a slowly volatile bitumen solvent, such as kerosene, the quantity of such solvent being limited to that which can be absorbed by the surfaces of the stones, adding a quantity of lime to the aggregate and distributing it as a coating over the surfaces of the stones, or mixing with the aggregate bitumen in sufficient quantity to completely coat the stones thereof, laying the mixture on the roadbed to form a wearing surface, and compacting the said mixture upon the roadbed.

4. The method of forming a roadway, which consists in adding to separate stone and sand aggregate a slowly volatile bitumen solvent which is limited in quantity to that which can be absorbed by the surfaces of the stones and of the sand particles, mixing bitumen with the respective aggregate to completely cover the stones and particles thereof, laying the stone mixture on the roadbed and compacting it to form a wearing surface, and sealing the wearing surface by partly filling the recesses therein with the sand mixture and without forming a coating on the top of the wearing surface.

5. The method of mixing a bituminous paving composition consisting of applying a bitumen solvent to the surfaces of pieces of stone constituting an aggregate, which solvent is limited in quantity to that which can be absorbed by the surfaces of the stones, adding a coating of lime to the surfaces of the pieces of stone, and subsequently adding a bitumen to the aggregate.

6. The method of mixing a bituminous paving composition consisting of applying a bitumen solvent to the surfaces of pieces of stone constituting an aggregate, the said aggregate being at approximately atmospheric temperature and the said solvent being limited in quantity to that which can be absorbed by the surfaces of the stones, adding a coating of lime to the surfaces of the pieces of stone, and subsequently adding heated melted bitumen to the aggregate which is maintained at or near the said atmospheric temperature until engaged by the bitumen.

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