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BITUMINOUS PAVING METHOD

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1 Claim. (Cl. 94—23)

This invention relates to bituminous paving compositions and methods of making such compositions and producing pavements therefrom. It relates more particularly to and is an improvement upon paving compositions and methods of the cold type as distinguished from hot mix compositions and methods.

In an operation of the cold mix type avoidance of the necessity for heating the binder is accomplished by utilizing two binder components, one a bituminous flux oil and the other a powdered asphalt, which components become amalgamated in the binder for the finished pavement so as to provide the desired toughness and hardness under service conditions in the finished pavement. When the flux oil is mixed with the particles of the paving aggregate it coats the surfaces of the particles with films of the flux oil and when the powdered asphalt is incorporated it adheres to the flux oil films coated on the aggregate particles as a dust. Sometimes in cold weather the bituminous flux oil may be warmed somewhat so that it will become distributed more readily over the surfaces of the aggregate particles in the form of relatively uniform coatings or films. When the prevailing atmospheric temperature is such that the rate of amalgamation between the flux oil and powdered asphalt is excessively slow at such temperature, heating to a temperature above atmospheric temperature may be resorted to so as to increase the amalgamation rate. However, even in such cases an operation of this type is referred to as a cold mix operation, as contrasted with the hot mix type of operation.

The capacity of a paving composition of the cold mix type to be stored is due to the fact that whereas the bituminous flux oil and powdered asphalt that are used are adapted to gradually amalgamate with each other, the amalgamation to produce the ultimate binder is greatly accelerated by the consolidation of the paving composition as by the use of a roller or other pressure-applying means after it has been spread upon the prepared foundation. The kneading action of traffic also has an accelerating action on the amalgamation of the flux oil and powdered asphalt. Consequently the bituminous flux oil and powdered asphalt used may be such as to amalgamate slowly prior to laying and then set up to the desired toughness and hardness when the pavement is laid and consolidated and thrown open to traffic.

In an operation of the cold mix type the bituminous flux oil may be quite fluid but in any case it is insufficiently viscous to become a solid at an atmospheric temperature of about 30° F. and in the usual case has a Saybolt furol viscosity under 1200 seconds at 122° F. The powdered asphalt is a hard refined asphalt that is sufficiently brittle to be reduced to a powder at atmospheric temperatures up to 115° in an ordinary impact mill and in the usual case has a softening point (as measured by the Standard Ball and Ring Method ASTM Designation D36–26) of about 200° to about 300° F. and a penetration (as measured by the test for penetration of Bituminous Materials ASTM Designation D5–52) of not

over 10 at 115° F. in 5 seconds using a 100 gram load. In addition to the above, which is concerned primarily with the physical properties that are desirable in the case of the flux oil for coating the surfaces of the aggregate particles and in the case of the powdered asphalt for production in the powdered form in which it adheres as a dust to the flux oil coatings for the aggregate particles, these binder components likewise must be capable of eventual amalgamation for producing the type of binder required in the pavement. Moreover, the rate at which the amalgamation takes place also is important from the standpoint of storage time, shipping conditions and the length of the time interval after laying that is required before the pavement can safely be thrown open to traffic.

Further information as to the nature of bituminous flux oils and powdered asphalts used in the cold paving process is contained in the Ebberts Patents No. 1,937,749 issued December 5, 1933, and No. 2,067,264, issued January 12, 1937, which are particularly concerned with formulation practice whereby the amalgamation rate may be both assured and controlled.

While the ability to control the amalgamation rate by the judicious selection of the flux oil and powdered asphalt employed is important, there are other problems that are incapable of solution in this way. Thus because of present-day heavy traffic conditions, one of the most important considerations is that the pavement be such that it can be opened to traffic as soon as possible after it has been laid. Hot mix paving compositions have this advantage. It is also possible to attain this advantage using the cold method provided the flux oil and powdered asphalt employed are such that they are adapted to amalgamate and set up rapidly during consolidation of the pavement when it is laid and as the result of the kneading action of the traffic initially encountered. However, if a fast setting binder combination is employed, one in large measure loses the valued feature incident to the use of cold process paving compositions, namely, that of being capable of storage and shipment in ready-to-lay condition. Cold process paving compositions are frequently stored in large piles, or shipped long distances by rail in 40- to 50-ton lots. In either case there is sufficient pressure, particularly at the bottom of the pile or the car load, to cause the paving composition to harden up sufficiently to become unworkable. For example, while, from the point of view of being able to throw a newly laid pavement open to traffic as soon as possible, it would be desirable to employ a flux oil containing about equal parts by weight of straight run residue and cracking coil residue, it becomes necessary when better storage and shipping characteristics are required to use a flux oil containing about 75% by weight of straight run residue and about 25% by weight of cracking still residue, but in such case substantial sacrifice has to be made as regards the rapidity with which sufficient amalgamation can be realized so that the pavement can be thrown open to traffic.

It is an object of this invention to provide a paving method and composition whereby the foregoing difficulties and drawbacks may be overcome that have been incident to the practice of the cold process for making pavements. Thus it is an object of this invention to provide a paving composition and method whereby using a single pair of flux oil and powdered asphalt binder components one can obtain not only good storage and shipping characteristics but also rapid amalgamation upon laying and consolidating the pavement. Moreover, in the practice of this invention it is possible to vary the amalgamation rate both prior to and after consolidation when using the same pair of flux oil and powdered asphalt binder components.

According to this invention, the foregoing objectives have been attained by the controlled use of water while the paving aggregate is in a friable condition with the aggregate particles coated with the flux oil. The addition of a small amount of water has a retarding effect on the rate of amalgamation of the flux oil with the powdered bitumen. By incorporating water in the paving composition while it is in the friable condition, its capacity for storage and shipment without premature set up can be improved, and by subsequently removing the water prior to consolidation of the composition at the time the pavement is being produced the advantage of a quick setting mix likewise can be had. Moreover, by varying the amount of water the amalgamation rate can be varied.

In preferred practice of this invention the aggregate particles are first coated with the films of flux oil, and water is then incorporated in the mix. The powdered asphalt is added and mixed in right after the incorporation of water. The resulting paving composition is such that it can be stored or shipped. Whenever desired, the composition can be spread out where it is to be laid while it is still in a friable condition to form a course or layer that is relatively open and when this has been done the water evaporates, thereby restoring the amalgamation rate to that of the flux oil and powdered asphalt in the absence of water so that the composition will have a rapid setting up time if the flux oil and powdered asphalt combination initially employed was of this character. In preferred practice of this invention a flux oil and powdered asphalt are used that have such compatibility as to have a relatively rapid amalgamation rate and then by the controlled presence of water in the composition retard the amalgamation to the extent desired during shipment and storage and, if desired, during laying. In this way it is possible when using but one grade of flux oil and one grade of powdered asphalt, to provide a paving composition that is adaptable for use under different conditions and for any and all purposes.

The practice of this invention may be exemplified in connection with a typical paving composition containing in percentages by weight 30% of ¼" stone, 55% of fine sand, 7% of filler dust, 4.8% of flux oil and 3.2% of powdered asphalt. The flux oil is a blend of about equal parts of straight run residue and cracking still residue having a Saybolt furol viscosity of about 600 seconds at 122° F. The powdered asphalt is a similar blend of about 260° F. softening point. The flux oil and powdered asphalt above referred to are illustrative of a combination that exhibits a relatively rapid rate of amalgamation in the absence of water so as to be adapted to set up rapidly upon laying and consolidating a pavement.

The rapidity with which a given combination of bituminous flux oil and powdered asphalt will amalgamate with each other so as to affect the rate of setting up of a paving composition can be determined with reasonable dependability by heating a mixture of the two to about 300° F. to 325° F. in such proportions that the resulting blend after amalgamation has a penetration of 70 at 77° F. (as determined by the above-identified penetration test) and then determining the ductility of the amalgamated blend at 77° F. by the ordinary ductility test (ASTM Designation D113–44). When reference is made herein or in the claims to the penetration or ductility of an amalgamated blend of bituminous flux oil and powdered asphalt a blend obtained by amalgamation at elevated temperatures, as aforesaid, is intended and when reference is made herein to a 70 penetration amalgamated blend the penetration of the blend at 77° F. is intended. A higher value for the ductility of a 70 penetration amalgamated blend is indicative of a higher amalgamation rate.

This invention is of especial utility and value when the ductility of a 70 penetration amalgamated blend of the bituminous flux oil and powdered asphalt comprised in the paving composition is at least 60 cms. at 77° F. and it is still more desirable that the bituminous flux oil and powdered asphalt used be such that a 70 penetration blend thereof has a ductility at 77° F. of at least 75 cms. When the bituminous flux oil and powdered asphalt are such that the ductility of a 70 penetration amalgamated blend is of the order aforesaid, the combination is a rapid setting one; and such a combination has the advantage of being such that a paving composition which uses it may be thrown open to traffic promptly after it has been consolidated in place. Moreover, the higher ductility and amalgamation rate is due to a greater intersolubility of the binder component that affords finished pavements which are tougher and longer lasting. According to this invention, the better storage and shipping characteristics, that heretofore have been obtained by using a bituminous flux oil and powdered asphalt combination having a much slower amalgamation rate, are afforded by incorporation of a small amount of water, as aforesaid; and then by drying the mass of paving composition prior to its consolidation in place as a pavement the advantages of a rapid setting combination of a bituminous flux oil and powdered asphalt are obtained upon consolidation of the paving composition in place as a pavement. When the ductility at 77° F. of an amalgamated blend of bituminous flux oil and powdered asphalt used in a paving composition is under 30 cms., the paving composition is slow setting and while its capacity to be shipped and stored without setting up excessively is usually adequate, its properties in this regard may be improved according to this invention. As the ductility of a 70 penetration blend of bituminous flux oil and powdered asphalt is increased above 30 cms. the matter of poor shipping and storage qualities becomes of increased seriousness. However, by the employment of the small amount of water and by removing the water just prior to consolidation of the pavement in place according to this invention, good storage and shipping qualities are obtained while also obtaining the desirable attributes of a rapid set-up after laying and consolidation and capacity to form a tough and long-lasting pavement.

Typical and preferred steps in mixing the composition according to this invention consist in first placing the stone aggregate in a pug mill or similar mixing means; the stone, sand and filler being added in any sequence and mixed together. The flux oil is added, and the mixing is continued until the surfaces of the aggregate particles are thoroughly coated with films of the flux oil. Water is then added by spraying it into the mixer while it is in operation, the amount of the added water being about 1% of the dry weight of the entire batch. After mixing for about 15 seconds the powdered asphalt is added and the mixing is continued for about 15 to 30 seconds so as to distribute it throughout the mix. The mixing of the batch having thus been completed, the batch is discharged from the mixer.

The paving composition after having been prepared as above described may be stored in large piles or shipped in freight cars, for excessive setting up of the flux oil and powdered asphalt is prevented due to the retarding action of the water which remains in the composition for a long period of time under such conditions. However, when the composition is spread out while still in a friable condition in the form of a relatively thin course appropriate for a pavement, the small amount of added water contained in the paving composition evaporates and the composition can be rolled, pressed or otherwise consolidated in place to produce a pavement having the advantage of a rapid setting up time for the flux oil and powdered asphalt components of the binder.

The amount of water that is added will depend partly upon the storage qualities desired and partly upon the nature of the aggregate that is employed. Thus in the case of the foregoing example, if it is desired to have the storage properties of the mixed paving composition further extended the amount of water could be increased

to about 1.5% by weight of the dry paving composition. On the other hand, if the amount of water were to be reduced to only about 0.5% by weight of the dry paving composition, the amalgamation rate or setting time would be only slightly retarded.

As regards the effect of the nature of the aggregate on the amount of water that is used, the finer aggregates have a larger superficial area to be moistened and consequently require a larger quantity of water. Thus, by way of further example, if the mixture consists of 80% of fine sand, 10% of filler, 6% of flux oil and 4% of powdered asphalt (all by weight), or if 90% of stone screenings were to be employed instead of the sand and filler, then the amount of water for attaining comparable effectiveness is roughly doubled as compared with the example first given.

More generally, if the amount of water is less than about 0.5% by weight of the dry paving composition or approximately one gallon per ton, the amount is too small to have the desired effectiveness. Ordinarily, it is not necessary to employ more than about 1.5% by weight of water or approximately 4 gallons per ton. However, for the finer aggregates it may be desirable to increase the amount of water to 2% or even 3% by weight of the dry paving composition.

The foregoing sequence in the mixing operation is preferred for it assures thorough coating of the aggregate particles with the flux oil and the water exercises its effectiveness to maximum degree in retarding the amalgamation of the flux oil and powered asphalt. Different aggregates differ as regards their relative affinity for water and for a flux oil. If the aggregate is characterized by being hydrophobic so that it has a preferential affinity for the flux oil as compared with water, the flux oil will tend to displace the water from the surfaces of the aggregate particles if the water is added first. If, on the other hand, the aggregate is hydrophilic and has a preferential affinity for water as compared with the flux oil, then it is necessary that the aggregate be dry when the flux oil is mixed with the aggregate particles for otherwise the moisture will prevent bonding of the flux oil with the surfaces of the aggregate particles. When, however, the flux oil is mixed with such a hydrophilic aggregate so as to thoroughly coat the surfaces thereof prior to adding the water, the surfaces of the aggregate particles in effect are water-proofed and one may subsequently incorporate water in the practice of this invention without any adverse effects. Whether a hydrophilic aggregate is used in this way or whether a hydrophobic aggregate is used

from which moisture has been displaced by the flux oil, the resulting condition is essentially the same, i. e., paving aggregate particles whose surfaces are coated with flux oil films have water distributed among them. Moreover, either type of operation is regarded as comprising the steps of coating the surfaces of the aggregate particles with flux oil films and distributing water among the coated particles. However, in normal preferred practice of this invention the aggregate while dry is coated with the flux oil.

While it is preferable to add the powdered asphalt after the water has been incorporated due to the fact that the effectiveness of the water is greatest under such conditions, the presence of the water also has a substantial retarding effect on the amalgamation of the flux oil and powdered asphalt if the water is added after the powdered asphalt has been distributed among the aggregate particles that previously have been coated with films of the flux oil.

I claim:

A method of making a bituminous pavement wherein paving aggregate particles are coated and bonded together with an amalgamated blend of bituminous flux oil and powdered asphalt, the ductility of an amalgamated blend of said flux oil and said powdered asphalt having a penetration of 70 at 77° F. being at least 30 cms. at 77° F., which comprises mixing a mass of paving aggregate particles with said bituminous flux oil to coat the surfaces of said particles with said flux oil, mixing the resulting coated particles with water in the amount of about 0.5% to about 3% by weight of the dry aggregate mass to form a water film over the coated aggregate particles, mixing powdered asphalt with the coated aggregate particles to overlie the water film, laying the so prepared mass on a prepared road bed, drying the mass by evaporation of said water and consolidating the mass in place on said roadbed as a finished pavement with amalgamation of said bituminous flux oil and said powdered asphalt as an amalgamated blend bonding said aggregate particles.

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