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Cramwinckel et al.

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[54] **METHOD OF LAYING WIDE ASPHALTIC OPEN MESH REINFORCED STRIPS**

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[51] **Int. Cl.** **E02b 3/12,** E01c 23/03

[58] **Field of Search** 61/63, 7, 37, 38; 156/575; 404/77

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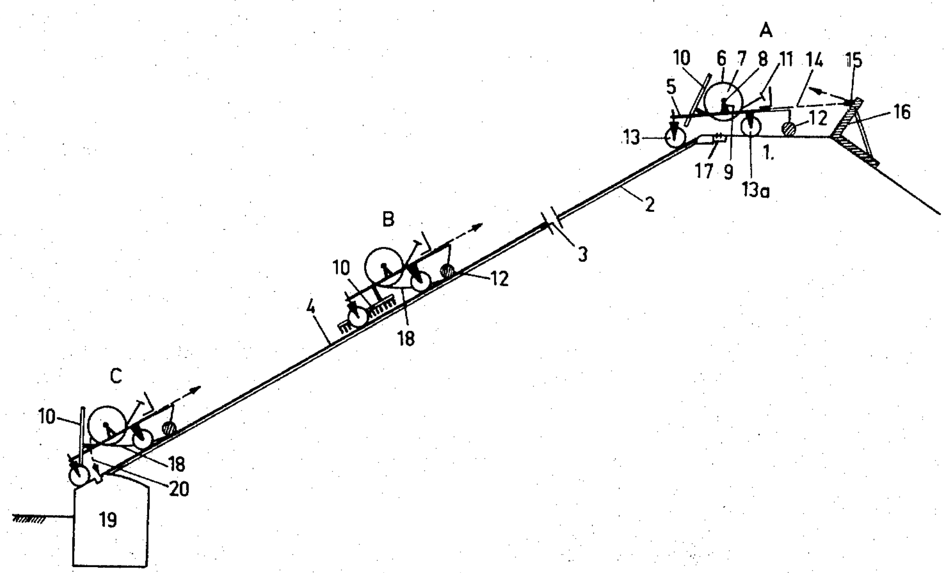
Primary Examiner—Jacob Shapiro

[57] **ABSTRACT**

A water retaining earth surface is lined with a reinforced layer of asphalt in which a unilaterally externally reinforced wide strip of asphaltic mastic wound onto a reel is unwound onto the surface to be lined in such a way that the reinforced surface faces earth surface.

12 Claims, 1 Drawing Figure



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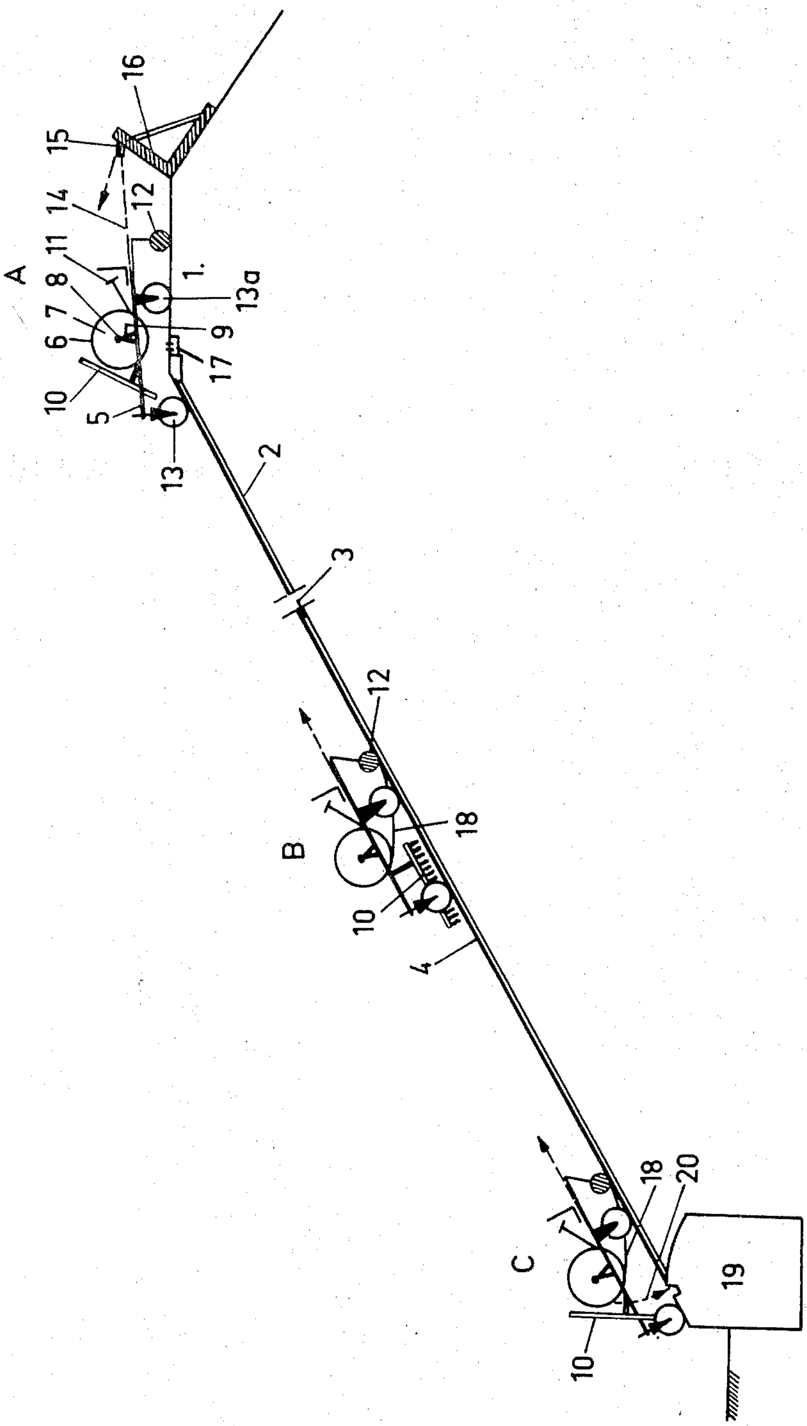

METHOD OF LAYING WIDE ASPHALTIC OPEN MESH REINFORCED STRIPS

The invention relates to a method of sealing a water-retaining layer by means of a reinforced layer of asphalt.

In this Application by asphalt is understood a ready-made mixture containing bitumen and mineral matter.

By asphaltic mastic is understood an asphaltic composition which contains more asphaltic bitumen than corresponds with the volume of the voids in between the mineral matter.

By bitumen is understood a bitumen derived from a mineral oil and mixtures thereof with bitumen derived from coal-tar. In this Application mineral matter is understood to comprise broken stone, gravel, sand and filler. Broken stone and gravel have a particle size greater than that of sand, and filler has a particle size smaller than that of sand. By sand is understood mineral matter which is retained on a 0.075 sieve but passes a 2.4 sieve. The sieves are Netherlands standard sieves as defined in N480 and N574 (Netherlands Standards). Sand according to the "Specifications laid down by Rijkswaterstaat (State Water Authority) for building materials in Road Construction, 1957" may itself also contain minor quantities of material which does not comply with the said sieve specifications. The term "sand" in the Application should also be understood to have this meaning.

Asphaltic mastic is a mass which is easy to apply in hot condition on a surface by spreading or pouring. Asphaltic mastic is a mass which is permanently water-impermeable and is therefore particularly suitable for lining bottoms of water reservoirs and slopes.

Asphaltic mastic is of course also excellently suitable for permanently impermeabilising the water-retaining side of weirs, but has never been used for this purpose since a lining large surfaces of weirs with mastic by spreading, as is done, for example, in lining small sloping surfaces, so much man-power is required that his procedure is not feasible. Applicants have now sought for a new technique to apply asphaltic mastic on a slope and have found that this can very suitably be done by laying ready-made wide strips of asphaltic mastic which are unilaterally externally reinforced on the relevant slope side-by-side in engagement with each other.

The invention therefore relates to a method of impermeabilizing a water-retaining surface with a reinforced layer of asphalt, in which an unilaterally externally reinforced wide strip of asphaltic mastic wound onto a reel is unwound onto the surface to be lined, in such a way that the reinforced side faces this surface.

The invention will be further illustrated below with reference to lining the water-retaining sides of weirs, it being obvious that the method according to the invention is suitable for lining any slope as well as horizontal surfaces.

In the case of slopes, the laying operation can be carried out in such a way that the wound-up unilaterally externally reinforced asphaltic mastic strip wound up onto a reel is unwound on the water-retaining side of the weir in a downward or upward direction.

A wide strip may have a length of, for example, 200 metres, a width of, for example, 2 metres and a thickness of, for example, 2 cm. At a specific weight of 2.15 kg per litre such a wide strip has a weight of 43 kg per square metre. If this wide strip were to be suspended from its reinforcement, the tensile strength required for the reinforcement would then be 8,600 kg per metre. Since a reinforcement can meet this tensile strength and the tensile strength required is considerably lower when the wide strip is laid on a slope and experiences frictional resistance, it follows that the wide strips can be made as long as the length of the slope of the weir.

After a wide strip has been laid, the next wide strip is laid in adjoining arrangement with the strip already applied. The joint between the two adjoining strips can be impermeabilized, for example by pouring or spreading heated asphaltic mastic into the joint, for example from a platform which is drawn along the joint with the aid of suitable means.

When the strips of asphaltic mastic is being unwound from the reel, the radius of curvature of the unwinding part increases to infinity and this transition may result in crack formation in the asphaltic mastic, especially in the case of very rigid and thick layers. A number of measures may be taken to prevent crack formation completely. In the first place it is possible to ensure that the transition of the radius of curvature to infinity occurs gradually by unwinding the roll while it is at a certain distance above the surface of the slope. The unwound strip can then be laid on the slope whilst sagging. Further, the rigidity of the asphaltic mastic layer, the ambient temperature, the reel diameter and unwinding speed can be mutually adapted. The reel diameter is preferably at least one metre and the thickness of the asphaltic mastic layer is preferably not more than 2.5 cm. If it is desired to obtain a reasonable lining speed even in the most unfavourable case of a low ambient temperature of, for example, 7° C and the strip must therefore be unwound at a speed of 2 metres of strip per minute, a reel diameter of 2 metres is chosen with a strip thickness of 2.5 cm. With a smaller strip thickness and a higher ambient temperature it is possible to increase the unwinding speed or to use a reel with a smaller diameter. There is much freedom in the choice of reel diameter, strip thickness and unwinding speed if during the laying operation the unwinding part of the strip, for example the sagging portion, is heated, for example, by an infra-red heater.

If it is desired to protect the water-retaining side of a weir by an asphaltic mastic layer having a thickness in excess of 2.5 cm, two layers of unilaterally externally reinforced strips are then preferably laid one on top of the other, the reinforcement of the upper strip facing the mastic side of the lower strip. The upper layer of strips is then preferably so laid that a joint between two lower strips is covered by an upper strip.

The cold flow of asphaltic mastic is proportional to the square of the layer thickness. If two layers of 2.5 cm each are laid on top of each other, any cold flow which may occur is not that of a 5-cm layer, but that of a 2.5 cm layer because both layers are reinforced. Further, two layers offer the advantage that the reinforcement of the upper layer is enclosed between the asphaltic mastic layers of the upper and lower strips and can never be affected by corrosion. The strength of this reinforcement is therefore permanent.

The asphaltic mastic can be prepared from any suitable bitumen, for example from the type of bitumen used for road construction and for the maintenance of asphaltic roadways. A bitumen of this type is usually of the straight-run type. It is also possible, however, to use blown bitumen and mixtures of straight-run bitumen and blown bitumen. The flow properties of the mastic can be adapted to the climatic conditions.

It should be borne in mind that the temperature of the mastic may rise to 70° C when the portion of the mastic layer which is not covered by water is exposed to direct sun heat. In this connection preference is given to a mastic of which the bitumen has the highest possible softening point compatible with the requirement that it must be possible for the ready-made strip to be unwound from the reel without the rigidity of the mastic layer being an obstacle thereto. A particularly suitable bitumen is obtained when mixing a straight-run bitumen having a penetration of 80–100 dmm at 25° C (80–100 bitumen) with preferably a similar quantity by weight of blown bitumen having a penetration of 40 dmm at 25° C and a softening point — Ring and Ball — of 85° C (85–40 bitumen). A bitumen mixture consisting of straight-run 80–100 bitumen and blown 85/40 bitumen has so far never been used for the preparation of asphaltic mastic. Tests have shown that asphaltic mastic prepared therefrom has sufficient flexibility with respect to winding onto and unwinding from a reel having a diameter of at least one metre, and good viscosity — temperature properties with respect to flow, which is negligible even at 70° C. To improve the viscosity properties use may be made, if desired, of additives, such as asbestos fibres and natural or synthetic rubber, which additives are usually not more than 15 percent by weight, based on the bitumen.

The quantity of bitumen in the mastic may be chosen between 10 and 20 percent by weight.

When choosing the dimensions and nature of the mineral matter incorporated in the mastic allowance is preferably made for the flow requirements and for the requirement that the asphaltic mastic should not be forced away into the dam surface by the water to be retained by the dam. Preference is given to materials the particles of which are irregularly shaped, such as broken stone and sharp sand. For example a mixture of broken sand with a particle size of up to 3 mm, fine natural sand with a particle size of up to 2 mm and filler is chosen. Thus, for example, mastic containing 30–40 percent by weight of broken sand (0/3mm), 15–30 percent by weight of fine sand (up to 2 mm), 18–32 percent by weight of limestone filler and 12–16 percent by weight of bitumen is very suitable. In this case the bitumen used is preferably a mixture of equal parts by weight of 80–100 bitumen and 85/40 bitumen, as described above. If desired, it is also possible to use a different type of bitumen and mineral matter with other dimensions and in other quantities by weight than those mentioned, if this is necessary or allowed, for example in connection with the gradient of the slope to be covered and the climatic conditions.

Closely interwoven strips as described in the Netherlands Pat. application No. 6,707,673 are less suitable as reinforcement, since this results in a unilaterally reinforced asphaltic mastic strip with a substantially flat and smooth reinforcement side. In that case a good adhesion to the dam surface and between the two layers is not very well possible. The reinforcement chosen is therefore preferably a gauze, for example a metal gauze, the meshes of which are so dimensioned that at least the greater portion of the mineral matter can pass through the meshes. Use is therefore made, for example, of a mesh size which exceeds the D 85 of the mineral aggregate (D 85 designates the sieve mesh through which 85 percent by weight of the mineral matter can pass), a mesh size equal to one and a half times the D 85 of the mineral component of the asphaltic mastic being preferred. Since in general no mineral matter with a D 85 greater than 4 mm is chosen for the preparation of mastic, the upper limit of the mesh size is therefore in practice 6 mm at the preferred mesh size of one and a half times the D 85 of the mineral matter.

The reinforcement is adapted to the requirement that it must be capable of transmitting the forces occurring in the strip laying on a slope. A reinforcement consisting of steel-wire gauze is preferred. Steel-wire gauze has elongation properties which correspond to the plastic deformation which may occur in the mastic layer lying on a slope and when the wire thickness is correctly chosen it is sufficiently strong to resist the pulling forces which may occur in strips having a thickness of up to 2.5 cm and a length of up to, for example, 200 metres.

If desired, metal gauze made of galvanized steel wire may be used. It is also possible to employ gauze made of suitable plastic. The strength of the gauze is more important than the corrosion resistance, since in cases where permanent strength is required, the reinformcement is embedded between two mastic layers and is consequently protected against corrosion.

When unilaterally externally reinforced asphaltic mastic strips are prepared and unwound the following procedure may be followed. A concrete floor with a smooth finish, which has a width of, for example, two metres and a length which is adapted to that of the slope to be lined, is completely covered with reinforcement. The floor has upright, for example steel, edges of which the height above floor surface is equal to the thickness of the strip to be prepared, for example, 2 centimetres, and as a rule at most 3 cm. Asphaltic mastic, consisting of bitumen and mineral matter as hereinbefore described and preferably prepared by mixing the components at 160°–190° C, care being taken that no air is occluded during mixing, is poured in hot condition on the floor and on the reinforcement present on the floor. A heated screed is moved over the upright edges of the floor in order to obtain a smooth surface of the mastic layer. After cooling off until the rigidity of the poured layer is sufficient, the strip is wound on to a reel, which is, for example, rotatably suspended in a vehicle which is being moved over the floor. The reel has preferably flanges which are so demensioned that the completely wound-up strip does not exceed the flange height, so that the fully wound reel can be rolled away and stored without its weight pressing on the mastic strip. Before the ready-made strip is wound up it is preferably covered with a plastic film, for example a film of polyethylene or polypropylene. This offers two advantages, i.e., the wound-up strip of asphaltic mastic cannot stick to a previous winding, and after unwinding on the slope, the plastic film may be left in position until a possible second layer of reinforced strips must be laid. After removal of the plastic film this second layer can then be laid on a clean mastic layer.

For unwinding the reel it is rotatable on a horizontal shaft placed on a vehicle which is moved over the surface of the water-retaining side of the dam by means of a winch. The loose end of the strip is attached to the top or foot of the slope by suitable means. While unwinding the reel and moving the vehicle care should preferably be taken that the unwinding strip has such a degree of sagging that the change in the radius of curvature of the unwinding portion of the strip is as gradual as possible. If desired, the unwinding portion may be heated as already described. The unwound strip is preferably pressed onto the dam surface by means of a rolling device which follows the vehicle and is preferably connected therewith.

It is advisable to heat the surface on which the strip is being laid, just before laying. Mastic which has penetrated through the reinforcement adheres more readily to a heated than to a cold lower surface. To this end it is also useful for the lower surface to be coated with a bituminous paint or to be finished with asphalt. The heating source is preferably an infra-red heater which is so attached to the vehicle that the surface, on which the unwinding strip is subsequently laid, is heated.

When laying a second layer of asphaltic mastic strips on a first layer already applied, the surface of the first layer is always heated during the application of the second layer to ensure a good and complete adhesion of the second layer to the first one.

The dam surface is preferably given a flat finish. For this finish preferance is given to an asphalt having a bitumen content at most of 6 percent by weight, a volume of voids of at most 25 percent and a pore structure which precludes the pressing away of the asphaltic mastic. As bitumen component for this asphalt any road construction bitumen is suitable. The finishing course is preferably compacted in a direction normal to the surface, for example by means of a vibratory roller which is moved over the finishing course by means of a winch.

An asphalt suitable for levelling the lower surface is, for example, composed as follows: 90 percent by weight of graded broken 3/15 mm stone, 5 percent by weight of limestone filler and 5 percent by weight of 80–100 bitumen, pore volume 20–25 percent and weight 1.8 kg/dm^3. The lower surface is preferably finished with 75 kg/m^2 of this asphalt, i.e., a layer thickness of about 4 cm.

Weirs are usually made up of irregularly shaped stone blocks. A surface consisting of these stone blocks cannot be levelled economically with the above finishing course. If a dam of this type is not finished and consequently shows this rough surface a blinding layer, for example consisting of 30/100 mm broken stone, is first laid in a quantity of 400 kg/m^2 corresponding to an average blinding layer thickness of about 25 cm. After compacting of the blinding layer the above asphalt can be used for levelling purposes.

An apparatus suitabe for laying wide strips of asphaltic mastic is provided with supports on which a reel with wound-up asphaltic mastic strip can be placed in such a way that the reel is rotatable around a horizontal shaft normal to the travelling direction of the vehicle means for generating radiation heat at the front of the vehicle and a roller at the rear thereof. The vehicle is preferably provided with a steering gear and an infrared heater which can be fed with gaseous hydrocarbons, such as propane.

The drawing shows diagrammatically a preferred embodiment of the vehicle and the laying of a unilaterally externally reinforced wide asphaltic mastic strip on the slope of a dam by means of this vehicle.

Referring to the drawing, **1** is the crest of a dam, **2** is the boundary of the supporting body of the dam, **3** is a blinding layer of broken stone and **4** is a levelling layer consisting of asphalt. The drawing shows three positions of the vehicle, i.e., A, B and C. The chassis of the vehicle is designated by the numeral **5.** A reel **6** with a flange **7** rests with its shaft **8** in supports **9.** The vehicle has an infra-red heater **10** which is at A in the inoperative position and a steering gear **11.** A rolling device **12** is connected to the vehicle. The vehicle which is provided with wheels **13** and **13***a*, is connected to a cable **14** which is wound on a winch (not shown) via a block **15.** The block **15** is mounted on supports **16.** When the vehicle is put into operation the infra-red heater **10** is directed to the surface **4,** the free end of a unilaterally externally reinforced asphaltic mastic strip wound onto the reel **6** is attached to the crest at **17** and the cable **14** is paid out. The vehicle in operation is shown in position B. The unwinding asphaltic mastic strip **18** is laid on the lower surface **4** heated by the infra-red heater **10** and is compacted by the rolling device **12.** In position C the vehicle has arrived at the end of the slope, the infra-red heater is set in the inoperative position and the end of the asphaltic mastic strip is attached to the supporting body **19** (designated by a broken line **20**).

We claim:

1. A method of impermeabilizing a water retaining surface with a unilaterally reinforced asphalt mastic strip which comprises:

a. winding upon a reel, having a diameter of at least one meter, a wide unilaterally reinforced asphalt mastic strip, having a thickness of at the most 2.5 cm., externally reinforced with a guaze the meshes of which are so dimensioned so that the greater portion of the mineral matter contained in said asphalt can pass through the meshes, said mastic comprising mineral matter and a bitumen mixture composed of straight-run bitumen and blown bitumen;

b. unwinding said unilaterally reinforced asphalt mastic strip from said reel onto said surface to be impermeabilized in such a way that the reinforced side of the mastic strip faces said surface, the mastic strip being unwound with the unwinding part sagging freely.

2. A method as claimed in claim **1,** characterized in that the bitumen component consists of equal quantities by weight of straight-run 80/100 bitumen and blown 85/40 bitumen.

3. A method as claimed in claim **1,** characterized in that the bitumen content of the asphaltic mastic is 10–20 percent by weight.

4. A method as claimed in claim **3,** characterized in that the asphaltic mastic used consists of 30–40 percent by weight of broken sand with a particle size of up to 3 mm, 15–30 percent by weight of fine sand having a particle size of up to 2 mm, 18–32 percent by weight of limestone filler and 12–16 percent by weight of bitumen mixture consisting of equal quantities by weight of straight-run 80/100 bitumen and blown 85/40 bitumen.

5. A method as claimed in claim **1,** characterized in that the mesh size of the gauze is equal to 15 times the D **85** of the mineral aggregate of the asphaltic mastic, the D **85** being up to 4 mm.

6. A method as in claim 1, characterized in that the reel is attached to a vehicle which is moved over said surface.

7. A method as in claim 6 in said surface, characterized in that during unwinding of the asphaltic mastic strip the unwound portion is heated before being laid on said surface.

8. A method as claimed in claim 7, characterized in that the unwound strip is pressed onto the surface by means of a rolling device

9. A method as claimed in claim 8, characterized in that the rolling device is connected to the vehicle.

10. A method as in claim 6, characterized in that in order to prepare the laying of a wide asphaltic mastic strip, the water-retaining surface is levelled by lining it with asphalt having a volume of voids of at most 25 percent and a bitumen content of at most 6 percent by weight.

11. A method as in claim 6, characterized in that the wide strips are laid on a heated lower surface.

12. A method as in claim 1, characterized in that the surface is impermeabilized with two layers of unilaterally externally reinforced wide asphaltic mastic strips.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,822,556 Dated July 9, 1974

Inventor(s) Arnaud Cramwinckel et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 5, line 2, "15" should read --1.5--.

Signed and sealed this 1st day of October 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents