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(54) WATER BARRIER PANEL AND METHOD

(71) We, AMERICAN COLLOID COMPANY, a Corporation organised and existing under the laws of the State of Illinois, United States of America, of 5100 Suffield Court, Skokie, Illinois 60076, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to methods of and means for containing water to restrict its flow and it has for its principal object the provision and use of means in the form of a preformed moisture-impervious panel which is impervious to water containing high concentrations (more than 4%) of sodium chloride.

It has already been proposed to provide a seepage resistant structure by disposing a mass of swellable bentonite across a path of possible seepage or flow of water and confining the mass to the area of possible water seepage. One such method and means for impeding the seepage or flow of water is described in United States Patent Specification No. 2,277,286. As is more fully described in that Specification, a commercial bentonite is used to block seepage or flow of water and formations of various types are safeguarded against leakage by blocking the path of flow of water with bentonitic or highly colloidal clay which possesses the capacity to swell and gelatinize upon contact with water.

Some physical characteristics which distinguish bentonite from other clays are its permeable texture and its extremely small grain size. The grain particles, when wetted, absorb films of water that are thicker than the films which form on other clay-like materials and, after the bentonite has been wetted, the water cannot be expelled,

even at high pressures. The strong adsorptive powder of commercial bentonite, which will absorb almost five times its weight of water, is partially attributable to the preponderance of extremely small grains or particles, providing tremendous surface area for the exertion of adsorptive powers and the film-retaining capacity of these particles.

Commercial bentonite swells, when contacted with water, by as much as ten to twenty times its dry volume. One factor which causes this swelling is the separation of the small particles by the water adsorbed thereon. Another is the distinctive nature of the particles themselves, which are composed of minute plate-like structures that possess the peculiar property of allowing water molecules to penetrate their crystal lattice. The crystal structure itself is thus expanded. A third factor is the mutual repulsion of the particles due to like negative polarity.

In its swollen condition, bentonite has several advantageous properties; it will carry materials in suspension; it exerts a cohesive effect; when left quiescent it forms a permanent gel, the viscosity of which increases upon aging. An important aspect of the swelling of bentonite is that it will swell only to the extent necessary to fill available space without exerting substantial pressure when confined against further swelling. These properties make it an ideal material for incorporation in a dry or slightly moist state at points where leakage possibilities occur, so that if cracks or other leakage should develop, the bentonite will come into contact with the leaking or seeping water and swell to stop the seepage, but will not create pressure which might cause further damage.

The present invention is predicated on the discovery that certain compositions can, when formed into panels, as by filling ones

formed with a corrugated sheet, be used to prevent seepage of water therethrough in a particularly advantageous manner. When the ground water supply contains large amounts of sodium chloride, for example up to 15 percent of sodium chloride, the backfill for the panels is formed of or includes a porous granular material, such as sand, and this backfill is flooded to hydrate the composition inside the panel, causing the composition to swell to the degree permitted by the composition of the backfill.

Accordingly, it is one of the principal objects of the present invention to provide methods and panels for forming foundations and other in-ground structures which will prevent seepage therethrough of water, particularly water containing 4% or more sodium chloride.

The panels according to the present invention each comprise two opposing spaced sheets having between them a sealant composition comprising bentonite, a water-soluble dispersing agent selected from water-soluble salts of acetic acid, water-soluble salts or phosphoric acid and water-soluble salts of boric acid, and a water-soluble polymer selected from polyacrylic acid, water soluble salts of polyacrylic acid, hydrolyzed polyacrylonitrile, polyvinyl acetate, polyvinyl alcohol, copolymers of the foregoing and copolymers of acrylic acid and maleic anhydride, the acrylic of water-soluble polymer in said sealant composition being from 0.1% to 3.0%, by weight, and the amount of water-soluble dispersant to water soluble polymer being from 6:1 to 1:6.

Such panels, which are particularly intended for preventing the seepage through them of water containing more than 4% (by weight) of sodium chloride, may be formed by disposing a sealant composition as defined above between opposing faces of sheet material to form a dry panel but one into which water can penetrate through the sheet material to cause expansion of the sealant composition, such panels are used by fitting a dry panel in its position of use and wetting it by causing or allowing water to reach it so as to cause expansion of the sealant composition in the panel.

According to a further feature of this invention a water barrier is formed around an in-ground foundation by the method which comprises forming a foundation in soil by removing soil, constructing a foundation in the space defined by unremoved soil surrounding the original location of the removed soil, locating a panel as defined above against said foundation while maintaining a void space between the panel and the unremoved soil and filling said void space with removed soil or with

another water-pervious soil aggregate.

The void space may be filled with a suitable granular aggregate which is then flooded with water which is substantially uncontaminated with sodium chloride to hydrate the sealant composition so that the panel will then prevent seepage through it of water contaminated with sodium chloride.

The invention makes possible the provision of panels filled with a bentonite composition which do not disintegrate when contacted with water containing up to 20 per cent of sodium chloride.

The invention provides and uses panels filled with a composition containing bentonite, a water-soluble dispersant, and a water-soluble polymer. The bentonite composition is contained between spaced facing sheets to provide a panel useful in preventing leaking of salt contaminated water into a below-ground structure, such as a building foundation.

The invention will now be more fully described, by way of example, with reference to the accompanying drawing in which:—

Fig. 1 is a front view of a panel exemplifying the invention;

Fig. 2 is a section through this panel, taken on the line 2-2 of Fig. 1;

Fig. 3 is a perspective view of the same panel.

Referring now to the drawing, there is illustrated a preformed moisture impervious panel, generally illustrated at 10, and formed of a corrugated paperboard carrier or form 12 including a pair of spaced paperboard facing sheets 13 and 14, joined and interconnected by a paper corrugated strip 15 to form a plurality of voids between the strips 15 and the facing sheets 13 and 14. The voids are filled with a compacted mass of finely divided swellable bentonite composition 16.

It will be appreciated that the panel 10 may be preformed and assembled into a moisture impervious structure which may be readily sawed or cut to the desired shape in the field. When subjected to leakage or seepage of moisture, the water pervious paper facing sheets 13 and 14 will pass the moisture to the bentonite composition 16. The bentonite composition first contacted absorbs water, swells and forms a gel which is permanently resistant to seepage.

The facing sheets 13 and 14 need not be impervious to water; it is sufficient that they give suitable physical strength during shipping and assembly of the panel 10 and that they have no openings which permit the escape of the compacted bentonite composition therethrough. When the confined bentonite composition is contacted

(17)

with water which has seeped through the facing sheets 13 or 14, the bentonite composition at the surface of the respective facing sheets 13 or 14 immediately absorbs water, swells enormously and forms a gelatinous mass which in itself is impervious to water and provides a moisture impervious panel. Moreover, the water impervious surface of the bentonite composition will prevent swelling of the remainder of the bentonite composition so that only the amount of bentonite composition which can fill the voids will absorb moisture and swell to capacity.

Although the physical strength of the mass of bentonite composition 16 in the voids may be increased by packing the bentonite composition in place, to provide a structure capable of transportation without spilling the bentonite 16 from the ends of the void, the edges of the panel 10 may be sealed with wax, tape, or other suitable means. The panel can also be sealed with a suitable water-soluble gum.

25 THE BENTONITE COMPOSITION

The bentonite utilized in the present invention is one which will hydrate in the presence of water, i.e., will swell in the presence of water. A preferred bentonite is sodium bentonite which is basically a hydratable montmorillonite clay which has sodium as its predominant exchangeable ion. However, the bentonite utilized in the present invention may also contain other cations such as magnesium and iron, provided that it contains replaceable or exchangeable cations, which may be sodium or calcium. As noted above, the sodium bentonite will swell in water and is therefore the type of bentonite which is particularly useful in the present invention.

In order to assure that the bentonite composition is capable of preventing leakage of water contaminated with sodium chloride it is absolutely necessary that the soil sealant composition include a water-soluble dispersant and a water-soluble polymer.

The water-soluble dispersant is preferably a water-soluble salt of phosphoric acid (a phosphate) such as hypophosphate, orthophosphate, metaphosphate, and pyrophosphate. The particular cation forming the salt is not important providing that the resulting salt is water-soluble. For example, the cation can be almost any metal such as an alkali metal. Exemplary of the alkali metal salts are sodium orthophosphate, trisodium orthophosphate, sodium metaphosphate, and sodium pyrophosphate. Other alkali metal salts which may be utilized in the present invention are potassium orthophosphate, potassium hydrogen phosphate (K_2HPO_4), potassium pyrophosphate, and lithium phosphate.

As noted above, the water-soluble phosphoric acid salts are the preferred dispersants for the bentonite composition; however, other water-soluble dispersants can be used among which may be mentioned the borates and acetates. Any of the water-soluble boric acid salts are useable, particularly those derived from the alkali metal and alkaline earth metals. Exemplary of such borates are sodium metaborate and sodium tetraborate. Also there may be mentioned lithium and potassium borates. Salts of acetic acid which are useable are the water-soluble alkali metal and alkaline earth metal salts such as sodium acetate, potassium acetate, and lithium acetate.

The amount of dispersant utilized in the soil sealant composition of the present invention may vary from 0.1% to 3% with the preferred range being from 0.5% to 3% usually 0.5% to 2%) by weight based on the entire weight of the bentonite, water-soluble dispersant, and water-soluble polymer.

The preferred water-soluble polymer of the bentonite composition is polyacrylic acid. As is known in the art, the salts of polyacrylic acid can be polymerized directly from the salts of acrylic acid. If desired, the salt of polyacrylic acid can be acidified to give polyacrylic acid. In this invention, polyacrylic acid can be utilized per se or, preferably, the water-soluble salts or partial salts thereof.

Other water-soluble polymers which may be utilized in the bentonite composition are hydrolyzed polyacrylonitrile, polyvinyl acetate, and polyvinyl alcohol. Additionally copolymers of the foregoing can also be utilized and, preferably copolymers of polyacrylic acid and polyacrylonitrile, polyvinyl acetate, or polyvinyl alcohol. Moreover, another preferred copolymer is the copolymer of acrylic acid and maleic anhydride.

It is preferred that the above polymers have a molecular weight of at least 100,000 and preferably 150,000 or more. The preferred molecular weight is between 500,000 and 2,000,000 although it may be more.

The amount of water-soluble polymer utilized in the soil sealant composition of the present invention may range from 0.1% to 3.0%, by weight with the preferred range being from about 0.5% to 3% (generally 0.5% to 2%) by weight. The weight ratio of water-soluble dispersant to water-soluble polymer is preferably from 6:1 to 1:6.

The bentonite composition is made very easily by merely dry mixing the bentonite, the water-soluble polymer, and the water-soluble dispersant to form a dry, granular

or powder like composition. This dry composition can be easily introduced into the open ends of a corrugated sheet, as shown in the drawing. It is understood that other structural panels can also be used as the facing sheets for confining the bentonite composition so long as the bentonite composition has access to surrounding water.

10 WHAT WE CLAIM IS:—

1. A panel for providing a water barrier, comprising two opposing spaced sheets having between them a sealant composition comprising bentonite, a water-soluble dispersing agent selected from water-soluble salts of acetic acid, water-soluble salts of phosphoric acid and water-soluble salts of boric acid, and a water-soluble polymer selected from polyacrylic acid, water-soluble salts of polyacrylic acid, hydrolyzed polyacrylonitrile, polyvinyl acetate, polyvinyl alcohol, copolymers of the foregoing and copolymers of acrylic acid and maleic anhydride, the amount of water-soluble polymer in said sealant composition being from 0.1% to 3.0%, by weight, and the amount of water-soluble dispersant in said sealant composition being from 0.1% to 3.0%, by weight, the weight ratio of water-soluble dispersant to water-soluble polymer being from 6:1 to 1:6.

2. A panel according to claim 1, wherein the water-soluble polymer is selected from polyacrylic acid and water-soluble salts of polyacrylic acid.

3. A panel according to claim 1 or claim 2, wherein the water-soluble dispersing agent is a water-soluble salt of phosphoric acid.

4. A panel according to claim 3, wherein the water-soluble salt of phosphoric acid is an alkali metal pyrophosphate.

5. A panel according to claim 4, wherein the alkali metal pyrophosphate is sodium pyrophosphate.

6. A method of forming a water-imperious panel useful for preventing seepage of water contaminated with more than 4% sodium chloride therethrough, which comprises:

disposing a sealant composition between opposing faces of sheet material, to form a dry panel, said sealant composition comprising bentonite, a water-soluble dispersing agent selected from water-soluble salts of acetic acid, water-soluble salts of phosphoric acid and water-soluble salts of boric acid, and a water-soluble polymer selected from polyacrylic acid, water-soluble salts of polyacrylic acid, hydrolyzed polyacrylonitrile, polyvinyl acetate, polyvinyl alcohol, copolymers of the foregoing and a copolymer of acrylic acid and maleic anhydride, the amount of water-soluble polymer in said soil sealant composition being from 0.1% to 3.0%, by weight, and the amount of water-soluble dispersant in said soil sealant composition being from 0.1% to 3.0%, by weight, the weight ratio of water-soluble dispersant to water-soluble polymer being from 6:1 to 1:6, and filling said void space with removed soil or with another water-pervious solid aggregate.

7. A method according to claim 6, which includes fitting the panel in its position of use and wetting the dry panel with water substantially devoid of sodium chloride to cause expansion of said sealant composition.

8. A method according to claim 6 or claim 7, wherein the water-soluble polymer is selected from polyacrylic acid and water-soluble salts of polyacrylic acid.

9. A method according to claim 6 or claim 8, wherein the water-soluble dispersing agent is a water-soluble salt of pyrophosphoric acid.

10. A method of forming a water barrier around an in-ground foundation comprising:

forming a foundation in soil by removing soil, constructing a foundation in the space defined by unremoved soil surrounding the original location of the removed soil,

locating a panel against said foundation while maintaining a void space between the panel and the unremoved soil, said panel containing a soil sealant composition comprising bentonite, a water-soluble dispersing agent selected from water-soluble salts of acetic acid, water-soluble salts of phosphoric acid and water-soluble salts of boric acid, and a water-soluble polymer selected from polyacrylic acid, water-soluble salts of polyacrylate acid, hydrolyzed polyacrylonitrile, polyvinyl acetate, polyvinyl alcohol, copolymers of the foregoing and a copolymer of acrylic acid and maleic anhydride, the amount of water-soluble polymer in said soil sealant composition being from 0.1% to 3.0%, by weight, and the amount of water-soluble dispersant in said soil sealant composition being from 0.1% to 3.0%, by weight, the weight ratio of water-soluble dispersant to water-soluble polymer being from 6:1 to 1:6, and filling said void space with removed soil or with another water-pervious solid aggregate.

11. A method according to claim 10, wherein the void space is filled with a granular aggregate which is then flooded with water substantially uncontaminated with sodium chloride to hydrate the sealant composition, whereby said panel will prevent seepage of water contaminated with sodium chloride through said panel.

12. A panel as claimed in claim 1, substantially as herein described with reference to the accompanying drawings.

or powder like composition. This dry composition can be easily introduced into the open ends of a corrugated sheet, as shown in the drawing. It is understood that other structural panels can also be used as the facing sheets for confining the bentonite composition so long as the bentonite composition has access to surrounding water.

10 WHAT WE CLAIM IS:—

1. A panel for providing a water barrier, comprising two opposing spaced sheets having between them a sealant composition comprising bentonite, a water-soluble dispersing agent selected from water-soluble salts of acetic acid, water-soluble salts of phosphoric acid and water-soluble salts of boric acid, and a water-soluble polymer selected from polyacrylic acid, water-soluble salts of polyacrylic acid, hydrolyzed polyacrylonitrile, polyvinyl acetate, polyvinyl alcohol, copolymers of the foregoing and copolymers of acrylic acid and maleic anhydride, the amount of water-soluble polymer in said sealant composition being from 0.1% to 3.0%, by weight, and the amount of water-soluble dispersant in said sealant composition being from 0.1% to 3.0%, by weight, the weight ratio of water-soluble dispersant to water-soluble polymer being from 6:1 to 1:6.

2. A panel according to claim 1, wherein the water-soluble polymer is selected from polyacrylic acid and water-soluble salts of polyacrylic acid.

3. A panel according to claim 1 or claim 2, wherein the water-soluble dispersing agent is a water-soluble salt of phosphoric acid.

4. A panel according to claim 3, wherein the water-soluble salt of phosphoric acid is an alkali metal pyrophosphate.

5. A panel according to claim 4, wherein the alkali metal pyrophosphate is sodium pyrophosphate.

6. A method of forming a water-imperious panel useful for preventing seepage of water contaminated with more than 4% sodium chloride therethrough, which comprises:

disposing a sealant composition between opposing faces of sheet material, to form a dry panel, said sealant composition comprising bentonite, a water-soluble dispersing agent selected from water-soluble salts of acetic acid, water-soluble salts of phosphoric acid and water-soluble salts of boric acid, and a water-soluble polymer selected from polyacrylic acid, water-soluble salts of polyacrylic acid, hydrolyzed polyacrylonitrile, polyvinyl acetate, polyvinyl alcohol, copolymers of the foregoing and a copolymer of acrylic acid and maleic anhydride, the amount of water-soluble polymer in said soil sealant composition being from 0.1% to 3.0%, by weight, and the amount of water-soluble dispersant in said soil sealant composition being from 0.1% to 3.0%, by weight, the weight ratio of water-soluble dispersant to water-soluble polymer being from 6:1 to 1:6, and filling said void space with removed soil or with another water-pervious solid aggregate.

7. A method according to claim 6, which includes fitting the panel in its position of use and wetting the dry panel with water substantially devoid of sodium chloride to cause expansion of said sealant composition.

8. A method according to claim 6 or claim 7, wherein the water-soluble polymer is selected from polyacrylic acid and water-soluble salts of polyacrylic acid.

9. A method according to claim 6 or claim 8, wherein the water-soluble dispersing agent is a water-soluble salt of pyrophosphoric acid.

10. A method of forming a water barrier around an in-ground foundation comprising:

forming a foundation in soil by removing soil, constructing a foundation in the space defined by unremoved soil surrounding the original location of the removed soil,

locating a panel against said foundation while maintaining a void space between the panel and the unremoved soil, said panel containing a soil sealant composition comprising bentonite, a water-soluble dispersing agent selected from water-soluble salts of acetic acid, water-soluble salts of phosphoric acid and water-soluble salts of boric acid, and a water-soluble polymer selected from polyacrylic acid, water-soluble salts of polyacrylate acid, hydrolyzed polyacrylonitrile, polyvinyl acetate, polyvinyl alcohol, copolymers of the foregoing and a copolymer of acrylic acid and maleic anhydride, the amount of water-soluble polymer in said soil sealant composition being from 0.1% to 3.0%, by weight, and the amount of water-soluble dispersant in said soil sealant composition being from 0.1% to 3.0%, by weight, the weight ratio of water-soluble dispersant to water-soluble polymer being from 6:1 to 1:6, and filling said void space with removed soil or with another water-pervious solid aggregate.

11. A method according to claim 10, wherein the void space is filled with a granular aggregate which is then flooded with water substantially uncontaminated with sodium chloride to hydrate the sealant composition, whereby said panel will prevent seepage of water contaminated with sodium chloride through said panel.

12. A panel as claimed in claim 1, substantially as herein described with reference to the accompanying drawings.





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13. A method as claimed in claim 6 or claim 7, substantially as herein described with reference to the accompanying drawings.

5 14. A method as claimed in claim 10, substantially as herein described with reference to the accompanying drawings.

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