United States Patent

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[54] **RESILIENT FOUNDATION FOR CONCRETE**
11 Claims, 2 Drawing Figs.

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[50] **Field of Search** 94/3, 4, 7, 10, 22, 24, 19

[56] **References Cited**

UNITED STATES PATENTS

823,950	6/1906	Langguth	94/3
1,134,578	4/1915	Armstrong	94/3
1,949,063	2/1934	Merrill	94/7
2,024,158	12/1935	Gallagher	94/7
2,420,833	5/1947	Monroe	94/4X
2,737,092	3/1956	Gramelspacher	94/4
2,977,864	4/1961	Pullar	94/22X
3,000,276	9/1961	Foulger	94/10

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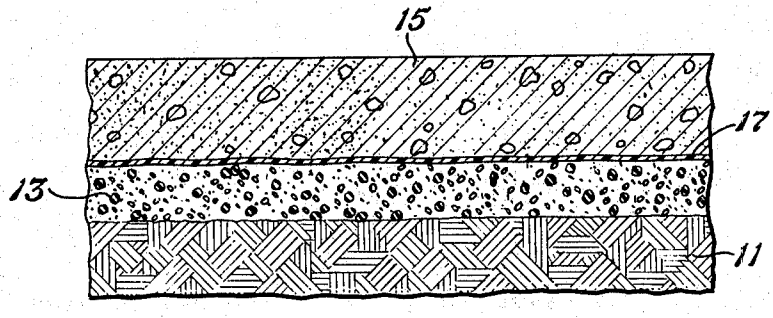
ABSTRACT: This specification discloses an improvement in a method of constructing a concrete slab over a relatively flat base between retaining walls, characterized by:

(*a*) depositing on the base of a layer of solid particles that are resilient and hydrophobic, the layer being of sufficient thickness to effect a discrete layer of the particles at the top of the base;

(*b*) pouring a concrete slurry over the layer of particles; and

(*c*) allowing the concrete to set.

Moreover, the resulting article of manufacture, as well as specific limitations on the properties of the particles are disclosed.



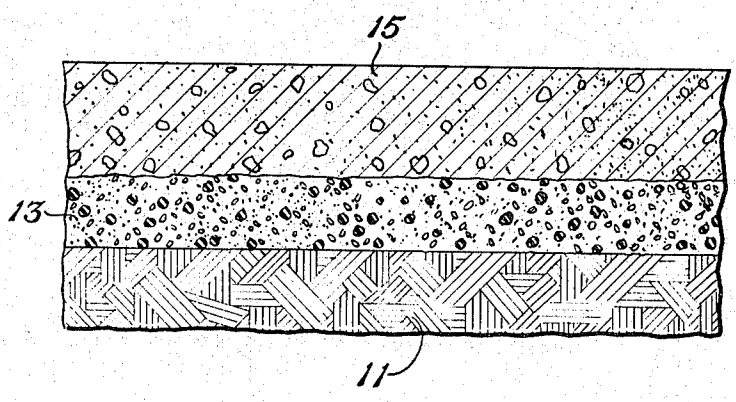


Fig. 1

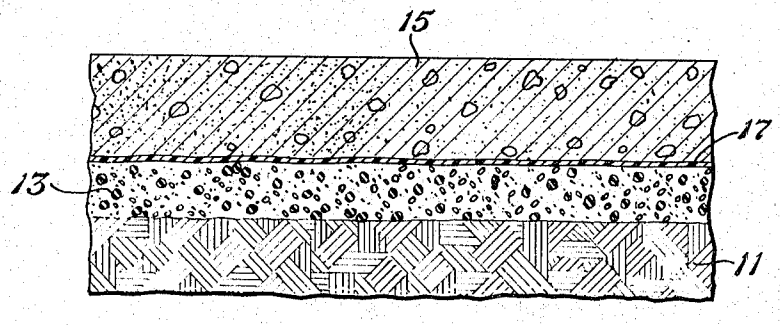


Fig. 2

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RESILIENT FOUNDATION FOR CONCRETE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to concrete slabs formed upon a base. More particularly, it relates to concrete slabs laid upon a base wherein relative motion between the base or elements thereof and the concrete may occur, infrequently.

2. Description of the Prior Art

Concrete slabs are employed in construction of roads, aircraft runways, floors for buildings, and other similar uses. Usually the concrete slabs are constructed by laying a conglomerate of freshly prepared concrete upon a prepared flat base between retaining sidewalls. The conglomerate of wetted concrete mix is ordinarily referred to and is referred to herein; as a concrete slurry, without the physical chemistry connotations of a thin watery mixture, and is comprised of a portland cement, an aggregate, and water. Other slurries may be employed for specialty purposes, or additional constituents may be added for desired properties. The retaining sidewalls may be of a temporary nature; such as, wooden boards; or they may be the sides of an excavation per se. Once emplaced, the concrete slurry is thereafter allowed to cure, or set, into a hard solid mass.

During the curing process, the concrete undergoes complex chemical changes, known as hydration. These changes are ordinarily accompanied by physical contraction. Furthermore, the concrete in a solid state undergoes dimensional changes; such as, when subjected to changes in temperature. Moreover, the earth beneath the concrete slab shrinks and contracts as the moisture content changes. For example, the clays, when dry, may shrink and cause shifting of the earth with respect to the concrete. Moreover, it is theorized that tremors of various sorts may effect sharp movement of the base, or earth, with respect to the concrete. For example, dynamite blasts in quarries, heavy vibration from traffic like trains or heavy trucks and even sonic booms are believed to contribute to failure and cracking of concrete slabs.

The prior art methods of forming concrete slabs employed particulate matter; such as, ground clinker, sand, or gravel; and form artificial bases to attempt to compensate for such movements and redistribute the concentration of stress accompanying such relative movement between the slab and the earth therebeneath. In addition, it is known to employ multiple layers of polyethylene between layers of concrete to effect a reduced friction and facilitate movement between the layers of concrete. The constituents of such artificial bases were ordinarily hydrophillic materials which were readily wet by water. Therefore, when a high concentration of moisture was reached in the soil about the base and the slab; such as, when the water table was raised to the level of the slab by rain; the water came through the base and up through the concrete mass effecting at least "internal sweating" of the concrete floor. Since this change in moisture content often was accompanied by a shifting or relative movement between the concrete and the earth, a crack was frequently induced such that the water could more readily reach the interior surfaces. Sometimes this effected flooding of basements and the like employing the concrete slabs.

In addition, there appears to be a "puddling" action attending the small relative vertical movement between the concrete slab; such as, a highway; and the base. This "puddling" action comprises a packing and capillary action analogous to patting of the wet sand at a beach to form a free water layer. The constituents of the prior art artificial bases, being hydrophillic, allowed the puddled water to accumulate in and flow through interstices immediately adjacent the concrete slab. This, in turn, created voids and ultimately cracks in the concrete slab by washing smaller particles away. It also worsened difficulties attending freezing and thawing of near surface free water. In general, this puddling action appears to have been ignored in favor of trying to solve other problems.

To try to alleviate the problem of water coming directly through the concrete, a sheet of water impervious material; such as, polyethylene; was frequently emplaced before the concrete slurry was poured.

It has also been known in the prior art to try to employ continuous films of substances between the concrete and the base. For example, thin films of asphalt impregnated paper have been employed, films of plywood having films of rubber on either side have been employed. Moreover, it has been known to try rolling into a layer of asphaltic material, serving as the base, particles of rubber to mitigate the deleterious effects of gasoline which might go through the concrete to the asphaltic base.

The layers beneath the concrete that have been tried in the prior art approaches have not been altogether satisfactory in that they either (1) have not been thick enough to effect discrete layers that would reapportion any stress concentration induced by relative movement between the concrete and the base, or the earth formation, and alleviate undesired cracking; (2) have not been able to accommodate the relative movement regardless of direction and magnitude; (3) have not been able to alleviate problems with moisture diffusing through the layer and the concrete thereabove; or (4) have not been able to prevent puddling of water and the creation and flow of a layer of water immediately adjacent the concrete slab.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a partial cross-sectional view of a concrete slab employing one embodiment of the invention; and

FIG. 2 is a partial cross-sectional view of a concrete slab employing another embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

It is a particular feature of this invention to provide, between the concrete and its base, a layer of particulate and resilient solids thick enough to be able to accommodate relative movement and reapportion any stress concentration induced by such relative movement between the concrete and the base and alleviate undesired cracking and resilient enough to accommodate the relative movement regardless of direction and magnitude; the solids also being hydrophobic to prevent by denial of capillary action, the puddling of water adjacent the concrete slab and to resist wetting by water and thus alleviate problems with moisture diffusing through the layer and thence through the concrete.

In accordance with the invention there is provided an improvement in a method of constructing a concrete slab over a relatively flat base and between retaining walls. The improvement comprises:

a. depositing on the base a layer of solid particles that are resilient and hydrophobic, the layer being of sufficient thickness to effect a discrete layer of the particles at the top of the base;

b. pouring a concrete slurry over the layer of particles; and

c. allowing the concrete to set.

In another aspect of the invention, there is provided an article of manufacture, comprising:

a. a base that is relatively flat;

b. a discrete layer of solid particles that are resilient and hydrophobic; and

c. a layer of concrete.

In order to effect the features of the invention, the solid particles, before being compressed, should be resilient enough to undergo a volume compression in the range of 15 to 34 percent under a compressive force of 1,000 pounds per square inch (p.s.i.) pressure. Moreover, the particles should be hydrophobic and resist wetting by water. By hydrophobic is meant that in a three-phase system in which an interface between water and oil is placed adjacent the material from which the particles are made, the angle the interface makes with the solid material, measured through the water phase, will be greater than 90°.

The solid particles may be made by particulating, or reducing in size, any material having these properties of resiliency and hydrophobicity. For example, the solid particles may be comprised of natural or synthetic rubber, or the bases of either natural or synthetic rubber containing the inert fillers; such as, carbon; or miscellaneous tension inducing agents; such as, rayon and nylon cord or any other cords used in the manufacture of tires. Specifically, the solid particles may be comprised of natural rubber in either the trans-isomer form or the cis-isomer form. Even better results may be obtained when the solid particles are comprised of synthetic rubbers; such as, butadiene-styrene copolymer, butadiene-acrylonitrile copolymer, polychloroprene, or isobutylene diolefin copolymer. The term solid is employed in its broad context to mean a material that is not gaseous or liquid. Hence, amorphous or noncrystalline solids; such as, rubbers of high molecular weight dimethyl siloxane polymers or alkylene polysulfide polymers; can frequently be employed; particularly, in conjunction with an inert filler.

The particulating, or reducing, in size may be accomplished by grinding, shredding, cutting, or any other method effecting the desired size and distribution of particles.

In the preferred embodiment, the solid particles comprise rubber from old tires which has been particulated, or reduced to the desired size. The tires may be those prepared from either natural rubber or synthetic rubber.

The sizes of the solid particles may range from fines about the size of flour particles to coarse shreds having a diameter about the size of pea gravel and being several inches in length. Ordinarily, the sizes will be between these extremes and will comprise a distribution of particle sizes having diameters of about 1 mil with one-sixteenth inch or so in length up to particles having a diameter of about 0.25 inch, and about 3 inches in length. With particles having a concentration of fines; for example, about the size of flour particles, or a mean effective diameter of about 1 mil; there are difficulties with spreading of the particles in winds, with inhalation of the particles by workmen, and with the tendency of the particles to agglomerate under compression and behave more nearly approaching that of unitary film, found to be satisfactory as delineated hereinbefore. On the other hand, particles that are too large leave too much void space such that water can flow between the particles and up to and adjacent the concrete slab. Moreover, larger particles, because of the void space therebetween, are less effective in transferring the stresses and in expanding to alleviate stresses in a portion of the concrete that might otherwise become unsupported because of relative motion between the concrete and the earth. It is preferred to have a distribution of particle sizes ranging from the small diameter shreds up to the large diameter shreds referred to hereinbefore. For best results, the particles should have a distribution of sizes such that less than 5 percent by weight have a mean effective diameter of less than about 1 mil and less than 5 percent by weight have a diameter larger than about 0.25 inch and longer than about 3 inches. By having a distribution of both particles and shreds, the voids, or interstices, are small enough that capillary action is denied any water attempting to infiltrate into the interstices; and the interweaving of the shreds effects a distribution pattern to compensate for stress concentrations that is difficultly, if at all, obtainable by any other means. For example, employing a 4-inch diameter funnel with a filter paper in the bottom, I have partially filled the funnel with rubber particles having the desired distribution sizes and have poured a fourth of a cup of water thereover and let stand for 12 hours. Although the filter paper was damp at the end of 12 hours, there was essentially no loss of water per se.

The layer of solid particles between the concrete and the base must be thick enough to effect a discrete layer of particles. When the concrete is poured directly upon the particles without an intermediate sheet therebetween the concrete sets about the uppermost layer of particles and robs them of their inherent ability to compensate for stress concentrations and to expand to fill voids that may develop. For this reason, therefore, a discrete layer of particles that do not have the concrete encompassing them is required. For best results, the discrete layer of particles should be approximately one-half inch thick. Preferably, the layer is at least 1 inch thick for concrete slabs of appreciable thickness; e.g., about 4 inches or more. The layer may be 4 inches or more in thickness.

A diagrammatic representation of a partial cross section of a concrete structure constructed in accordance with the invention is illustrated in FIG. 1. Therein, base **11** has been prepared in the conventional way; such as, excavating to form a level surface of the earth between retaining walls, which may be the walls of the excavation. If desired, a layer of sand, gravel or the like, can be employed in base **11**, but is not necessary. Over base **11** is laid a layer **13** of solid particles that are resilient and hydrophobic as delineated hereinbefore. A layer of concrete **15** is formed over the layer **13** of solid, resilient, hydrophobic particles. Ordinarily, layer of concrete **15** is formed by pouring a concrete slurry over the layer of solid particles **13** and allowing the concrete slurry to set. Any one of the numerous conventional concrete slurries can be employed in the invention since ordinarily no constituent of the slurry will attack the solid particles employed in layer **13**.

In the initial stages of curing, strength of the concrete develops rapidly, but the rate of increase decreases with time until the ultimate strength is eventually reached after many months. In practice, it is usual to apportion the cement, aggregates, and water to give a 28-day cure strength much in excess of the stresses to which the concrete slab is ordinarily subjected. During the curing operation, however, the tensile strength of the concrete is low, such that any relative movement between the concrete **15** and base **11** will tend to induce cracks into the concrete. One advantage of the invention is that the layer of solid particles **13** have a relatively high degree of expansion to take up any stress concentration caused by such relative shifting.

A diagrammatic representation of a partial cross section of a concrete structure constructed in accordance with another embodiment of the invention is illustrated in FIG. 2. Therein base **11** is prepared and a layer **13** of solid particles that are resilient and hydrophobic emplaced thereon, as described hereinbefore. Before the concrete slurry is poured over layer **13**, however, a sheet **17** of material is placed over the solid particles in layer **13** to prevent displacement of the particles during the pouring of the concrete slurry and prevent the curing of the concrete about the particles in the upper portion of layer **13**. Sheet **17** may be a sheet of asphalt-impregnated paper or a sheet of plastic; such as, polyethylene or any other pliable material such as paper. Moreover, sheet **17** need not be waterproof, although I have obtained good results employing a sheet of polyethylene.

Next, layer **15** of concrete slurry is poured on top of sheet **17**. The sheet minimizes displacement of the solid particles during the initial pouring operation and maintains a substantially uniform thickness of layer **13**.

The following is a specific example illustrating different aspects of the invention.

EXAMPLE

The base for the new concrete floor was an old concrete floor which was extremely erratic in its contour, having been chipped badly. Earlier, a layer of concrete had been emplaced over one-half of the old concrete floor, a space 40 feet by 12 feet. The old concrete floor is in a building near a quarry in which there is a continuing series of explosions of dynamite charges, a succession of railway car traffic over the railroad immediately behind the concrete floor, and a continuous rumble of heavy trucks passing near the concrete floor. The new concrete poured on the old floor one day developed hairline cracks by the following morning. At the end of 1 week, the floor had developed cracks completely through it and coinciding with cracks in the old concrete floor serving as the base. The speed and severity of the cracking of the newly emplaced

concrete floor indicated the locale was difficult one in which to attempt to build an effective concrete slab. On top of the other half of the old concrete floor, a layer of solid rubber particles was laid down. The layer of solid rubber particles was 40 feet long by 12 feet wide by 2 inches thick. At least 90 percent by weight of the particles of rubber were shreds from 1/16 to 1½ inches long, and slightly larger in diameter than sand and smaller than pea gravel. The diameters were estimated to range from about 6 mils to about 180 mils. The rubber particles were waste products, being rubber ground from tires before tires were recapped. The majority of the rubber particles comprised synthetic rubber containing carbon filler. Particulated rubber peeled from the tires and chopped or shredded to effect the desired particle size is also feasible.

A film of polyethylene was laid over the rubber particles and a layer of concrete slurry poured thereover. Under the weight of the concrete slurry the layer of rubber particles compressed approximately one-half inch. The concrete slurry set to form a layer of concrete having a substantially uniform thickness of about 4 inches. The floor maintained its integrity even though heavy machinery was concentrated in spots and even though the very large size ordinarily would have made such a slab of concrete very susceptible to cracking. In fact, the concrete slab had a resiliency that made work less tiring to personnel working in this area.

In addition, the concrete slab used up scrap rubber which is becoming more difficult to dispose of in these days of increasingly stringent laws regarding the pollution of the air. This serendipitous benefit is readily appreciated by referring to an article entitled "Tire Disposal Breakthrough"', the "Tire Times," Vol. 3, No. 5, Oct. 1968, Akron Ohio and R. P. Nelms, "End to Scrap Casing Problems"', Modern Tire Dealer, Sept. 1968, Page 66. These articles explicitly and implicitly reveal the difficulties of disposing of scrap tires in the face of new legislation forbidding the spewing of sulphurous and carbonaceous fumes into the atmosphere.

It can be seen that the invention provides a method and an article of manufacture in which the undesired cracking of concrete slabs through shifting of the foundation thereunder is alleviated; the difficulties attending the influx of water from the earth through the concrete foundation are alleviated; the puddling of water and attendant creation of voids is mitigated and the serendipitous benefit of disposing of difficulty disposable old tires is made economically advantageous. Moreover, the resilient foundation of the concrete slab not only absorbs and reapportions stress occasioned by relative shift between the slab and its base, but also adds a degree of resiliency to the floor that is advantageous in terms of comfort of employees working thereon.

Although I have described my invention with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

I claim:

1. An article of manufacture comprising:
   a. a base that is relatively flat;
   b. a discrete layer of solid elastomeric particles that are resilient and hydrophobic; and
   c. a slab of concrete on said discrete layer.

2. The article of claim 1 wherein said particles are resilient enough to undergo a volume compression in the unloaded condition within the range of from 15 to 34 percent at 1,000 pounds per square inch pressure.

3. The article of claim 1 wherein said particles have a distribution of sizes such that less than 5 percent by weight have a means effective diameter less than about 1 mil and no more than 5 percent by weight have a diameter larger than about 0.25 inch and a length greater than about 3 inches.

4. The article of claim 3 wherein 90 percent by weight of the particles have diameters within the range of 6—180 mils, and lengths within the range of 1/16 inch—1½inches.

5. The article of manufacture of claim 1 wherein said solid elastomeric particles are selected from the group consisting of natural rubber, and synthetic rubber.

6. The article of claim 5 wherein said solid elastomeric particles comprise natural rubber selected from the group consisting of the trans-isomer, the cis-isomer, and bases thereof including inert fillers.

7. The article of claim 5 wherein said solid elastomeric particles comprise synthetic rubber selected from the group consisting of butadiene-styrene copolymer, butadiene-acrylonitrile copolymer, polychloroprene, isobutylene diolefin copolymer, alkylene polysulfide, dimethyl siloxane polymer, and bases thereof including inert fillers.

8. The article of claim 5 wherein said solid elastomeric particles comprise particulated tires prepared from rubber selected from the group consisting of natural rubber and synthetic rubber.

9. The article of claim 1 wherein a sheet of material is interposed between said layer of solid particles and said layer of concrete.

10. The article of claim 9 wherein said sheet of material is waterproof.

11. The article of claim 9 wherein said sheet of material is polyethylene.