# United States Patent

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[54] **INSULATION METHOD AND CONSTRUCTIONS**
**12 Claims, 2 Drawing Figs.**


[52] **U.S. Cl.** ..... **94/4,** 94/7, 94/25, 106/41, 260/2.5
[51] **Int. Cl.** ..... **E01c 9/00**
[50] **Field of Search** ..... 106/41; 260/2.5; 264/128; 94/3, 4, 10, 7, 25



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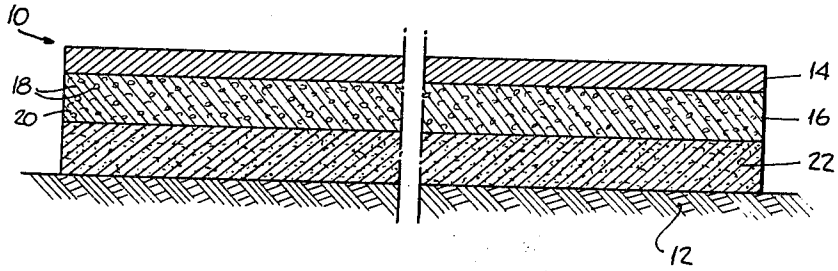
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**ABSTRACT:** Pavement procedures and constructions for materially reducing frost heave in pavements and the like; during construction of the pavement or like structure, an insulating layer consisting essentially of particulate thermal insulating material dispersed throughout a matrix of soil cement is applied to define a frost barrier which insulates the subgrade.

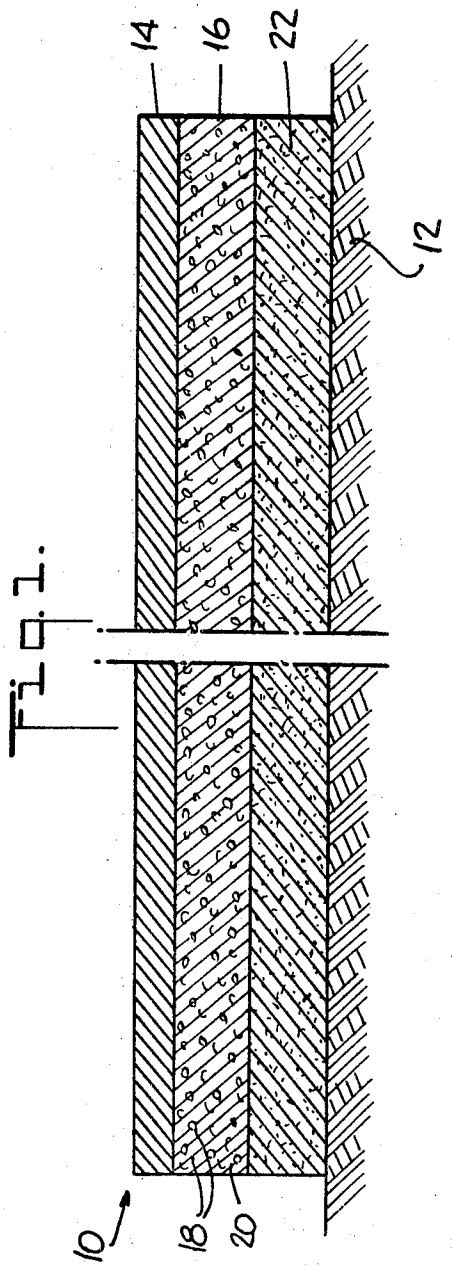



Fig. 1.

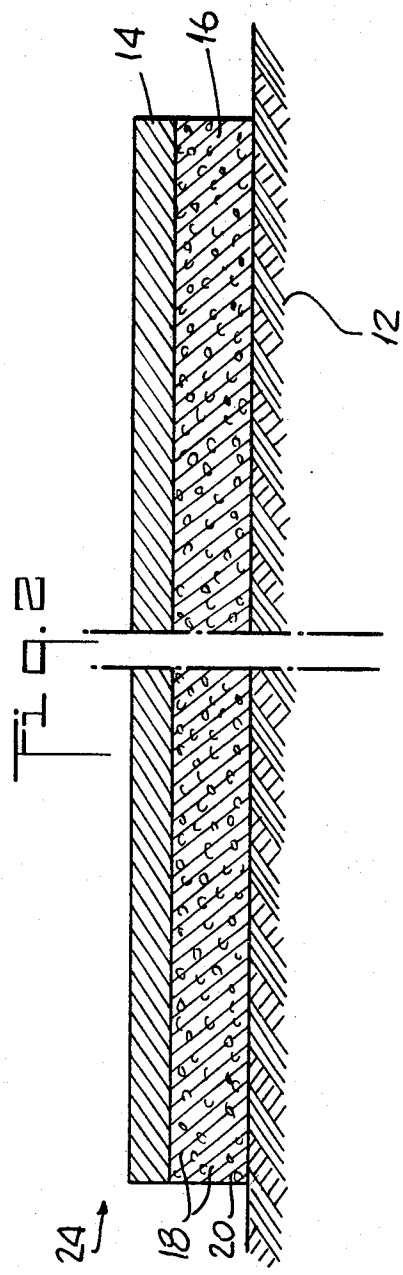



Fig. 2

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# INSULATION METHOD AND CONSTRUCTIONS

This invention relates generally to pavement arrangements for roads, highways, and the like, and more particularly, to novel procedures and constructions permitting substantial reduction in pavement heaving caused by climatic conditions.

It is well known that the combination of a high water table accompanied by low temperatures, particularly as present in certain northern regions, results in what is commonly known as heaving of highways and like surfaces. While many procedures have been tried to minimize this condition, no completely satisfactory, workable and inexpensive solution has been found. Thus, for example, one widely known procedure used to prevent heaving of pavement surfaces is to excavate the subgrade or ground near the trouble spot to a depth below the frost or freezing line of the region, and backfill with a grade of nonfrost susceptible material, such as aggregates containing gravel and/or coarse sand. The resultant backfilled grade is then paved in any conventional manner. In many regions the frost or freezing line extends to a depth of 3 or 4 feet below the surface, and thus this procedure requires deep excavation as well as the use of a substantial amount of nonfrost susceptible material. Since, however, nonfrost susceptible materials, particularly gravel, are becoming scarce and thus very expensive, this widely used backfilling procedure is becoming economically outmoded.

Recently, another procedure has been suggested in an attempt to overcome some of the drawbacks of the discussed backfilling procedure. Briefly, this procedure employs the use of sheets of plastic foam beneath the highway pavement to insulate the subgrade, and thus prevent frost penetration and damage. In one variation, which is really a hybrid of the backfilling procedure described above, the foam plastic sheets are employed as an insulating layer between a layer of nonfrost susceptible material and the subgrade. In this procedure the foam sheets reduce the depth of freezing to a point where a given depth of insulating material, such as the foam sheets, can be substituted for an equivalent of several times the depth of nonfrost susceptible material, thus reducing the amount of costly nonfrost susceptible material. In another variation of this procedure, the foam sheets, usually about 2 inches thick, are placed directly on the subgrade and covered with a portland cement concrete pavement. This variation, like the former, has had some degree of success because of the apparent reduction in cost achieved by the partial or complete elimination of the use of nonfrost susceptible material.

However, while the employment of foam plastic and like insulative sheets may result in some cost saving, as compared to the conventional backfilling procedure, it has been found that in many instances the cost savings realized from the elimination of some or all of the nonfrost susceptible material are substantially offset by the additional costs attendant the use and installation of foam plastic and like insulating sheets. Thus, since sheets of foam plastic, such as expanded cellular polystyrene, are bulky and require excessive manual handling in their transport, significant transportation costs are encountered. Also, since the insulation layer defined by the foam sheets are laid as a separate layer and thus must be manually secured to the subgrade, usually by wooden pegs, and the seams between individual sheets carefully sealed, significant costs are encountered not only in terms of wages for the manhours spent in installing the sheets, but also in terms of tying up road building equipment while the sheets are being installed. Since the foam plastic sheets lack structural strength, great care must be taken to provide an adequate load bearing surface above them to avoid collapse of the roadbed.

In accordance with the present invention there is provided novel pavement procedures and constructions which greatly reduce the costs of providing pavements substantially free from heaving problems as compared to those suggested in the prior art, and which do not entail the expenditure of excessive transportation and installation costs.

According to one aspect of the present invention, I have found that frost heaving of the pavement surface may be materially reduced and substantial costs savings realized by applying, during the construction of the pavement or like structure, an insulating layer consisting essentially of particulate thermal insulating material dispersed throughout a matrix of soil cement. The resultant insulator layer thus performs the dual function of defining a frost barrier to prevent frost penetration to the subgrade and of providing a load bearing surface capable of support of a surface layer for traffic and the like.



The materials used to define an insulation layer constructed in accordance with the present invention may consist of any known organic or inorganic particulate insulating materials having high insulation properties and of any known soil cement. As used herein, the term "particulate" designates a material which is in the form of discrete particles rather than a cohesive mass. Such particles may have a maximum dimension within the range of about one-sixteenth inches to about 6 inches. Thus, for example, organic materials such as cork, sugar cane (bagasse), cotton, wood, rubber and plastics, such as cellular polystyrene as well as inorganic material such as mica, slag, metals and glass may be used as the insulating material. The mixture and particle size of the insulating material is, obviously, determined by the climatic conditions encountered and the best insulating materials available. The most preferred particulate insulating material is a cellular plastic such as expanded polystyrene beads. Such materials are prepared either by expanding polystyrene beads impregnated with a volatile expanding agent under conditions which prevent substantial cohesion, or by expanding such polystyrene beads to form a cellular mass, then breaking or cutting said mass to form discrete cellular particles. In addition, mixtures of different insulating materials can be used. The soil cement may comprise any commonly known intimate highly compacted mixture of pulverized soil and measured amounts of cement and water.

Best results are obtainable if the insulation material comprises between 10—80 percent of the volume of the insulation layer. When less than 10 percent is utilized, the resultant layer formed from the described insulation mixture may have reduced insulating properties. On the other hand, if more than 80 percent of the mixture comprises insulation materials, the soil cement matrix may lack adequate structural foam As will be appreciated by those skilled in the art, the ultimate determination of the exact proportions of the mixture and the thickness of its application will be, in the main, dictated by the climatic conditions encountered in the vicinity of use as well as the nature of the insulation material and soil used. While it is not critical to the invention, I have found that fairly accurate estimates as to the proportions of the mixture and the thickness of its application may be determined by utilizing any of the known textbook analytical solutions relating to the use of FOAM sheets and other insulating materials as a frost barrier layer in pavements and which determine the thickness of the relative layers. Thus, for a given degree-day climatic region, the relative thickness of the apotheosized cement and foam layers are determined in accordance with such solutions and utilized to establish the proportion and thickness of the mixture of the present invention. In general, the thickness of the insulating layer prepared in accordance with the present invention will be of the order of from about 2 to about 10 inches, depending upon the exact materials employed, the relative proportions of cement and insulating material, and the severity of temperature fluctuations at the site of application.

There has thus been outlined rather broadly the more important features of the invention in order that the applications thereof that follows may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described hereinafter and which will form the subject of the claims appended hereto. Those skilled in the art will appreciate that the conception upon which this disclosure is based may readily be utilized as a basis for the designing of other structures for carrying out the several purposes

of the invention. Thus, for example, the constructions of the present invention may be used as an insulation base in arctic regions to keep the tundra or ground from defrosting during the warm seasons as well as an insulating material for surrounding large underground conduits and covering building foundations and the like. It is important, therefore, that the claims be regarded as including such equivalent constructions as do not depart from the spirit and scope of the invention.

An application of the present invention is illustrated by the accompanying drawing, which is diagrammatic in character. The relative thickness of some strata shown therein, in order to indicate the construction of a highway constructed in accordance with the present invention, is greater than would be necessary in practice. The same reference numerals are employed to designate like parts in both FIGS. wherein:

FIG. 1 is an elevational sectional view of a highway pavement constructed in accordance with the present invention; and

FIG. 2 is an elevational sectional view of another highway pavement constructed in accordance with the present invention.

Referring first to FIG. 1, a highway construction 10 developed on subgrade 12 in accordance with the present invention employs a traffic surface pavement 14 of any known construction, a base 16 defined by a layer comprising a mixture of expanded polystyrene beads 18 substantially uniformly dispersed throughout a matrix of soil cement 20, and a subbase 22 formed of a nonfrost susceptible aggregate. In some types of installations, particularly in warmer regions, the layer 22 of nonfrost susceptible material may be omitted as diagrammatically illustrated by the construction 24 in FIG. 2.

Preferably, the polystyrene beads 18 are shipped in bulk in unexpanded form and expanded at the mixing site by any well known method. This, of course, reduces their shipping and handling costs. The expanded polystyrene beads 18 are then mixed with soil cement by any known method now used to mix the soil and the cement to form soil cement. Of course, some minor modifications of such equipment may be necessary to handle the additional bulk, if necessary, as well as blowers, etc., for feeding the beads 18 into the mix. The mixture is then laid by conventional means to form layer 16 on the subgrade 12 or, if provided, on a layer of nonfrost susceptible material, and left to cure. Since the layer 16 is formed by conventional means no significant additional installation expenses, over and above those ordinarily encountered in the application of a pavement base, are necessary. The traffic surface 14 is then laid above and perhaps on the layer 16. It will be understood that further modifications may be made in the novel constructions, in accordance with proper construction techniques. As an example, plastic film materials may be introduced above and/or below the insulating layer to provide an additional water barrier.

It will be appreciated from the above that there has been disclosed novel pavement procedures and constructions which substantially reduce the costs of providing pavement substantially free from frost heave, and which do not entail the expenditure of excessive transportation and installation costs.

Having thus described the invention with particular reference to the preferred forms thereof, it will be obvious to those skilled in the art to which the invention pertains, after understanding the invention, that various changes and modifications may be made therein without departing from the spirit and scope of the invention as defined by the claims appended hereto.

I claim:

1. A method of providing thermal insulation between a structure and ground comprising applying between said structure and ground an insulating layer consisting essentially of particulate thermal insulating material intermixed with soil cement, said thermal insulating material comprising between 10 and 80 percent of the volume of said layer.

2. A method as in claim 1 wherein said structure is traffic pavement and wherein said traffic pavement is subsequently applied over said insulating layer.

3. A method as in claim 1 wherein said structure is traffic pavement and including the step of first applying between said structure and ground a layer of nonfrost susceptible material.

4. A construction for providing thermal insulation between a structure and ground comprising an insulative layer located between said structure and ground, said insulating layer including a mixture of particulate thermal insulating layer including a mixture of particulate thermal insulating material and soil cement, said thermal insulating material comprising between 10 and 80 percent of the volume of said layer.

5. A construction as in claim 4 wherein said structure includes a surface layer adapted for vehicle traffic.

6. A construction as in claim 5 including a layer of nonfrost susceptible material below said insulative layer.

7. A construction as in claim 5 wherein said particulate insulating material comprises expanded polystyrene beads.

8. A construction as in claim 7 wherein said polystyrene beads comprise at least 10 percent of the volume of said insulative layer.

9. A construction as in claim 4 wherein said particulate insulating material is selected from the group consisting of cork, bagasse, cotton, wood, rubber and cellular plastic.

10. A construction as in claim 4 wherein said particulate insulating material is selected from the group consisting of mica, slag, metal and glass.

11. A construction as in claim 4 wherein said structure comprises a conduit.

12. A construction as in claim 4 wherein said structure comprises building foundation structure.