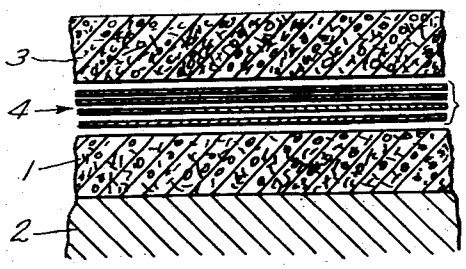
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CONSTRUCTION OF CONCRETE RAFTS, ROADS, AIRCRAFT RUNWAYS AND THE LIKE

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CONSTRUCTION OF CONCRETE RAFTS, ROADS, AIRCRAFT RUNWAYS AND THE LIKE

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This invention relates to the construction of concrete slabs, roads, aircraft runways and the like, hereinafter referred to, for convenience, as slabs.

Concrete slabs are usually constructed by laying a conglomerate of freshly prepared concrete upon a prepared flat base between retaining side walls which may be of a temporary nature, for example wooden boards, and the concrete conglomerate is thereafter allowed to cure into a hard solid mass.

The base may be natural ground, clinker, hardcore, gravel slabs or a previously cured concrete bed.

During the curing process, the concrete undergoes complex chemical changes, known as hydration, and these changes are accompanied by physical contraction. Furthermore, concrete in a solid state undergoes dimensional changes when subjected to changes in temperature or in moisture content.

Owing to friction between a slab and its base, which varies widely for different base materials but which often approaches a coefficient of friction of 1.0, the movements of the slab are resisted with the result that undesirable tensile stresses are set up in the concrete.

These stresses have the effect of overstraining the concrete slab with the result that the slab is more likely to crack under load. Furthermore, during the early stages of curing, the tensile strength of the concrete is low and if the tensile stresses set up by the resistance of the base to movement of the slab exceeds the tensile strength, the concrete will rupture and uncontrolled cracking will occur.

Where a base is composed of granular material such as gravel or clinker, longitudinal movements of the slab due to expansion and contraction give rise to dilation, that is, to rearrangement of the granular material such that the slab is no longer supported evenly along its length. Dilation results in undesirable distortion of the slab.

It is known to provide an interlayer of bitumen or paper between the slab and its base to reduce the friction between the slab and its base. With such an interlayer the effective coefficient of friction between the slab and the base is of the order of 0.5 to 0.6.

It is also known to provide a single plastic sheet, such as a single sheet of polyethylene between a concrete slab and its base to prevent loss of moisture by absorption by the base during the curing process. In this case, the effective coefficient of friction between the slab and the base will be either the coefficient of friction between the slab and the polyethylene or the coefficient of friction between the polyethylene and the base, whichever is the lower. This effective coefficient of friction is of the order of 0.7 to 0.8.

The object of the present invention is to provide improved means for reducing the coefficient of friction between a concrete slab and its base.

According to the present invention, there is provided a method of constructing a concrete slab upon a base, in which the effective coefficient of friction between the slab and the base is substantially reduced, which method comprises covering the base with a sheet assembly of at least two sheets of solid polymeric film material in which the coefficient of friction between at least two of the adjacent sheets is substantially less than the coefficient of friction between concrete and the base, followed by laying a conglomerate of freshly prepared concrete upon the sheet assembly and allowing the concrete conglomerate to cure.

The two adjacent sheets may be of the same or different polymeric film material.

The sheet assembly may comprise two or more separate polyethylene films placed together or preferably, may comprise a length of flattened polyethylene tubing, that is, a tubular film of polyethylene in the collapsed state, when the adjacent inner walls of the tubing are capable of sliding against each other in the same manner as two separate adjacent sheets of polyethylene.

The coefficient of friction between concrete and the base may be determined by finding the minimum force required to cause a flat slab of cured concrete to slide over the base. This test may conveniently be carried out laying the slab upon the base, attaching a spring balance to the slab and applying a force in a horizontal direction through the spring balance. The reading of the spring balance when the slab begins to slip is observed and by dividing the reading by the weight of the slab the desired coefficient of friction is obtained.

The coefficient of friction between concrete and known bases is usually about 1.0 and rarely less than about 0.6.

Since the effective coefficient of friction between the slab and its base is the lowest coefficient of friction between any of the possible sliding surfaces, relative movement of the slab with respect to the base effectively takes place between the adjacent sheets of the sheet assembly.

In a preferred form of the invention, the coefficient of friction between at least two of the adjacent sheets of the solid polymeric film material is not more than 0.25 and preferably about 0.1.

A preferred sheet assembly consists of two sheets of polyethylene film having an interfacial coefficient of friction of not more than 0.25.

A certain type of polyethylene, which owing to its method of manufacture is known as low pressure high density polyethylene, can be extruded into films having an interfacial coefficient of friction of about 0.2. However, polyethylene more commonly used, known as high pressure low density polyethylene, yields films having an interfacial coefficient of friction of about 0.6. Such films are most difficult to handle due to lack of slip between adjacent films and consequently, in the manufacture of such polyethylene films for commercial purposes, such as for wrapping and packaging materials, it is usual to incorporate a slip agent in the polyethylene prior to its extrusion as film, in order to reduce the interfacial coefficient of friction of the film to about 0.25.

Polyethylene film having a still lower interfacial coefficient of friction, suitable for use in a sheet assembly in accordance with the present invention, may be obtained by incorporating in the polyethylene prior to

extrusion, a suitable slip agent, examples of which are given in the following table.

Slip Agent	Percent by weight of slip agent in polyethylene	Interfacial coefficient of polyethylene film of thickness 0.002 in. incorporating the slip agent
A polyethylene glycol alkyl aryl ether such as is marketed as "Ethylan CF" (trademark)	0.2	0.14
A polyethylene glycol alkyl aryl ether such as is marketed as "Texofor F5" (trademark)	1.0	0.16
A polyethylene glycol alkyl aryl ether such as is marketed as "Scurol O" (trademark)	0.2	0.24
Octadecenamide	0.025	0.22
Do	0.050	0.20
Do	0.075	0.13
A polyethylene glycol amine condensate such as is marketed as "Catafor 06" (trademark)	0.2	0.23

The thickness of the polyethylene film for incorporation in the sheet assembly is not critical although if the film is too thin, there is a possibility of it being torn when the slurry of concrete is laid.

For the purpose of the present invention, a polyethylene film of thickness 0.0015 inch is found to be suitable. Thus, when using flattened polyethylene tubing having a wall thickness of 0.0015 inch the sheet assembly will have a thickness of 0.003 inch.

The width of the sheet assembly depends upon the width of the base to be covered and the width of the sheet polymeric film material that can be conveniently handled in practice.

When flattened polyethylene tubing is employed, a width of between 5 and 6 feet is found to be convenient.

A diagrammatic representation of a concrete structure constructed in accordance with the invention is illustrated in the accompanying drawing. In the drawing, a concrete base **1**, which has been laid upon a subsoil bed **2**, supports a concrete slab **3**. Between the concrete slab **3** and the base **1**, there is a sheet assembly **4** consisting of at least two sheets of a polymeric film material in which the coefficient of friction between at least two of the adjacent sheets is less than the coefficient of friction between concrete and the concrete base **1**, thus permitting free movement of the concrete slab **3** with respect to the concrete base **1**.

In the initial stages of curing, the strength of a concrete slab develops rapidly, but the rate of increase in strength decreases with time until the ultimate strength is eventually reached after many months. In practice, it is usual to decide upon the strength required after 28 days curing and to select the proportion of cement, aggregate and water required to give this strength from standard tables.

Since the tensile strength of concrete is difficult to measure in practice, it is usual to define the strength of concrete in terms of its compressive strength obtained by determining the force required to crush a standard cube of the concrete. The tensile strength of the concrete is about one tenth of its compressive strength.

For a concrete slab designed to have a compressive strength of about 5,000 pounds per square inch after 28 days curing, the compressive strength of the slab after 24 hours curing will be of the order of 1,000 pounds per square inch, that is, a tensile strength of about 100 pounds per square inch.

During the first 24 hours of curing a slab 45 feet long and 6 inches thick will shrink to an extent of about 0.075 inch and assuming that the coefficient of friction between the slab and its base is of the order of 0.5 such as would be obtained with a clinker base covered with a waterproofed paper, the tensile stress set up in the slab, due to the resistance of the base of the contraction of the slab, will be of the order of 100 pounds per square inch at the centre of the slab. Thus, there is a distinct possibility of the concrete slab cracking in an uncontrolled manner. However, by reducing the coefficient of friction between slab and base by providing a sheet assembly in accordance with the present invention, the tensile stresses set up in the slab by the resistance of the base are reduced and the danger of uncontrolled cracking is avoided.

Following is a specific example of the method of constructing a concrete slab in accordance with the present invention.

Example

Three beds of subsoil with side walls formed by wooden boards were prepared each 12 feet by 2 feet and on each bed were placed six paving slabs of size 2 feet by 2 feet with their rough side uppermost to form a base 12 feet by 2 feet.

The base of the first bed was covered with a length of flattened polyethylene tubing having a wall thickness of 0.0015 inch, and having an interfacial coefficient of friction of 0.13, manufactured from polyethylene containing 0.075% of octadecenamide as a slip agent.

The base of the second bed was covered with a single sheet of polyethylene 0.003 inch thick having an interfacial coefficient of friction of 0.4 when in contact with a similar sheet.

The base of the third bed was left uncovered.

To estimate the coefficient of friction between a paving slab base and concrete, a concrete paving slab weighing 98 pounds with its rough side in contact with the base was laid on the base and attached to a spring balance. The spring balance was pulled in a direction parallel to the base and was found to read 66 pounds at the point when the slab began to move. Thus the coefficient of friction between the slabs was

$$\frac{66}{98}=0.67$$

The following materials were then mixed to form a concrete conglomerate selected to have a compressive strength of 2,750 pounds per square inch after 28 days curing:

1 part by weight Portland cement.

10 parts by weight aggregate comprising 67.5% of river ballast of a size passing a ¾ inch sieve but retained by a ⅛ inch sieve and 32.5% sharp river sand of the grade known as Zone 1.

0.75 part by weight of water.

By Zone 1 grade sand is meant a sand of such a range of particle size that the percentage by weight of sand passing sieves of specific sizes falls within the following ranges:

Size of sieve, inch:	Percentage pass of sand
⅜	100
3/16	90–100
0.1320	60–95
0.0474	30–70
0.0236	15–34
0.0116	5–20
0.0060	0–10

The conglomerate was laid upon the bases in each of the beds to a depth of 2 inches and allowed to cure.

After a period of 24 hours, each of the slabs was inspected when it was known from standard tables that the compressive strength of the concrete would be about 630 pounds per square inch, that is, the tensile strength would be of the order of 63 pounds per square inch.

The slab in the first bed, constructed in accordance with the invention had no cracks. The slab in the second bed had one crack and the slab in the third bed had two cracks.

In order to estimate the degree of adhesion between each of the slabs and their bases, an attempt was made to slide the end base slab from beneath each of the slabs by inserting wedges between the end base slab and its adjoining slab.

In the case of the first slab, the base slab was moved one inch without damage. In the case of the second slab, the base slab cracked when withdrawn one quarter of an inch and in the case of the third slab, the base slab cracked without appreciable movement of the base slab.

Assuming that the degree of adhesion of the base slab to the subsoil was the same in each case, the above observations indicated that the degree of adhesion of the slab to the base was least in the slab constructed in accordance with the invention, and greatest in the slab laid directly upon the slab base.

One advantage of constructing a slab in accordance with the present invention is that concrete rafts having lower compressive strengths may be laid upon similar bases with greatly reduced risk of cracking during the early stages of curing. Thus, where it was necessary in the past to design a slab with increased strength in order to ensure that its tensile strength in the early stage would not be so low as to give rise to uncontrolled cracking, by using the method of the present invention, concrete of lower compressive strength may be used with a consequent saving of cement.

In slabs of long length, it is the practice to induce the formation of cracks at predetermined intervals in order to form a space between successive lengths of slab for allowing for expansion and contraction due to temperature changes. This controlled cracking is usually induced by placing triangular-shaped rods upon the base at selected intervals before laying the concrete conglomerate. Thus by decreasing the coefficient of friction between the slab and the base by the provision of a sheet assembly in accordance with the invention, the slab has greater freedom of movement during contraction, the tendency for local stresses leading to undesirable uncontrolled cracking is reduced and controlled cracking at the predetermined points is facilitated.

A further advantage of constructing a slab in accordance with the present invention is that the slab is capable of dimensional changes due to changes in temperature or moisture content with a reduced tendency for undesirable local stresses to be set up due to resistance to movement arising from the friction between the slab and the base. Consequently such a slab is likely to withstand climatic changes, without detriment, to a greater extent than slabs constructed in accordance with previous practice.

Furthermore, when the base comprises granular material, the reduction of the coefficient of friction between slab and base by the provision of the sheet assembly reduces the tendency for the granules to be disturbed by the slab movements, and undesirable effects owing to dilation are substantially avoided.

Although polyethylene film has been described as a suitable polymeric film material for use in the sheet assembly, other polymeric film materials having a suitable interfacial coefficient of friction may be used, for example, polytetrafluoroethylene and polyvinyl chloride.

The film material may be either self-supporting or may be a coating upon a suitable base material for example such as paper.

I claim:

1. A method of constructing a concrete slab upon a base, in which the effective coefficient of friction between the slab and the base is substantially reduced which method comprises covering the base with a sheet assembly of at least two sheets of polyethylene in which the coefficient of friction between at least two of the adjacent sheets is less than 0.25, followed by laying a conglomerate of freshly prepared concrete upon the sheet assembly and allowing the concrete conglomerate to cure, the said polyethylene containing between 0.025% and 0.075% by weight of octadecenamide as a slip agent.

2. A method of constructing a concrete slab upon a base, in which the effective coefficient of friction between the slab and the base is substantially reduced which method comprises covering the base with a sheet assembly of at least two sheets of polyethylene in which the coefficient of friction between at least two of the adjacent sheets is less than 0.25, followed by laying a conglomerate of freshly prepared concrete upon the sheet assembly and allowing the concrete conglomerate to cure, the said polyethylene sheet assembly consisting of a length of flattened tubing, wherein said polyethylene contains between 0.025% and 0.075% by weight of octadecenamide as a slip agent.

3. In an article of manufacture comprising a concrete slab, and a base supporting said slab, in which the effective coefficient of friction between the slab and the base is substantially reduced, the improvement comprising a sheet assembly of at least two sheets of polyethylene each having a slip agent incorporated therein to attain a coefficient of friction between at least two of the adjacent sheets of less than 0.25, said sheet assembly resting on and covering said base, and said slab resting on said sheet assembly, the said polyethylene sheet assembly consisting of a length of flattened tubing.

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