

[54] CONCRETE FORM SURFACING

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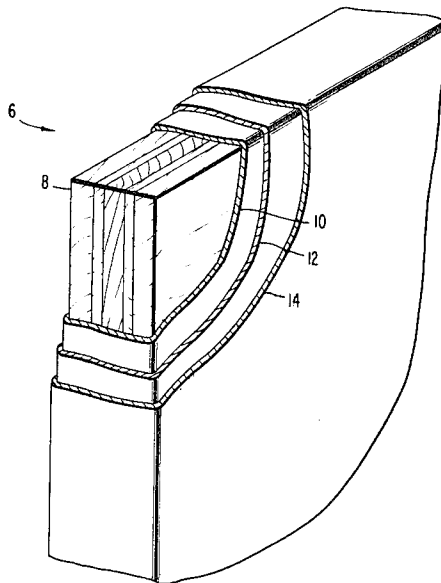
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ABSTRACT

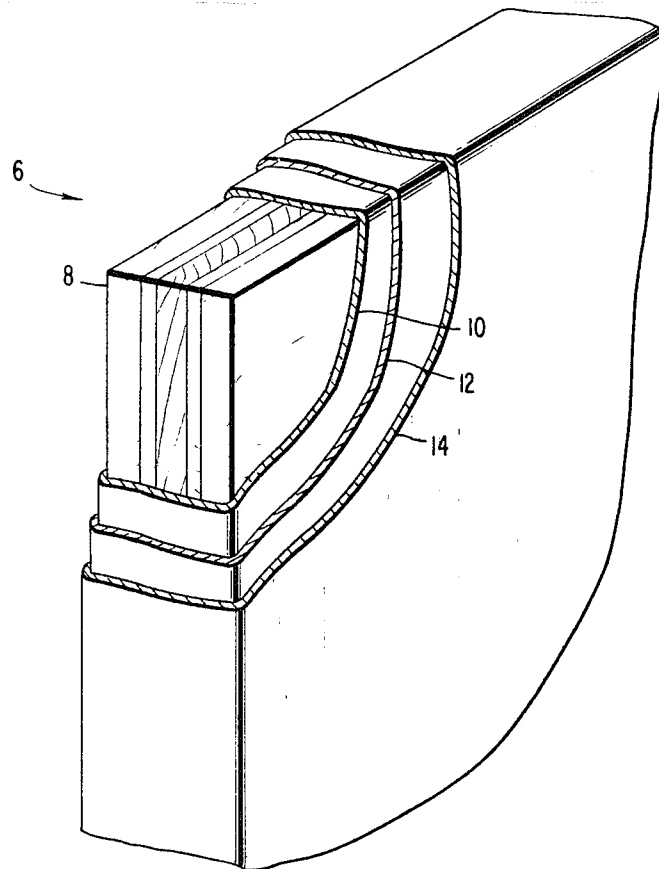
There is disclosed herein a method for preparation and construction of concrete pouring forms in which the surfaces and edges of the form members are treated with several coats of a resinous material exhibiting particularly advantageous mechanical and chemical properties. A preferred material is a moisture cured urethane prepolymer solution.

7 Claims, 1 Drawing Figure



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CONCRETE FORM SURFACING

BACKGROUND OF THE INVENTION

This invention relates to the preparation and construction of forms used for concrete casting, and more particularly to the use of a resinous coating material on the forms to provide greater durability, increased and usable lifetime, and an extremely smooth and uniform surface on the finished concrete product.

Use of forms for casting concrete structures such as wall panels, facades, decking, etc. is well known in the construction industry. Such forms are ordinarily constructed of panel members formed of wood, steel, etc. to provide the concrete forming surface, and of suitable supporting and spacing structure or framing. Ordinarily, wood panels are preferred since wood forms are often less expensive to manufacture and easier to handle due to lighter weight. However, there are several significant disadvantages. For example, the forms are reused many times over in the course of a construction project, but the wood panels rapidly absorb moisture in use. This causes panel surface deterioration and buckling or warpage. Frequent replacement is therefore necessary to assure a flat and uniform surface on the cast concrete product.

Use of steel form panels overcomes several of the above-noted disadvantages, particularly the limited durability of the wood panels. Steel is therefore preferred for extremely large projects or permanent installations. However, the steel forms are heavier and often more costly. Also, they are subject to surface deterioration due to rusting, corrosion, etc.

In recognition of these problems, it has been proposed to improve the durability of wood form panels by coating them with a suitable waterproof plastic. However, such efforts were not completely satisfactory.

In a further effort to overcome these disadvantages, it has been proposed to use a composite panel structure employing a central core of wood or other material with built-up composite faces formed of fiberglass reinforced polyester resin. Such forms may be more durable than forms currently in use, but are also subject to several serious disadvantages. Construction of even simple forms in this manner is relatively complex and costly, and requires utilization of skilled labor. Moreover, such forms can ordinarily not be built at the construction site, but must be prefabricated elsewhere and trucked to the site for assembly. Further, while the panels are relatively durable, they are subject to damage in use, for example, while the finished concrete panel is being removed from the form. The forms are quite difficult to repair, again, requiring skilled labor. As a result, fiberglass reinforced polyester forms are not in use commercially and have not gained acceptance, insofar as applicant is aware.

SUMMARY OF THE INVENTION

In accordance with the present invention, it has been found that the disadvantages of uncoated wood forms and of the heretofore proposed alternatives can be overcome, and form panels can be manufactured in a simple and inexpensive manner by utilization of materials having certain quite specific properties. Forms made according to this invention are durable and may be reused many times, yet they are easily manufactured at the construction site by unskilled workmen. Forms constructed in accordance with this invention have an additional advantage in that the usual form release compositions employed to facilitate separation of the concrete product from the forms may be dispensed with, except for occasional application.

Also, because of the smooth and uniform surface against which the concrete is poured, the resulting product possesses an extremely smooth and uniform surface. In this regard, it has been found quite surprisingly that the concrete surface is so smooth and glossy that it reflects light without substantial diffusion. This property may be of decorative value in some instances, but if desired, the surface may be conveniently treated by sand blasting or otherwise to remove the high surface gloss.

In accordance with the invention, the improved form panel is made by coating a core member formed of wood, steel, or fiberglass with a resinous material having certain particular properties. After suitable curing, a second (and in the case of wood core members) a third coating is applied. After final curing, the panel is ready for use in the assembly of form structures of any desired type.

Coating materials found to be suitable are air or moisture curable resins capable of being thinned to low viscosity for convenient application. In the cured state the coating material should exhibit high hardness and tensile strength, good impact and abrasion resistance, and negligible water absorption. Surprisingly, materials having the requisite properties have been available for some time without industry recognition of their efficacy for the present purpose.

Accordingly, an object of this invention is to provide a new surface treatment for concrete form panels, and to produce such panels having substantially increased durability and extended useful lifetime.

Another object of this invention is to provide a simple and inexpensive technique for construction of concrete forms, whereby the forms may be built by relatively unskilled laborers directly at the construction site. A related object is to provide improved concrete pouring forms, which may readily be repaired at the construction site by unskilled labor.

It is also an object of this invention to provide a concrete pouring form which does not require use of a form release compound on the concrete forming surfaces after each use.

It is a further object of this invention to provide a concrete pouring form which may be utilized to produce concrete having an extremely smooth or glossy and uniform surface.

The exact nature of the invention, as well as other objects and advantages thereof will be apparent from consideration of the following detailed description, and the accompanying drawing in which the single FIGURE shows a simple form panel constructed in accordance with this invention.

DETAILED DESCRIPTION

Referring now to the drawing, there is illustrated a form panel member 6 manufactured according to the present invention. The composite panel includes a core member 8 which may be formed of wood, steel, fiberglass or other suitable material. Core member 8 is coated on all sides and edges with a resinous material having particular properties as specified hereinafter.

For most applications, core member 8 is made of wood, preferably one-fourth to 1 inch plywood. Low grade plywood panels, e.g., grade BB, may be employed since the applied coating provides a smooth and uniform surface even on the rough and nonuniform plywood. As illustrated, on a wood core 8, there are provided several coats of resinous material, e.g., three coats, as indicated at 10, 12 and 14. Best results are achieved if both sides and all edges of the core member are coated with the resinous material. The coating may be applied in any suitable fashion, e.g., by dipping (immersion) brushing, rolling, or spraying. Due to the advantageous properties of the resinous material, each coat may be relatively thin, e.g., 3-6 mils. On wood core members, a minimum of three coats should be employed to provide the desired durability, and to prevent buckling and/or warping of the panel. The inner coat 10 is preferably diluted approximately 50 percent with solvent to reduced the solids concentration, and to promote absorption into the wood surface, whereby this coat serves as a primer. When applied to metal or other nonabsorptive materials, the diluted inner layer may be dispensed with.

After the panel has been coated in the manner hereinafter described, it may be employed in the construction of any conventional or desired type of form. Thus, this invention is applicable to simple forms used for poured-in-place slabs, vertical wall panels or even complex frames or decorative facades. In the latter case, form preparation according to this invention is of special value since the resulting concrete surface is smooth and uniform even if the actual surface profile is quite

complex. However, since the detailed nature of the form itself does not constitute a part of this invention, a description of typical form constructions is omitted in the interest of brevity.

As pointed out above, essential to the success of this invention is the employment of a resinous coating material having certain special properties. Specifically, it has been found that the coating material must be such that the cured coating possesses high hardness without brittleness, high tensile strength, and impact resistance, virtually negligible water absorption, and high resistance to abrasion.

More specifically, it has been found that resinous materials appropriate to the practice of this invention should produce a cured coating which exhibits a minimum tensile strength of between 2,000 and 5,000 p.s.i., elongation between about 20-150 percent, hardness (Sward) between about 30 and 60, Taber Abrasion weight loss (CS10 wheel, 1,000 g. wt. 1,000 cycles) not exceeding about 75 mg., and minimum impact resistance (Gardner) of 140 in.-lbs. (direct and reverse). In the uncured state, the resinous material should not exhibit a viscosity (Brookfield) significantly exceeding about 150-160 c.p.s. or a specific gravity significantly exceeding about 0.95-1.0.

While materials exhibiting the foregoing combination of properties are not common, there are a number of highly suitable materials available. These include single component resin systems such as air cured urethane oils (isocyanate modified drying oils) and moisture curable isocyanate terminated urethane prepolymers. Heat curable urethane resins (single component) may also be suitable, but do not lend themselves to convenient use at the construction site. Likewise, two component systems including catalysts may be suitable but less convenient.

One particularly satisfactory material is a moisture cured aromatic diisocyanate prepolymer known as Neorez U 105, distributed by Polyvinyl Chemicals Inc., Wilmington, Mass. Using this material, a cured coating (thickness 3 mils) may be produced having properties as set forth in Table I below:

Tensile Strength	Elongation	7000 p.s.i.
Hardness (Sward):		
1 day		24
Ultimate		45
Impact Resistance		
Direct		160 inch-lb.
Reverse		140 inch-lb.
Taber Abrasion (CS10 wheel,		
1000 g. load, 1000 cycles)		23 mg.

TABLE I: Film Properties of Preferred Resinous Material

By virtue of these properties the described prepolymer is the preferred coating material, but it will be understood that other materials exhibiting comparable properties may also be employed. For example, a similar material can be obtained from the C. P. Hall Chemical Company of Chicago, Illinois or Cook Paint and Varnish Company, Kansas City, Missouri.

Liquid coating materials exhibiting the above properties should also be susceptible to solvent thinning or other viscosity adjustment to permit application to the form panels by dipping, brushing, rolling, or spraying. For the urethane prepolymer materials described this can be accomplished by use of xylene, Cellosolve acetate (ethylene glycol monoethyl ether acetate) or mixtures thereof.

Further in this regard, it should be noted that the solids concentration of the liquid coating material is directly related to the durability. However, excessive solids concentration is unsatisfactory since high viscosity results, preventing satisfactory application to the core members. In particular, for the materials suitable for use according to this invention, it has been determined that the solids concentration and viscosity vary in the manner set forth in Table II below:

Solids Concentration	Viscosity (Brookfield) cps.
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60%	1200
50%	700
40%	160
30%	100

TABLE II: Variation of Viscosity with Solids Content

Best results are obtained for coating by brushing, rolling or dipping at a viscosity of about 150-160 c.p.s. while spraying is best accomplished at a viscosity of about 100 c.p.s. Thus thinning to solids concentrations of 40 percent for brushing, etc. or 30-35 percent for spraying, yields best results.

In addition to the foregoing, certain other requirements for proper application of the coating material to the form panels, curing, etc. should be observed for best results. The following examples illustrate the manner in which all requirements should be met in successful practice of this invention.

EXAMPLE 1

A plywood board, three-fourths inch, grade BB is cut to the proper size and shape. A moisture curable, urethane prepolymer exhibiting film properties as set forth in Table I, and having a solids concentration of approximately 40 percent, a viscosity of 150 c.p.s. is xylene thinned 50 percent to reduce solids concentration. The thinned prepolymer solution is applied to all surfaces and edges of the plywood core member as a primer coat. This may be done by dipping, brushing, or rolling as desired. The coated core member is then cured in air for approximately 3 to 4 hours under conditions of at least 50 percent relative humidity. Then, second and third coats of unthinned prepolymer solution (40 percent solids, 150 c.p.s. viscosity) are applied to the once-coated core member, again by brushing, rolling, or dipping. The second and third coats are each air cured in the manner previously described. The composite form panel is then ready for use in a form of any desired design. Plywood form panels prepared in the manner described can be used one hundred or more times without significant surface or structural deterioration.

EXAMPLE 2

A steel plate (7 gauge) is sandblasted or otherwise treated and then cleaned to produce a rough, generally uniform surface. The urethane prepolymer solution described in Example 1 is solvent thinned to a 30 to 35 percent solids concentration. At least two coats of the prepolymer solution are sprayed onto the plate on both sides and all edges. After each application, the coating is air cured as in Example 1. The result is an ultradurable, rustproof concrete form panel usable well in access of one hundred times without resurfacing. When necessary, the panel may be sandblasted and recoated. The panel so treated is found to be completely renewed and ready for use.

EXAMPLE 3

A fiberglass core member is precast in any desired surface configuration to produce a forming surface usable in the casting of decorated facade panels, etc. The durability of such panels may also be enhanced according to this invention. Thus, the fiberglass surface is sanded or otherwise roughened. Two coats of a polyurethane coating solution exhibiting film properties as set forth in Table I is thinned to a viscosity of approximately 150 c.p.s. and applied to the fiberglass core member by dipping, rolling, or brushing. Each coat is cured until hard. In this way, a highly durable form member may be produced having an extremely smooth and uniform surface. The form member so treated may be used to form intricate surface patterns without the necessity of form release compounds.

EXAMPLE 4

As noted above, a particular advantage of the form panels manufactured in accordance with this invention is the amenability to rapid and effective repair by unskilled personnel.

Thus, in the event that a panel prepared as in Examples 1-3 has been damaged, e.g., from impact with the cast concrete product during removal from the forms, the affected portion can be repaired as follows: the damaged area is rough-sanded, and deep scars in the core member are built up with a suitable filler composition e.g., a compatible epoxy-type filler). The affected area is leveled by sanding and cleaned. The area is then recoated as described above with two or three coats of the coating material and each coat is cured. A damaged panel is completely renewable in this manner.

As may be seen from the foregoing, several variations in the appropriate procedure may be possible. Also, in Example 1, use of a moisture cured, urethane prepolymer under dry conditions, for example, below about 50 percent relative humidity, may be unsatisfactory since the curing time is substantially lengthened, and, in the case of extremely low humidity, curing is completely inhibited. Under such conditions, air cured urethane-modified drying oil compositions or other materials exhibiting properties as set forth herein should be substituted. Alternatively, a cross-linker, for example, a polyhydroxy amine such as sold under the name Quadrol by Wyandotte Chemical Corporation may be added to the prepolymer in a concentration of about 2 to 4 oz. per gallon for curing at a relative humidity between about 30 and 50 percent. For relative humidity substantially below about 30 percent, 6 oz. of cross-linker per gallon of prepolymer solution may be employed.

Further, under low temperature conditions, the curing time for the prepolymer is increased. To overcome this, a suitable accelerator compatible with the particular urethane prepolymer may be employed.

As an additional extension of the present concepts, it is contemplated that form surface repair can be facilitated by preparing the liquid resinous material in aerosol form with a conventional compatible propellant. This would permit convenient on-the-spot repair of minor damage. As will be appreciated, the various mechanical properties described herein should be observed in selection of the resinous material for aerosol packaging. Again, however, the moisture curable isocyanate terminated prepolymer is preferred.

The present invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A method of making a rigid form member with a cured, single component resin coated exterior for a concrete pouring form having surface characteristics of tensile strength of at least 2,000 to 5,000 p.s.i., hardness (Sward) between about 30 and 60, impact resistance (Gardner) of at least about 140 in. lbs. direct and reverse, and Taber Abrasion (CS10 wheel, 1,000 grams, 1,000 cycles) maximum weight loss of less than 75 milligrams, which comprises:

providing a wooden core member having a preselected shape and dimensional configuration;

applying a first coating to all surfaces of said core member, said coating consisting of a moisture curable, isocyanate-terminated, urethane prepolymer in a solvent, having a solids concentration of approximately 20 percent and a viscosity (Brookfield) of less than 100 c.p.s.

exposing said coated surfaces to ambient atmospheric moisture for a period sufficient to cure said coating;

subsequently, applying a plurality of additional coatings to all surfaces of said member; each of said additional coatings consisting of the said urethane prepolymer in a solvent having a solids concentration of about 30 percent to about 40 percent and a viscosity (Brookfield) not exceeding approximately 150 c.p.s.

successively exposing said coated surfaces to ambient atmospheric after each of said coatings is applied for a period sufficient to cure said coating before each additional coating is applied.

2. The method of claim 1 wherein the wooden core member is plywood.

3. The method of claim 1 wherein the solvent is at least one member selected of the group consisting of xylene and ethylene glycol monoethyl ether acetate.

4. The method of claim 1 wherein the curing period is from 3 to 4 hours in relative humidity of greater than 50 percent.

5. A method of making a rigid form member with a cured, single component, resin coated exterior for a concrete pouring form having surface characteristics of tensile strength of at least 2,000 to 5,000 p.s.i., hardness (Sward) between about 30 and 60, impact resistance (Gardner) of at least about 140 in. lbs. direct and reverse, and Taber Abrasion (CS10 wheel, 1,000 grams, 1,000 cycles) maximum weight loss of less than 75 milligrams which comprises:

providing a core member having a preselected shape and dimensional configuration, said core comprising steel, wood, or fiberglass;

applying a first coating to all surfaces of said core member, said coating consisting of a moisture curable, isocyanate-terminated, urethane prepolymer in a solvent having a solids concentration of approximately 50 percent of the solids concentration of subsequently applied coatings and a viscosity (Brookfield) of less than approximately 150 c.p.s.

exposing said coated surfaces to ambient atmospheric moisture for a period sufficient to cure said coating;

subsequently applying at least one additional coating to all surfaces of said member; said additional coating consisting of the said urethane prepolymer in a solvent having a solids concentration of about 30 percent to about 40 percent and a viscosity (Brookfield) of approximately 150 c.p.s.

successively exposing said additionally coated surface to ambient atmospheric moisture for a period sufficient to cure said coating.

6. The method of claim 5 wherein the solvent is at least one member selected from the group consisting of xylene and ethylene glycol monoethyl ether acetate.

7. The method of claim 5 wherein the curing period is from 3 to 4 hours in relative humidity not greater than about 50 percent.

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