

DESCRIPTION

CURING ACRYLIC RESIN TOPCOAT PAINT COMPOSITION FOR CONCRETE
FORM PLYWOOD, CONCRETE FORM PLYWOOD, AND MANUFACTURING PROCESS
5 OF THE CONCRETE FORM PLYWOOD

FIELD OF THE INVENTION

The present invention relates to a curing acrylic resin
topcoat paint composition for concrete form plywood, a
10 concrete form plywood and a manufacturing process thereof.
More particularly, the invention relates to a curing acrylic
resin topcoat paint composition for concrete form plywood that
enables a concrete form plywood coated with the composition
to be released (stripped) extremely easily from hardened
15 concrete and whereby permits reuse of the concrete form many
times, i.e., the composition imparts good release and reuse
properties to the coated concrete form plywood; the invention
also relates to a concrete form plywood reusable many times
to build a form, and to a process for manufacturing the concrete
20 form plywood.

BACKGROUND OF THE INVENTION

Wooden boards (substrates) without surface coating such
as painting are sometimes used as concrete form plywoods. But

most often concrete form plywoods are coated with paints or the like to prevent problems such as insufficient curing of concrete surface by deterioration of wood materials, color of concrete surface with a resin exudate from wood materials, and
5 penetration and attachment of wood vessels caught in the surface of hardened concrete.

Processes for coating a concrete form plywood include:

(a) attaching phenolic resin-impregnated paper to a surface of the concrete form plywood, (b) pressure bonding molten
10 plastic powder, and (c) applying polyester urethane resin paints, epoxy resin paints and acrylic urethane resin paints.

However, the attachment of phenolic resin-impregnated paper and the pressure bonding of molten plastic powder to the concrete form plywood require high-cost manufacturing
15 facilities and materials. Further, a concrete form plywood coated with a polyester urethane resin paint tends to cause insufficient hardening of concrete (which is a hardened product from reaction of water, cement, sand and gravel, and generally has high strength). Moreover, coating a concrete
20 form plywood with an epoxy resin paint results in poor weathering and crack resistance.

Acrylic urethane resin paints are capable of imparting tolerable weathering and crack resistance to a concrete form plywood. In general, a concrete form plywood is successively

coated with two paints: a filler coat paint and a color paint. After several uses in concrete placement, the paint film on the forming plywood will bear lime wash (a hardened product from reaction of cement and water, poor in strength but very fine grained) or concrete waste to cause lowered form-release properties. Moreover, repeated use results in cracks in a plywood being a form substrate, ply separation of the plywood when the form is released, removal of the paint film from the form plywood surface, and damaged surfaces such as depressions (tears) in the substrate that are caused when vessels of the wood-based substrate surface are caught in and torn by hardened concrete, and fuzzing vessels. Furthermore, the paint film of the form plywood is cracked and consequently the concrete surface becomes uneven. Still further, saps of wood materials adhere to the concrete surface and color the surface dark brown. Accordingly, reuse of the concrete form plywoods is practically limited to 5 or 6 times and the plywoods used are incinerated.

However, the incineration of construction waste materials including the concrete form plywoods at building sites has been legally prohibited from the viewpoint of pollution problems. Consequently, the transportation and disposal costs of used form plywoods have added a greater burden on the business of building contractors and others.

Accordingly, there is a need for a concrete form plywood reusable as many times as possible, for example 10 or more times, to reduce costs for transportation and outsourced disposal of used form plywoods.

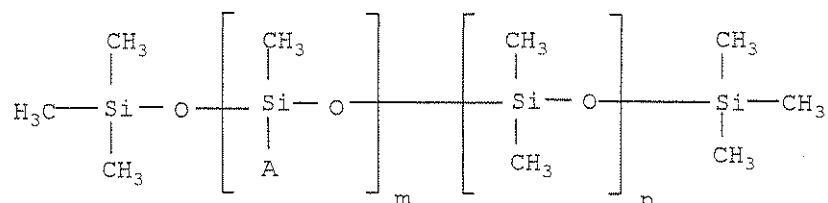
5 Meanwhile, acrylic urethane topcoat paints that contain organopolysiloxanes containing a crosslinkable unsaturated group, and modifications thereof with silicon compounds have been proposed (for example, Patent Documents 1 to 8, and 10).

Japanese Patent No. 2583230 (Patent Document 1)

10 discloses a coating composition that comprises: (i) a copolymer mixture including (a) a copolymer with an active hydrogen group and (b) an acryl copolymer resin with an active hydrogen group which has a solubility parameter larger by 0.7 or more than that of the copolymer (a); and (ii) a curing agent
15 having a solubility parameter larger by 0.5 to 1.5 than that of the copolymer (a). The copolymers (a) described include fluoro-resins and silicon-containing copolymers having at least one bond selected from -OH, -COOH, -NH₂, >NH, -SH, -SiOH and -SiH. The document also describes that the coating
20 composition applied to a general topcoat paint film can give a topcoat exterior paint film having excellent resistance to weather, solvent and contamination, superior appearance and good adhesion with the substrate and recoated paint film.

JP-A-H02-261868 (Patent Document 2) discloses a

two-package paint composition that comprises a principal component including a hydroxyl-containing paint-forming resin, a leveling agent, a lubricant and a solvent, and an isocyanate curing agent component, wherein the principal component contains predetermined amounts of a leveling agent containing at least an acrylic acid and an alkyl acrylate polymer, and a wetting agent being a polysiloxane polyether copolymer. The polysiloxane polyether copolymers described as the wetting agent include copolymers of nonionic polyether (A), such as ethylene oxide or propylene oxide, and methylpolysiloxane, represented by the formula:



wherein $m > 1$, $n \geq 0$ and A = nonionic polyether. According to the patent document, the two-package paint composition can be applied as a primer to an automobile bumper RIM (reaction injection molded) article containing an internal mold release agent such as metal soap to form a paint film with excellent adhesion. The document also describes that the paint can be applied without cissing.

JP-A-H10-67844 (Patent Document 3) discloses a thermosetting resin composition that comprises: (A) a film-forming polyol resin having a specific hydroxyl value and

a specific number-average molecular weight; (B) a blocked isocyanate curing agent or an amino resin capable of reacting with the resin (A); and (C) a silicate condensate obtained by treating at least one partially hydrolyzed condensate of an alkoxy silane compound of the formula $(R^1)_n-Si-(OR^2)_{4-n}$ (definitions omitted) with a silane coupling agent of the formula $R^3Si(R^4)_m(OR^4)_{3-m}$ (definitions omitted). The polyol resins (A) described include (modified) acrylic polyol resins and (modified) silicone polyol resins. The patent document describes that the thermosetting resin composition applied as a prime coat on a polyester primer-coated steel plate shows good curing properties, contamination resistance, hardness and acid and alkali resistance, and the paint has excellent properties such as storage stability.

JP-A-2001-329214 (Patent Document 4) discloses a topcoat paint composition that contains: (A) a polyol resin solution and/or a polyol resin dispersion in which a polyol resin with a weight-average molecular weight of 160,000 to 1,000,000 is dissolved and/or dispersed in a nonaqueous solvent; (B) a curing agent reactive with the hydroxyl group of (A); and (C) a condensate of a silane compound. The composition is described to be suitable as a topcoat paint for repairing an old paint film in the building exterior and interior and also suitable as a topcoat paint for applying to

substrates such as concrete and metals.

JP-A-2001-329223 (Patent Document 5) discloses a topcoat paint composition that contains: (A) a polyol resin solution and/or a polyol resin dispersion in which a polyol
5 resin is dissolved and/or dispersed in a nonaqueous solvent; (B) a curing agent reactive with the hydroxyl group of (A); and (C) a condensate of a silane compound having a specific structure. The composition is described to give a paint film that has good adhesion with a paint overcoated for repairing
10 and is excellent in resistance to contamination by raindrops.

JP-A-H11-286648 (Patent Document 6) discloses a curing topcoat composition (a) that comprises: 100 parts by weight of an acrylic copolymer (A) having a reactive silyl group bonded with a carbon atom, and a hydroxyl group, represented by the
15 formula (1): $(R^1O)_{3-a}-Si(R^2)_a-C\equiv$ (wherein R^1 and R^2 : H or C1-10 alkyl group, a: integer from 0 to 2); 2 to 70 parts by weight of a silicon compound and/or a partially hydrolyzed condensate thereof (B) represented by the formula (2): $(R^3O)_{4-b}-Si-R^4_b$
(wherein R^3 and R^4 : C1-10 alkyl group, b: 0 or 1); and 0.1 to
20 50 parts by weight of a crosslinking agent compound (C) having at least two isocyanato groups. The document describes that a topcoat paint film with superior contamination resistance, adhesion, solvent resistance and impact resistance can be obtained by applying the curing topcoat composition (a) to a

substrate surface such as a metal or cement that has been primer coated with an epoxy sealer or to a surface coated with a usual topcoat paint such as an acrylic paint or a urethane paint.

JP-A-H11-315252 (Patent Document 7) discloses a coating
5 resin composition obtained by copolymerization of: (A) a copolymer resin having an active hydrogen in the molecule, the copolymer resin being produced from polydialkylsiloxane with a polymerizable unsaturated group, organopolysilsesquioxane with a polymerizable unsaturated group and a compound with a
10 polymerizable unsaturated group; (C) an optional copolymer resin; and (B) a crosslinking agent capable of reacting with the active hydrogen, preferably an isocyanate compound. The document describes that the composition can give a paint film that possesses excellent weathering resistance, oil
15 resistance, marker-ink repellency and stability thereof, peeling strength stability, and non-migration to an adhesive layer.

JP-A-2000-86975 (Patent Document 8) discloses a coating resin composition that comprises a crosslinking agent in which
20 a specific organopolysiloxane is incorporated in the molecular skeleton and whose molecule has at least two reactive groups capable of reacting with an active hydrogen to form a crosslinked structure, and a specific silicate. The document describes that the composition can give a paint film having

good adhesion with a substrate and excellent weathering resistance, anticontamination properties and easy contamination release properties, and can be favorably used as top coats for buildings and vehicles.

5 JP-A-S61-103966 (Patent Document 10) discloses a process for making a composite film, which comprises steps in which a substrate is coated with a primer composition that contains an acrylic polyol and a polyfunctional organic isocyanate compound, the acrylic polyol containing a
10 (meth)acrylate represented by $\text{CH}_2=\text{CR}-\text{CO}_2\text{X}$ (definitions omitted), the coating is heated to dryness and cured, and the resultant primer coat is coated with a coating composition including an organosilicon compound of the formula $\text{R}^1_a\text{R}^2_b\text{Si}(\text{OR}^3)_{4-a-b}$ (definitions omitted) and/or a hydrolyzate
15 thereof, followed by curing. The document describes that the composite film provided on substrates such as glass, metals and surfaces coated with various paints can exhibit good mar resistance and surface hardness.

However, close investigation of Patent Documents 1 to
20 8 and 10 does not find any technical idea that a concrete foam surface is coated with a form-release agent. Accordingly and naturally, these documents do not describe or suggest that the coating compositions and paints they disclose can be applied to a form to permit easy release from hardened concrete and

repeated use of the form.

There have been proposed plywood filling urethane resin paints (Patent Documents 9 and 11).

JP-A-H04-288379 (Patent Document 9) discloses a process
5 of filling a wooden plywood, which comprises applying a paint
that contains an unsaturated polyester resin having at least
two unsaturated double bonds and at least one hydroxyl group
in the molecule, a polyisocyanate compound, an extender
pigment, an organic peroxide catalyst, a reactive diluent and
10 a drying accelerator. The unsaturated polyester resin is
described to result from esterification (dehydration
condensation polymerization) of an unsaturated dibasic acid
such as maleic acid and a polyhydric alcohol such as ethylene
glycol.

15 JP-A-2002-102792 (Patent Document 11) discloses a
process of producing a coated form plywood, which comprises
coating a form plywood with a solvent type penetrative sealer
having a specific viscosity; applying a prime coating paint
having a specific viscosity that contains a water-dispersible
20 resin and/or a water-soluble resin and a water-dispersible
polyisocyanate, or a prime coating paint that contains a
solvent type resin with a hydroxyl group and a solvent type
polyisocyanate; and applying a topcoat paint. Also disclosed
is a process of producing a coated form plywood, which comprises

coating a form plywood with an aqueous penetrative sealer having a similar specific viscosity that contains a water-dispersible resin and/or a water-soluble resin and a water-dispersible polyisocyanate, and applying the above
5 prime coating paint and topcoat paint sequentially.

The filled plywoods coated according to Patent Documents 9 and 11 show insufficient form-release and reuse properties when used as concrete forms.

Further, various urethane acrylate paints applicable to
10 concrete forms and wooden substrates have been proposed, as described in Patent Documents 12 to 20.

JP-B-H05-39768 (Patent Document 12) discloses a polyurethane concrete-releasing paint that comprises 100 parts by weight of a polyurethane paint having a specified
15 formula (omitted) and 10 to 300 parts by weight of a plasticizer having a boiling point of 250°C or above, wherein the polyurethane paint is obtained by reaction of an organic polyisocyanate having a specific molecular weight and at least two (on average) isocyanate groups with an active
20 hydrogen-containing compound having a specific molecular weight and at least two (on average) active hydrogen groups, and has a specific polyurethane crosslinking density. Also disclosed is a concrete form obtained by applying the paint to a board. The document describes that silicone and the like

can be added to the paint, and that the paint applied to a wooden or metal form surface permits easy release, high water resistance and reuse, namely, the coated form has good release and reuse properties.

5 JP-B-H05-39767 (Patent Document 13) discloses an embodiment in which the active hydrogen-containing compound described in JP-B-H05-39768 (Patent Document 12) contains as essential component a reaction product between a bisphenol and oxyalkylene ether. The same effects as achieved by Patent
10 Document 12 are described.

JP-B-H07-2931 (Patent Document 14) discloses a concrete releasing paint which is applied to a surface of a wooden member contacted with concrete to permit easy release from concrete, wherein a paint resin comprises an organic polyisocyanate and
15 an active-hydrogen containing compound such as polyol, and the organic polyisocyanate is non-penetrative in the wooden member. Also disclosed is a concrete form in which the paint is directly applied to a board surface. The document describes that
silicone and the like can be added to the paint and that
20 excellent effects can be achieved in surface smoothness of the paint film and concrete, easy release and reuse properties (at least 10 times).

JP-B-H07-98918 (Patent Document 15) discloses an acrylic urethane paint composition for coated concrete form

plywood that comprises an acrylic resin and a polyisocyanate curing agent wherein the acrylic resin has a solid hydroxyl value of 10 to 150 mg KOH/g, a glass transition temperature of 20 to 100°C and a weight-average molecular weight of 30,000 to 100,000. Also disclosed is a process of fabricating a coated concrete form plywood, which comprises applying an acrylic emulsion paint to a plywood substrate followed by drying, and applying the acrylic urethane paint composition followed by quick drying at ambient temperature. The document describes that the acrylic urethane paint composition applied to the acrylic emulsion prime coat on the plywood can dry quickly at ambient temperature (20 to 25°C), and the thus-coated concrete form plywoods have good drying properties such that they can be stacked without blocking (sticking) between coated surfaces, and further describes that the paint film has good adhesion with the substrate and excellent concrete-release properties.

JP-A-H09-221627 (Patent Document 16) discloses a solvent-free urethane paint composition for coated concrete form plywood that contains a polyol-modified acrylic resin having a hydroxyl value of 50 to 400 mg KOH/g and a polyisocyanate compound, wherein the polyol-modified acrylic resin comprises a polyol having at least two hydroxyl groups in the molecule and an acrylic resin having a hydroxyl group.

The document describes that the paint composition applied to a primer coated plywood provides good concrete-release properties.

JP-A-H10-120896 (Patent Document 17) discloses: a
5 curing composition that comprises in combination (A) a polyol having a specific weight increase rate and viscosity, (B) a polymer having a specific hydroxyl value, and (C) an isocyanate compound having at least two isocyanate groups in the molecule;
a curing composition that comprises in combination (A') a
10 polyoxyalkylene polyol, (B) the polymer, and (C) the isocyanate compound; and a paint containing any of the above curing compositions. The document describes that the paint has good curing properties, provides excellent appearance of a paint film, and is suitably used for painting a concrete form
15 plywood.

JP-A-H11-116893 (Patent Document 18) discloses a concrete form paint composition that essentially includes: a principal component comprising (a) a polyol from addition reaction of (poly)alkylene oxide to both ends of bisphenol A
20 and/or (b) a compound having at least two hydroxyl groups per molecule, and (c) xylene having no reactive group in the molecule and has a specific substituent group; and a curing component being a polyisocyanate. The document describes that the composition applied to a wooden plywood can give a paint

film excellent in blocking resistance, form-release properties, weathering resistance and resource saving properties.

Japanese Patent No. 2866662 (Patent Document 19)

5 discloses a wood-painting polyurethane resin composition that contains: a copolymer obtained by polymerization of (A) a hydroxyl-containing monoethylenically unsaturated monomer, (B) a monobasic acid and/or a polybasic acid having an ethylenically unsaturated double bond, and (C) another
10 ethylenically unsaturated monomer; and polymethylene/polyphenyl/polyisocyanate. The document describes that the composition can be applied to a lauan plywood and dried at room temperature to give a paint film having superior gloss, alkali resistance and blocking resistance to
15 those of the conventional polyurethane paint films, and also describes that the composition is useful for painting concrete form plywoods.

JP-A-2002-97412 (Patent Document 20) discloses a painting resin composition containing a polyol (A1) or (A2),
20 a polyether polyol (B) and a solvent (C), wherein the polyol (A1) results from reaction of a hydroxyl-containing polymerizable unsaturated monomer and a polymerizable unsaturated monomer having a cyclic structure, and the polyol (A2) results from reaction of a hydroxyl-containing

polymerizable unsaturated monomer and a polymerizable
unsaturated monomer having a specific straight-chain and
branch structure. The document describes that the composition
can contain a resin such as a silicon resin or an organosilicate
5 condensate, can be used as prime, intermediate and topcoat
paints, can be applied to substrates such as plywoods, and can
provide superior gloss, weathering resistance and flexibility.
(But Patent Document 20 does not describe or suggest that the
composition can be applied to concrete form plywoods and
10 form-release properties.)

However, concrete form plywoods coated with the paints
and the like disclosed in Patent Documents 12 to 20, namely,
concrete form plywoods, are unsatisfactory in any of form
releasability, interlaminar bond strength with the substrate,
15 alkali resistance, crack resistance, substrate-surface hiding
properties and paint film appearance and state.

Meanwhile, use of urethane paints as concrete form paints
has been proposed (for example, Patent Documents 21 to 28).

Japanese Patent No. 2866662 (Patent Document 21)
20 discloses a wood-painting polyurethane resin composition that
contains: a copolymer obtained by polymerization of (A) a
hydroxyl-containing monoethylenically unsaturated monomer,
(B) a monobasic acid and/or a polybasic acid having an
ethylenically unsaturated double bond, and (C) another

ethylenically unsaturated monomer; and
polymethylene/polyphenyl/polyisocyanate. The document
describes that the composition can be applied to a lauan plywood
and dried at room temperature to give a paint film having
5 superior gloss, alkali resistance and blocking resistance to
those of the conventional polyurethane paint films, and also
describes that the composition is useful for painting concrete
form plywoods.

Japanese Patent No. 2719045 (Patent Document 22)
10 discloses a process for fabricating a coated concrete form
plywood, which comprises coating a form plywood with a prime
paint comprising an alkali resistant wood-filler, applying a
topcoat paint that comprises a moisture curing mixture
containing an NCO-terminated urethane polymer (reaction
15 product of polyoxypropylene polyol and polyisocyanate) and
polyisocyanate, and allowing the topcoat paint to cure with
help of a catalyst component in the prime paint.

JP-A-H08-142032 (Patent Document 23) discloses a
process of making a coated form plywood, which comprises
20 coating a form plywood with a prime paint that comprises a
water-dispersible resin and/or a water-soluble resin, a filler
and an isocyanate compound, and applying a topcoat paint based
on a silicon-modified urethane resin. Also described is a
method for moisture curing the silicon-modified urethane

resin.

JP-A-2000-167814 (Patent Document 24) discloses a process for producing a coated form board, which comprises coating a concrete form board, which is made by means of
5 compressing and heat bonding waste paper and a binder, with a prime coating paint that contains a moisture curing urethane resin (rigid urethane resin), and applying a topcoat paint that contains a two-package reaction type urethane resin (soft urethane resin).

10 JP-A-2002-309171 (Patent Document 25) discloses a method of preventing attachment of a hydraulic mixture such as cement by coating a substrate surface with an NCO-terminated urethane polymer that is obtained by reacting polyether polyol and/or polyester polyol, with polyisocyanate.

15 JP-A-2002-322240 (Patent Document 26) discloses a moisture curing urethane composition that contains an NCO-terminated urethane polymer and an oxazolidine-terminated urethane compound, wherein the NCO-terminated urethane polymer is obtained by reacting isocyanate with
20 polyoxyalkylene polyol. The document describes that the composition has excellent adhesion with a topcoat material.

JP-A-H11-310621 (Patent Document 27) discloses a coated concrete form plywood that is coated with a urethane elastomer obtained by reacting an NCO-terminated prepolymer with a

curing agent comprising a hydroxyl-containing compound. The coated form plywood is described to be reusable without use of a release agent.

JP-A-2002-294137 (Patent Document 28) discloses an
5 aqueous paint composition containing an acrylic silicone resin emulsion and a polyurethane emulsion. The document describes that a paint film from the composition displays greatly enhanced crack resistance.

However, concrete form plywoods coated with the paints
10 and the like disclosed in these patent documents, namely, concrete form plywoods, are unsatisfactory in any of crack resistance, form releasability, interlaminar bond strength with the substrate, alkali resistance, substrate-surface hiding properties and paint film appearance and state.

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Patent Document 1: Japanese Patent No. 2583230

Patent Document 2: JP-A-H02-261868

Patent Document 3: JP-A-H10-67844

Patent Document 4: JP-A-2001-329214

20 Patent Document 5: JP-A-2001-329223

Patent Document 6: JP-A-H11-286648

Patent Document 7: JP-A-H11-315252

Patent Document 8: JP-A-2000-86975

Patent Document 9: JP-A-H04-288379

- Patent Document 10: JP-A-S61-103966
- Patent Document 11: JP-A-2002-102792
- Patent Document 12: JP-B-H05-39768
- Patent Document 13: JP-B-H05-39767
- 5 Patent Document 14: JP-B-H07-2931
- Patent Document 15: JP-B-H07-98918
- Patent Document 16: JP-A-H09-221627
- Patent Document 17: JP-A-H10-120896
- Patent Document 18: JP-A-H11-116893
- 10 Patent Document 19: Japanese Patent No. 2866662
- Patent Document 20: JP-A-2002-97412
- Patent Document 21: Japanese Patent No. 2866662
- Patent Document 22: Japanese Patent No. 2719045
- Patent Document 23: JP-A-H08-142032
- 15 Patent Document 24: JP-A-2000-167814
- Patent Document 25: JP-A-2002-309171
- Patent Document 26: JP-A-2002-322240
- Patent Document 27: JP-A-H11-310621
- Patent Document 28: JP-A-2002-294137

SUMMARY OF THE INVENTION

The present invention has been made to solve the aforesaid conventional problems. It is therefore an object of the invention to provide a concrete form plywood reusable

many times and a manufacturing process thereof.

It is another object of the invention to provide a curing acrylic resin topcoat paint composition for concrete form plywood that enables a concrete form plywood coated with the composition to be released easily from hardened concrete and
5 whereby permits reuse of the concrete form many times. It is a further object of the invention to provide a concrete form plywood coated with the composition and a manufacturing process thereof.

10 It is another object to provide a concrete form plywood that is excellent in crack resistance and can be released (stripped) from hardened concrete and be reused many times, namely, that has good release and reuse properties, and a manufacturing process thereof.

15 A curing acrylic resin topcoat paint composition for concrete form plywood (topcoat paint composition) according to the present invention comprises a curing hydroxyl-containing acrylic resin (i), a polysiloxane compound (v), and an isocyanate curing agent (iii).

20 The topcoat paint composition may further comprise an anti-foaming agent (xii) and a leveling agent (xiii).

The topcoat paint composition preferably contains the polysiloxane compound (v) in an amount of 1 to 100 parts by weight per 100 parts by weight of the curing

hydroxyl-containing acrylic resin (i) (nonvolatile content).

A first concrete form plywood according to the present invention comprises a substrate and paint films (A), (B) and (C) provided in the order of (substrate/paint film (A)/paint
5 film (B)/paint film (C)), wherein:

the paint film (A) is a filler coat paint film formed from a curing acrylic resin composition that comprises a curing hydroxyl-containing acrylic resin (i), calcium carbonate (ii-a), talc (ii-b), and an isocyanate curing agent (iii);

10 the paint film (B) is an middle coat paint film formed from a curing acrylic resin composition that comprises a curing hydroxyl-containing acrylic resin (i), at least one color pigment (iv) selected from yellow iron oxide, titanium oxide and carbon black, and an isocyanate curing agent (iii); and

15 the paint film (C) is a topcoat clear paint film formed from a curing acrylic resin composition (C1) that comprises a curing hydroxyl-containing acrylic resin (i), a polysiloxane compound (v) and an isocyanate curing agent (iii), or a moisture curing urethane resin composition (C2) that comprises a
20 moisture curing urethane resin (vi), a polysiloxane compound (v), a moisture absorbent (vii) and a curing catalyst (viii).

In the first concrete form plywood, the composition for the filler coat paint film (A) may further comprise at least one of a vinyl resin (ix), yellow iron oxide (iv-a), a

thixotropic agent (x) and an anti-settling agent (xi); the composition for the middle coat paint film (B) may further comprise at least one of an anti-settling agent (xi) and an anti-foaming agent (xii); and the composition (C1) or (C2) for
5 the topcoat clear paint film (C) may further comprise at least one of an anti-foaming agent (xii) and a leveling agent (xiii).

The composition (C1) for the topcoat clear paint film (C) preferably contains the polysiloxane compound (v) in an amount of 1 to 100 parts by weight per 100 parts by weight of
10 the curing hydroxyl-containing acrylic resin (i) (the resin content other than the solvent, namely, the nonvolatile content).

A process for manufacturing the first concrete form plywood according to the present invention comprises forming
15 the paint films (A), (B) and (C) on a surface of a substrate in the order of (substrate/paint film (A)/paint film (B)/paint film (C)).

A second concrete form plywood according to the present invention comprises a substrate and paint films (A'), (B') and
20 (C') provided in the order of (substrate/paint film (A')/paint film (B')/paint film (C')), wherein:

the paint film (A') is a filler coat paint film (A'1) formed from a solvent type curing acrylic resin composition (a'1) that comprises a curing hydroxyl-containing acrylic

resin (i), an isocyanate curing agent (iii) and at least one extender pigment (ii) selected from calcium carbonate, talc, clay and barium sulfate, or a filler coat paint film (A'2) formed from an aqueous emulsion composition (a'2) that
5 comprises at least one extender pigment (ii) selected from calcium carbonate, talc, clay and barium sulfate;

the paint film (B') is an middle coat paint film formed from a moisture curing urethane resin composition that comprises a moisture curing urethane resin (vi), a curing
10 catalyst (viii) and a moisture absorbent (vii); and

the paint film (C') is a topcoat paint film formed from a curing acrylic resin composition that comprises a curing hydroxyl-containing acrylic resin (i), an isocyanate curing agent (iii) and at least one color pigment (iv) selected from
15 titanium oxide, yellow iron oxide, cyanine blue and carbon black.

In the second concrete form plywood, the composition for the filler coat paint film (A') may further comprise at least one color pigment (iv) selected from titanium oxide, yellow
20 iron oxide, cyanine blue and carbon black.

In the second concrete form plywood, the composition for the filler coat paint film (A'1) may further comprise at least one of a vinyl resin (ix), a thixotropic agent (x) and an anti-settling agent (xi); the composition for the filler coat

paint film (A'2) may further comprise at least one resin selected from an acrylic resin, a vinyl acetate resin, an epoxy resin and a urethane resin, and may further comprise an isocyanate curing agent (iii).

5 In the second concrete form plywood, the composition for the middle coat paint film (B') may further comprise at least one of a leveling agent (xiii) and an anti-foaming agent (xii); and the composition for the topcoat paint film (C') may further
10 comprise at least one of an anti-settling agent (xi), a leveling agent (xiii) and an anti-foaming agent (xii).

 A process for manufacturing the second concrete form plywood according to the present invention comprises forming the paint films (A'), (B') and (C') on a surface of a substrate in the order of (substrate/paint film (A')/paint film
15 (B')/paint film (C')).

 The first concrete form plywood coated with the aforesaid topcoat paint composition has excellent releasability, and the second concrete form plywood possesses superior crack resistance. When mixed concrete is poured into a form built
20 with the above form plywoods, the form plywoods can be easily stripped from hardened concrete; the hardened concrete will not remain attached to the plywoods. Therefore, the form plywoods can be reused many times (for example, 10 or more times) without repainting. Thus, the concrete form plywoods

of the invention are advantageous in economical cost, resource saving, and building/construction workability.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

5 Hereinbelow, the topcoat paint composition, concrete form plywood and manufacturing process thereof according to the invention will be described in detail.

First, part of ingredients used in the topcoat paint composition, and in the paint compositions for the first and
10 second concrete form plywoods will be described.

Curing hydroxyl-containing acrylic resin (i)

The curing hydroxyl-containing acrylic resin (i) is an acrylic polyol resin that contains a unit derived from a (meth)acrylic acid and/or a (meth)acrylate and a unit derived
15 from a hydroxyl-containing (meth)acrylate. In the resin (i), the units may form blocks or be present randomly. The resin (i) may be modified with another segment commonly used in paints, with examples including polyether and polyether polyol. Further, the resin (i) may contain a functional group other
20 than the hydroxyl group, for example carboxyl or alkoxyphenyl group.

The curing hydroxyl-containing acrylic resin (i) may be produced by common procedures, for example:

(a): (Meth)acrylic acid and/or (meth)acrylate being

hydroxyl-free vinyl monomers copolymerizable with a hydroxyl-containing (meth)acrylate are/is copolymerized with a hydroxyl-containing (meth)acrylate.

(b): A hydroxyl-containing (meth)acrylate is
5 homopolymerized.

(C): A modifier monomer (for example, a carboxyl-containing monomer or a polyoxyalkylene-containing monomer) is added during the copolymerization of (a) and is copolymerized.

10 The monomer addition and mixing sequence is not particularly limited.

When the topcoat paint composition contains the acrylic resin (i), the resin (i) may be modified with silicone or may have a functional group other than the hydroxyl group, for
15 example alkoxysilyl group. Further examples of the modifier monomers (c) include alkoxysilyl-containing monomers and siloxane bond-containing monomers. The silicone-modified hydroxyl-containing acrylic resin may be prepared, for example, by performing esterification of silicone having a hydroxyl
20 group at one or both ends or side chains, with a carboxyl group, of the acrylic resin.

Known (meth)acrylates and vinyl monomers (other than the hydroxyl-containing (meth)acrylates, the same applies hereinafter) may be widely used, with examples including:

(meth)acrylate monomers having a hydrocarbon substituent group, such as methyl (meth)acrylate, ethyl (meth)acrylate, n-propyl (meth)acrylate, i-propyl (meth)acrylate, n-butyl (meth)acrylate, i-butyl (meth)acrylate, sec-butyl (meth)acrylate, t-butyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, n-octyl (meth)acrylate, lauryl (meth)acrylate, stearyl (meth)acrylate, cyclohexyl (meth)acrylate, phenyl (meth)acrylate, benzyl (meth)acrylate and dibromopropyl

10 (meth)acrylate;

styrene derivatives such as styrene, α -methylstyrene and vinyltoluene;

polymerizable unsaturated nitriles such as acrylonitrile and methacrylonitrile;

15 acrylamide monomers such as N-methylol (meth)acrylamide, N-methoxymethyl (meth)acrylamide and N-butoxymethyl (meth)acrylamide;

vinyl esters such as vinyl acetate;

epoxy-containing monomers such as glycidyl

20 (meth)acrylate and (meth)acryl glycidyl ether; and

basic monomers such as dimethylaminoethyl (meth)acrylate and diethylaminoethyl (meth)acrylate.

Of these, the (meth)acrylate monomers and styrene are preferred.

The above monomers may be used singly or in combination or two or more kinds.

The hydroxyl-containing (meth)acrylates include:

2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl

5 (meth)acrylate, 3-hydroxypropyl (meth)acrylate,

2-hydroxybutyl (meth)acrylate, 3-hydroxybutyl (meth)acrylate,

4-hydroxybutyl (meth)acrylate, 3-chloro-2-hydroxypropyl

(meth)acrylate, di-2-hydroxyethyl fumarate,

mono-2-hydroxyethyl-monobutyl fumarate, and ring-opening

10 adduct of 2-hydroxyethyl (meth)acrylate or 2-hydroxypropyl
(meth)acrylate with ethylene oxide or propylene oxide;

hydroxyalkyl esters of α,β -ethylenically unsaturated
carboxylic acids, such as adducts of the above

hydroxyl-containing (meth)acrylates with ϵ -caprolactone, and

15 adducts of polyethylene glycol (and/or polypropylene glycol
mono(meth)acrylate) with ϵ -caprolactone (caprolactone-added
monomers available under the trade names of PLACCEL FM series
and FA series manufactured by DAICEL CHEMICAL INDUSTRIES,
LTD.); and

20 hydroxyl-containing (meth)acrylate monomers, such as
dimers and trimers of 2-hydroxyethyl (meth)acrylate and
2-hydroxypropyl (meth)acrylate.

The combined use of ϵ -caprolactone leads to improved
crack resistance of a paint film containing the curing

hydroxyl-containing acrylic resin (i).

The curing hydroxyl-containing acrylic resin (i) may be modified with another segment. To obtain a modified curing hydroxyl-containing (meth)acrylic resin (i), a monomer having
5 a modifying group may be copolymerized with the aforesaid (meth)acrylic acid, (meth)acrylates and hydroxyl-containing (meth)acrylates.

Commercially available curing hydroxyl-containing acrylic resins include:

10 ACRYDIC 51-302 (manufactured by DAINIPPON INK AND CHEMICALS, INCORPORATED, solvent: butyl acetate, nonvolatile content: 50%)

 ACRYDIC A-850 (manufactured by DAINIPPON INK AND CHEMICALS, INCORPORATED, solvent: toluene, butyl acetate,
15 nonvolatile content: 70%)

 HITALOID 3083-70B (manufactured by Hitachi Chemical Co., Ltd., solvent: toluene, methyl ethyl ketone, isobutyl acetate, nonvolatile content: 70%)

 OHLAC APO-101 (manufactured by Ohtake-Meishin Chemical
20 Co., Ltd., solvent: toluene, methyl isobutyl ketone, nonvolatile content: 60%)

 OHLAC APO-301 (manufactured by Ohtake-Meishin Chemical Co., Ltd., solvent: xylene, nonvolatile content: 65%)

The curing hydroxyl-containing acrylic resin (i)

desirably has:

a number-average molecular weight (M_n) (method: GPC, calculated using a calibration curve of standard polystyrene) of 500 to 50,000, and preferably 1,800 to 30,000; and

5 a weight-average molecular weight (M_w) (method: GPC, calculated using a calibration curve of standard polystyrene) of 5,000 to 100,000, and preferably 20,000 to 70,000. If the number-average and weight-average molecular weights are below the above ranges, the drying properties tend to be lowered and
10 thereby the paint film will have poor strength to cause bad weathering resistance. When the molecular weights exceed the above ranges, the paint tends to have an excessively high viscosity to cause bad application properties, and tends to have a reduced nonvolatile content.

15 The GPC measurement conditions are as follows:

(a) Equipment manufacturer and model number

Manufacturer: Water Asia Limited

Device (component) (used in combination):

- (1) Waters 410 Differential Refractometer
20 (2) Waters 600S Controller
(3) Waters 717 Plus Autosampler

(b) Column: TSK G2000H, TSK G4000H, TSK GMH-M

(c) Eluting solution: tetrahydrofuran

(d) Column temperature: 40°C

(e) Flow rate: 1 ml/min

(f) Detector: 600S Controller

The hydroxyl value is preferably in the range of 50 to 180 mg KOH/g, and more preferably 70 to 100 mg KOH/g, in which
5 case the paint composition displays adequate curing reactivity and gives a paint film having less residual hydrophilic group to exhibit excellent water resistance and acid and alkali resistance.

The curing hydroxyl-containing acrylic resin (i) is most
10 often used in the form of varnish containing the solvent and the like employed in the synthesis of the resin.

The curing hydroxyl-containing acrylic resin (i) generally has Tg in the range of about 6 to 130°C, and preferably about 30 to 120°C. The lower the Tg, the more brittle the
15 resultant paint film. When Tg is too high, the resultant paint film tend to be nonuniform and become too solid and crack easily.

The curing hydroxyl-containing acrylic resin (i) may be obtained by known polymerization processes, including
20 solution polymerization, bulk polymerization and emulsion polymerization. Solution polymerization is generally employed.

In the case of a solution polymerization process, the above-described monomers in mixture may be copolymerized in

the presence of an organic solvent and a polymerization initiator. The organic solvents include conventional organic solvents such as isopropyl alcohol, n-butanol, butyl cellosolve, toluene, xylene, SOLVESSO 100 and SOLVESSO 150 (ESSO). The polymerization initiators include conventional initiators such as azobisisobutyronitrile, benzoyl peroxide and cumene hydroperoxide. Where necessary, a chain transfer agent may be used, with examples including 2-mercaptoethanol, n-octyl mercaptan, n-dodecyl mercaptan and α -methylstyrene dimer.

Isocyanate curing agent (iii)

The isocyanate curing agents (iii) include compounds having two or more isocyanate groups (polyisocyanates) and blocked polyisocyanates.

Specific examples of the polyisocyanates include diphenylmethane-4,4'-diisocyanate, 1,6-hexamethylene diisocyanate (HDI), 1,4-tetramethylene diisocyanate, 1-methyl-2,4-diisocyanatocyclohexane, bis(4-isocyanatophenyl)methane, 4-methoxy-1,3-phenylene diisocyanate, 2,4- and 2,6-tolylene diisocyanate, tolylene diisocyanate (TDI), 6-isopropyl-1,3-phenylene diisocyanate, isophorone diisocyanate, xylylene diisocyanate, hydrogenated xylylene diisocyanate and hydrogenated diphenylmethane-4,4'-diisocyanate. Adducts of these

polyisocyanates, polyfunctional isocyanate compounds such as isocyanurate, and other compounds such as dimers and trimers thereof are also employable.

In general, form plywoods and wooden floor materials are
5 not heated at temperatures of 100°C or above because the heating can deteriorate properties of the material (substrate). Accordingly, high temperature drying, using blocked isocyanate as the polyisocyanate, is seldom performed.

Meanwhile, the after-mentioned isocyanate value and
10 hydroxyl value are measured by the methods described in the columns [0020] to [0026] of JP-A-H08-157769 (Japanese Patent Application H-06-301039) filed by the present applicant.

Commercially available isocyanate curing agents employable in the invention include:

15 MILLIONATE MR-200 (manufactured by NIPPON POLYURETHANE INDUSTRY CO., LTD., nonvolatile content: 100%, diphenylmethane diisocyanate)

 SUMIDULE 44V-20 (manufactured by Sumitomo Bayer Urethane Co., Ltd., nonvolatile content: 100%,
20 diphenylmethane diisocyanate)

 DISMODULE L-75 (manufactured by Bayer AG, solvent: ethyl acetate, nonvolatile content: 75%, tolylene diisocyanate prepolymer)

 OLESTER P45-75MT (manufactured by MITSUI TAKEDA

CHEMICALS, INC., solvent: toluene, methyl isobutyl ketone, nonvolatile content: 75%, tolylene diisocyanate prepolymer)

Moisture curing urethane resin (vi)

The moisture curing urethane resin (prepolymer) (vi) may
5 be selected from conventionally known ones. Examples thereof include those used in urethane resin compositions, particularly moisture curing urethane resin compositions, and paints as described in JP-A-H06-157987, JP-A-H11-116652, JP-A-2000-129115, JP-A-2003-128942 and JP-A-2000-37659.

10 The moisture curing urethane resin (prepolymer) may be obtained by reacting a glycol (polyol) with excess of the isocyanate curing agent (iii), for example diisocyanate, such that a free isocyanato group constitutes the molecule end.
(Polyol)

15 Examples of the polyols include those described in the columns [0044] and [0045] of JP-A-2000-37659 filed by the present applicant.

Specific examples include:

20 dihydric alcohols such as ethylene glycol, diethylene glycol, triethylene glycol, polyethylene glycol, propylene glycol, dipropylene glycol, tripropylene glycol, polypropylene glycol, butylene glycol, dibutylene glycol, tributylene glycol, polybutylene glycol, 1,5-pentanediol, neopentylglycol, 1,6-hexanediol, 1,10-decanediol, alkanediol

and cyclohexanedimethanol;

trihydric alcohols such as glycerol, trimethylolpropane (TMP), 1,2,6-hexanetriol, trimethylolethane, 2,4-dihydroxy-3-hydroxymethylpentane,

5 1,1,1-tris(bis-hydroxymethyl)propane and 2,2-bis(hydroxymethyl)butanol-3;

tetrahydric alcohols such as pentaerythritol and diglycerol;

pentahydric alcohols (pentitols) such as arabitol, 10 ribitol and xylitol;

hexahydric alcohols (hexitols) such as sorbitol, mannitol, galactitol and allostulcitol;

polyglycol compounds of up to about 10 carbon atoms, including polyhydroxy compounds such as polyglycerol and 15 polytetramethylene glycol;

polyester polyol, epoxy polyol (alkanolamine-modified epoxy), polyether polyol and acrylic polyol derived from phthalic anhydride, sebacic acid, fatty acid and epoxy resin.

Of these, ethylene glycol, propylene glycol, 20 1,6-hexanediol, glycerol, trimethylolpropane, pentaerythritol, polyester polyol and acrylic polyol are preferred.

(Isocyanate curing agent (iii))

The isocyanate curing agent (iii) may be the

aforementioned isocyanate curing agent (iii) and may also be appropriately selected from polyisocyanate curing agents as described in the columns [0052] to [0065] of JP-A-2000-37659 filed by the present applicant.

5 Commercially available moisture curing urethane resins (vi) (including a solvent) include:

 MT OLESTER M95-50A (manufactured by MITSUI TAKEDA CHEMICALS, INC., moisture curing urethane resin varnish, solvent: toluene, xylene, ethyl acetate, 3-methoxybutyl
10 acetate, nonvolatile content: 50%)

 MT OLESTER M75-50E (manufactured by MITSUI TAKEDA CHEMICALS, INC., moisture curing urethane resin varnish, solvent: toluene, xylene, ethyl acetate, nonvolatile content:
50%)

15 CORONATE 2014 (manufactured by NIPPON POLYURETHANE INDUSTRY CO., LTD., moisture curing urethane resin varnish, solvent: xylene, nonvolatile content: 50%)

Curing catalyst (viii)

 A variety of known moisture curing catalysts are
20 employable as the curing catalysts (viii) for the moisture curing urethane resin (vi). Examples include:

 metal salts of organic carboxylic acids, such as dibutyltin bis-triethoxy silicate, dibutyltin dimethoxide, dibutyltin diacetate, dibutyltin dilaurate, butyltin

tri-2-ethyl hexoate, lead-2-ethyl octoate, iron-2-ethyl
hexoate, cobalt-2-ethyl hexoate, manganese-2-ethyl hexoate,
zinc-2-ethyl hexoate, stannous caprylate, tin naphthenate,
tin oleate, tin butyrate, zinc naphthenate, cobalt naphthenate
5 and zinc stearate;

alkoxyaluminum compounds;

quaternary ammonium salts such as
benzyltriethylammonium acetate;

lower fatty acid salts of alkali metals, such as
10 potassium acetate, sodium acetate and lithium oxalate; and
amine curing agents, including dialkylhydroxylamines
such as dimethylhydroxylamine and diethylhydroxylamine.

These curing catalysts may be used singly or in
combination of two or more kinds.

15 Commercially available curing catalysts (viii) for the
urethane resins (vi) include:

U-CAT 651M (manufactured by San-Apro Ltd., curing
catalyst for moisture curing urethane resins, modified amine,
nonvolatile content: 100%)

20 NY-1 (manufactured by NIPPON POLYURETHANE INDUSTRY CO.,
LTD., tertiary amine, nonvolatile content: 100%)

Moisture absorbent (vii)

Known organic and inorganic moisture absorbents
unreactive with concrete can be used as the moisture absorbent

(vii). Examples thereof include anhydrous gypsum (CaSO_4), synthetic zeolite absorbents (such as Molecular Sieve (trade name)), ortho esters such as methyl orthoformate and methyl orthoacetate, orthoboric acid esters, silicates and

5 isocyanates (such as ADDITIVE T1 (trade name)). These moisture absorbents may be used singly or in combination of two or more kinds. Commercially available moisture absorbents include ADDITIVE OF (manufactured by Sumitomo Bayer Urethane Co., Ltd.).

10 Vinyl resin (ix)

The vinyl resin (ix) is an optional ingredient.

Examples thereof include vinyl chloride copolymer resins such as vinyl chloride/vinyl acetate copolymer resin, vinyl chloride/vinyl acetate/vinyl alcohol copolymer resin, vinyl
15 chloride/vinyl isobutyl ether copolymer resin and vinyl chloride/vinyl propionate copolymer resin; chlorinated rubber resins; chlorinated olefin resins; acrylic resins such as (meth)acrylic resins, (meth)acrylate resins and (meth)acrylate copolymer resins other than the curing
20 hydroxyl-containing acrylic resins (i); and styrene/butadiene copolymer resin. Of these, particularly preferable is the curing hydroxyl-containing vinyl chloride/vinyl acetate copolymer that has reactivity with isocyanate and permits good adhesion with wooden materials. Commercially available vinyl

resins include VINYLITE VAGD, VINYLITE VAGH and VINYLITE VAGC (manufactured by The Dow Chemical Company, curing hydroxyl-containing vinyl chloride/vinyl acetate copolymer resins).

5 Thixotropic agent (x)

Organic, inorganic and complex thixotropic agents (thixotropy regulators) (x) are employable. Organic thixotropic agents include those based on hydrogenated castor oil, amide, polyethylene oxide, polymerized vegetable oil and
10 surfactant. Complex thixotropic agents include amide/polyethylene-based agents. The thixotropic agent contributes to storage stability of the paint and prevention of sagging during application. Too much thixotropic agent will adversely affect the paint film smoothness by causing
15 brush marks on the paint film. Commercially available thixotropic agents include AEROSIL 200 (manufactured by NIPPON AEROSIL CO., LTD.) and DISPARLON 4200-20 (manufactured by KUSUMOTO CHEMICALS, polyethylene oxide-based type).

Anti-settling agent (xi)

20 The anti-settling agents (xi) include aluminum stearate, calcium stearate, zinc stearate, organic bentonite, polyethylene wax, amide wax, lecithin and alkylsulfonates. Commercially available anti-settling agents include DISPARLON 4200-20 (manufactured by KUSUMOTO CHEMICALS)

Anti-foaming agent (xii)

The anti-foaming agents (xii) include those based on silicone, oxyalkylene, proronic and minerals, such as FLOWLEN AC-300 (manufactured by Kyoeisha Yushi Kagaku Kogyo Co., Ltd.),
5 BYK-088, BYK-065 and BYK-P104 (manufactured by BYK Chemie Germany) and DISPARLON OX-70 (manufactured by KUSUMOTO CHEMICALS).

Leveling agent (xiii)

The leveling agents (xiii) include polybutyl acrylate,
10 polymethyl siloxane, modified silicone compounds and fluorine-based surfactants, such as POLYFLOW No. 7 and POLYFLOW No. 77 (manufactured by Kyoeisha Yushi Kagaku Kogyo Co., Ltd.) and BYK-354 and BYK-360P (manufactured by BYK Chemie Germany).

15 Curing acrylic resin topcoat paint composition for concrete
form plywood

The curing acrylic resin topcoat paint composition for concrete form plywood (also referred to "the topcoat paint") contains the curing hydroxyl-containing acrylic resin (i), a
20 polysiloxane compound (v) described later, and the isocyanate curing agent (iii).

The topcoat paint composition may further contain an organic solvent, which is generally used, and the aforesaid anti-foaming agent (xii) and leveling agent (xiii).

Curing hydroxyl-containing acrylic resin (i)

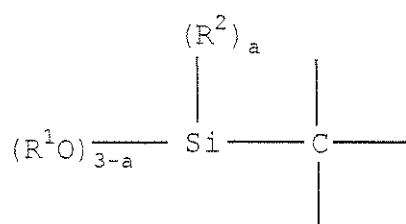
In the topcoat paint composition, the curing hydroxyl-containing acrylic resin (i) may be modified with another segment. To obtain a modified curing

5 hydroxyl-containing (meth)acrylic resin (i), a monomer containing a modifying group may be copolymerized with the aforesaid (meth)acrylic acid, (meth)acrylates and hydroxyl-containing (meth)acrylates.

The monomers containing a modifying group include
10 carboxyl-containing monomers; alkoxysilyl-containing monomers (i.e., alkoxysilyl-containing monomers in which a polymerizable unsaturated group, an alkoxy group and optionally an alkyl group are bonded to a silicon atom); and organopolysiloxane monomers in which a side chain contains a
15 polymerizable unsaturated group such as vinyl or (meth)acryl group and an alkyl group and the main chain has a ladder-like form (number-average molecular weight (Mn): several hundreds to several tens of thousands), as described in the columns [0026] to [0028] of JP-A-H10-67844 (Patent Document 3), the
20 columns [0023] to [0040] of JP-A-H11-286648 (Patent Document 6), the column [0018] of JP-A-H11-315252 (Patent Document 7) and the column [0009] of JP-A-2000-86975 (Patent Document 8). Specific examples include vinylmethyl dimethoxysilane and γ -(meth)acryloyloxypropyl trimethoxysilane.

The curing hydroxyl-containing acrylic resins (i) include:

acrylic copolymers (Mn: 1,000 to 30,000) which have a reactive silyl group and a hydroxyl group as described in JP-A-H11-286648 (Patent Document 6), represented by the formula:



wherein R^1 is a hydrogen atom or a C1-10 alkyl group; R^2 is a hydrogen atom, a C1-10 alkyl group or a monovalent hydrocarbon group selected from aryl and aralkyl groups; and a is an integer of 0 to 2; and

copolymer resins as described in JP-A-H11-315252 (patent Document 7) that are produced from a polydialkylsiloxane (a1) having at least one polymerizable unsaturated group per molecule, an organopolysilsesquioxane (a2) having a polymerizable unsaturated group, and another compound (a3) having a polymerizable unsaturated group, and that possess two or more active hydrogen atoms in the molecule of the copolymer resin.

20 Polysiloxane compound (v)

The polysiloxane compound (v) may be in any form of oil,

varnish, rubber and resin. In particular, a liquid form such as oil or varnish is preferable because of easy dissolution or dispersion in the paint.

The polysiloxane compounds (v) are not particularly
5 limited, and straight silicones such as dimethylpolysiloxane and various so-called polysiloxane derivatives and silicone derivatives are employable. These may be used singly or in combination of two or more kinds.

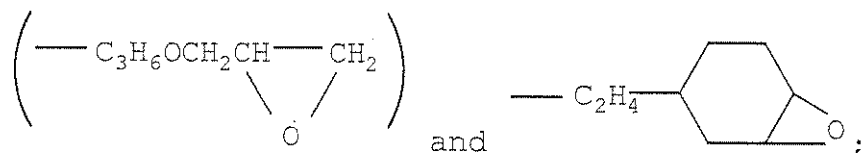
Conventionally known polysiloxane derivatives and
10 silicone derivatives may be widely used, with example including those in which a reactive or unreactive modifying group is attached to the dimethylpolysiloxane (or oligomer).

The modifying groups include phenyl group, hydrogen atom (H), alkyl group, amino group, epoxy group, polyether group,
15 aralkyl group, carboxyl group, hydroxyl group, thioether group (-SH), carbinol group, amido group, alkenyl group and combinations of at least two of the modifying groups (e.g., epoxypolyether group, alkylaralkyl group, hydroxyalkyl group and epoxyalkyl group). The polysiloxane compound (v) may
20 contain one or more kinds of the modifying groups.

Specific examples of the modifying groups include those listed in Table 6.1 on page 160 of SILICONE HANDBOOK (published from THE NIKKAN KOGYO SHIMBUN, LTD. on August 31, 1990), such as methylstyrene-derived group $[-CH_2CH(CH_3)C_6H_5]$; long-chain

alkyl groups $[-(\text{CH}_2)_n\text{CH}_3]$ where n is an integer of 0 or greater]; polyether groups (polyoxyalkylene groups) $[-\text{C}_3\text{H}_6\text{O}(\text{CH}_2\text{CH}_2\text{O})_n\text{R}]$ where n is an integer of 0 or greater and R is an alkyl group of about 1 to 10 carbon atoms]; carbinol-derived groups

5 $[-\text{C}_3\text{H}_6\text{O}(\text{CH}_2\text{CH}_2\text{O})_n(\text{C}_3\text{H}_6\text{O})_m\text{R}]$ where n and m are each an integer of 0 or greater and R is an alkyl group of about 1 to 10 carbon atoms] and $[-\text{C}_3\text{H}_6\text{OCH}_2\text{CH}_2\text{OH}]$; amine-derived groups $[-\text{C}_3\text{H}_6\text{NH}_2]$ and $[-\text{C}_3\text{H}_6\text{NHC}_2\text{H}_4\text{NH}_2]$; epoxy-containing groups having the formulae:



10 carboxyl-containing alkyl groups $[-(\text{CH}_2)_n\text{COOH}]$ where n is an integer of 0 or greater]; higher fatty acid-derived groups $[-\text{OCO}(\text{CH}_2)_n\text{CH}_3]$ where n is an integer of 0 or greater]; mercapto-containing group $[-\text{C}_3\text{H}_6\text{SH}]$; and (meth)acrylic acid-derived group $[-\text{C}_3\text{H}_6\text{OCOC}(\text{H}, \text{CH}_3)=\text{CH}_2]$.

15 One or more kinds of the modifying groups may be present in the dimethylpolysiloxane skeleton. The modification may take place at any site of side chains on one or both sides, and one or both ends of the long-chain silicone.

The polysiloxane compounds (v) with the modifying group

20 include polymers and oligomers having a structure in which the modifying group is bonded to the dimethylpolysiloxane (skeleton). Specific examples thereof include straight

silicone oils such as methylphenyl silicone oil and methylhydrogen silicone oil; the dimethylpolysiloxane and straight silicone oils having a further modifying group bonded, such as polyether-modified silicones, epoxy-modified silicones, amino-modified silicones, carboxyl-modified silicones, mercapto-modified silicones, carbinol-modified silicones, (meth)acryl-modified silicones, (meth)acrylic resin-modified silicones and long-chain alkyl-modified silicones.

10 The polysiloxane compounds may be used singly or in combination of two or more kinds.

Commercially available polysiloxane compounds in polymer or oligomer form include:

DC-57 (manufactured by Dow Corning Corporation,
15 dimethylpolysiloxane (silicone oil), nonvolatile content: 100%)

BYK-344 (manufactured by BYK Chemie, polyether-modified dimethylpolysiloxane copolymer solution (silicone oil), solvent: xylene/isobutanol = 4/1, nonvolatile content: 52%)

20 BYK-341 (manufactured by BYK Chemie, polyether-modified dimethylpolysiloxane copolymer solution (silicone oil), solvent: butyl cellosolve, nonvolatile content: 52%)

PERENOL S-4 (manufactured by SAN NOPCO LIMITED, organopolysiloxane copolymer solution, solvent: solvent

naphtha No. 3, nonvolatile content: 50%)

TEGO Glide A-115 (manufactured by Tego Chemie Service, organopolysiloxane copolymer, nonvolatile content: 100%)

Isocyanate curing agent (iii)

5 In the topcoat paint composition, the isocyanate curing agent (iii) has an isocyanate group content such that its equivalent ratio (NCO/OH) to the hydroxyl group content of the curing hydroxyl-containing acrylic resin (i) is in the range of 0.8 to 1.5, and preferably 0.9 to 1.2. The hydroxyl group
10 content (hydroxyl value) refers to the number of milligrams of potassium hydroxide corresponding to the hydroxyl group contained in 1 g of a sample.

Arbitrary ingredients

 According to need, the topcoat paint composition may
15 contain an ingredient commonly used in topcoat paints for concrete form. Such ingredients include organic solvents, which are generally employed, and the anti-forming agents (xii), the leveling agents (xiii), the moisture absorbents (vii), anti-sagging agents, surface conditioners, viscosity
20 modifiers, flatting agents, UV absorbers, dispersants, light stabilizers and catalysts as described in JP-A-2002-97412 (Patent Document 20).

 The organic solvents are not particularly limited, and include hydrocarbon solvents, ester solvents, ketone solvents,

alcohol solvents and ether solvents described in the columns [0069] to [0072] of JP-A-2002-97412 (Patent Document 20). For example, xylol and butyl acetate are used in the invention.

The topcoat paint composition preferably contains the
5 anti-foaming agent (xii) in view of smoothness of the resultant paint film, and prevention of foams on the film surface by bubbles caught in the paint during application.

The topcoat paint composition preferably contains the leveling agent (xiii), in which case the resultant paint film
10 can have a smooth surface.

The moisture absorbent (dehydrating agent) (vii) removes the water content of the topcoat paint composition (topcoat clear paint), and thereby prevents gelation of the paint and contributes to superior storage stability of the
15 paint.

The anti-sagging agents include those used also as solvent thickening agents, including organic bentonite, ultrafine silica powder, surface-treated calcium carbonate, amide wax, hydrogenated castor oil wax, benzylidene sorbitol,
20 metal soaps, polyethylene oxide, polymerized vegetable oil, surfate anionic activator, polyether/ester surfactants and polycarboxylic acid amine salts.

Commercially available anti-sagging agents include DISPARLON 6820-20M (manufactured by KUSUMOTO CHEMICALS) and

AEROSIL 200 (manufactured by NIPPON AEROSIL CO., LTD.).

Commercially available UV absorbers include TINUVIN series P, 328 and 130 (manufactured by CIBA GEIGY (Swiss)).

Commercially available catalysts include U-CAT 651M
5 (manufactured by San-Apro Ltd.).

The topcoat paint of the invention preferably contains the polysiloxane compound (v) in an amount of 1 to 100 parts by weight, and more preferably 2 to 80 parts by weight per 100 parts by weight of the curing hydroxyl-containing acrylic
10 resin (i) (resin content other than the volatile solvent, namely, solid content).

Further, the topcoat paint desirably contains the isocyanate curing agent (iii) in an amount such that the isocyanate groups in the isocyanate curing agent (iii) and the
15 hydroxyl groups in the curing hydroxyl-containing acrylic resin (i) have a numerical ratio ($[NCO]/[OH]$) of 0.8/1.0 to 1.2/1.0. For example, the composition preferably contains 13 to 25 parts by weight, and more preferably 15 to 20 parts by weight of the isocyanate curing agent (iii).

20 The topcoat paint may optionally contain:

the anti-forming agent (xii) preferably in an amount of 0.02 to 2.0 parts by weight, and more preferably 0.04 to 1.3 parts by weight; and

the leveling agent (xiii) preferably in an amount of 0.3

to 4 parts by weight, and more preferably 0.5 to 3 parts by weight.

The topcoat paint preferably contains (based on 100% by weight of the solid contents in the composition other than the solvent, the same applies hereinafter):

the curing hydroxyl-containing acrylic resin (i) (in terms of solid) in an amount of 30 to 99% by weight, and more preferably 40 to 98% by weight; and

the polysiloxane compound (v) in an amount of 1.0 to 50% by weight, and more preferably 1.5 to 45% by weight.

Moreover, the topcoat paint desirably contains the isocyanate curing agent (iii) in an amount such that the isocyanate groups in the isocyanate curing agent (iii) and the hydroxyl groups in the curing hydroxyl-containing acrylic resin (i) have a numerical ratio ($[NCO]/[OH]$) of 0.8/1.0 to 1.2/1.0. For example, the composition preferably contains 5 to 25% by weight, and more preferably 8 to 20% by weight of the isocyanate curing agent.

The topcoat paint may optionally contain:

the anti-forming agent (xii) preferably in an amount of 0.02 to 1.0% by weight, and more preferably 0.04 to 0.8% by weight; and

the leveling agent (xiii) preferably in an amount of 0.2 to 4% by weight, and more preferably 0.5 to 3% by weight.

When the topcoat paint contains the curing hydroxyl-containing acrylic resin (i) less than the above range, the resultant dry paint film tends to have lower smoothness and the paint cost tends to increase. If the amount
5 exceeds the above range, hiding properties are likely to be deteriorated.

When the paint composition contains the siloxane compound (vi) less than the above range, the resultant paint film will not show sufficient slip properties, form-release
10 properties and mar resistance. If the amount exceeds the above range, the dry paint film tends to become sticky.

When the paint composition contains the isocyanate curing agent (iii) less than the above range, the resultant paint film will show poor adhesion with wooden materials,
15 alkali resistance and water resistance. If the amount exceeds the above range, drying tends to be prolonged to complete and the paint film tends to be brittle.

When the topcoat paint contains the anti-forming agent (xii) less than the above range, application tends to result
20 in foams on the paint film surface. If the amount exceeds the above range, cratering or cissing will be caused in the paint film surface. When the topcoat paint composition contains the leveling agent (xiii) less than the above range, the surface smoothness tends to be deteriorated. If the amount exceeds

the above range, cratering, cissing or sagging tends to be caused in the paint film surface.

The topcoat paint can be produced by the conventional method, and is used as one-package system or two-package system
5 depending on the curing agent used.

The topcoat paint is curable at ordinary temperature (20 to 30°C) depending on the kind of the curing hydroxyl-containing acrylic resin (i), and becomes a heat-curing type depending on the kind of the isocyanate curing
10 agent (iii) (for example, blocked isocyanate). The topcoat paint composition is generally used in the form of solvent type paint. The solvents used herein may be selected from a wide range of known ones, with examples including organic solvents such as toluene, xylene, methyl ethyl ketone, methyl isobutyl
15 ketone and butyl acetate. The amount of solvent is not particularly limited, and the solvent generally constitutes 10 to 60% by weight of 100% by weight of the topcoat paint composition (including the solvent).

The concrete form plywood coated with the aforesaid
20 topcoat paint composition has excellent releasability from hardened concrete. The hardened concrete will substantially not remain attached to the form, so that the form can be reused many times, for example 10 or more times, preferably 12 or more times, and particularly preferably 15 or more times, without

recoating. Therefore, the concrete form plywood of the invention is advantageous in economical cost, resource saving, and building/construction workability.

The topcoat paint composition is preferably applied on
5 a concrete form substrate whose surface is coated with a filler coat paint film (A) and an middle coat paint film (B) described below. Namely, the topcoat paint is preferably applied to the middle coat paint film, in which case good adhesion with the substrate can be achieved and the concrete form plywood will
10 have the aforesaid superior properties, such as releasability from hardened concrete, surface smoothness and number of reusing times.

Next, the first concrete form plywood of the invention will be described.

15 First concrete form plywood

The first concrete form plywood according to the present invention comprises a substrate, which is preferably a plywood, and a filler coat paint film (A), an middle coat paint film (B) and a topcoat clear paint film (C) provided in the order
20 of (substrate/paint film (A)/paint film (B)/paint film (C)). The paint films (A), (B) and (C) are described below.

The filler coat paint film (A) is formed from a curing acrylic resin composition (filler coat paint) including a curing hydroxyl-containing acrylic resin (i), calcium

carbonate (ii-a), talc (ii-b), and an isocyanate curing agent (iii).

The middle coat paint film (B) is formed from a curing acrylic resin composition (middle coat paint) including a
5 curing hydroxyl-containing acrylic resin (i), at least one color pigment (iv) selected from yellow iron oxide, titanium oxide and carbon black, and an isocyanate curing agent (iii).

The topcoat clear paint film (C) is formed from a curing acrylic resin composition (C1) (topcoat clear paint (C1))
10 including a curing hydroxyl-containing acrylic resin (i), a polysiloxane compound (v) and an isocyanate curing agent (iii), or a moisture curing urethane resin composition (C2) (topcoat clear paint (C2)) including a moisture curing urethane resin (vi), a polysiloxane compound (v), a moisture absorbent (vii)
15 and a curing catalyst (viii).

In the first concrete form plywood, the composite paint film provided on the substrate plywood has high ply adhesion and superior releasability from concrete when the paint films (A), (B) and (C) all contain the curing hydroxyl-containing
20 acrylic resin (i) and the isocyanate curing agent (iii), that is, when the topcoat clear paint film (C) is formed from the curing acrylic resin composition (C1).

The urethane-based topcoat clear paint film (C) formed from the moisture curing urethane resin composition (C2) tends

to impart improved hardness to the composite paint film.

The concrete form substrate, the curing acrylic resin compositions (A), (B) and (C) for the filler coat paint film (A), middle coat paint film (B) and topcoat clear paint film (C), and the paint films (layers) from the compositions will
5 be described sequentially.

Concrete form substrate

Materials of the substrate for the first concrete form plywood are not particularly limited. Examples of natural
10 materials include meranti, bintangor, nyatoh, durian, mersawa, serapat, hekakoro, lauan, oak, birch, chinese ash, maple, japanese cherry birch, tilia japonica, sen and beech. In view of strength, dimensional stability and the like, the invention desirably employs a form plywood substrate that conforms to
15 JAS: Plywood for Forms used in Concrete Work (Notification No.932 of Ministry of Agriculture and Forestry, June 30, 1967).

Filler coat paint film (A)

The filler coat paint film (A) is formed by applying the curing acrylic resin composition (filler coat paint) to the
20 substrate followed by curing. The composition contains the curing hydroxyl-containing acrylic resin (i) and isocyanate curing agent (iii) similar to those used in the aforesaid topcoat paint composition, and further includes an extender pigment selected from calcium carbonate (ii-a), talc (ii-b),

clay and barium sulfate (preferably calcium carbonate and talc).

The composition for the filler coat paint film (A) may further contain an organic solvent as described above, which
5 is generally used, and at least one of the aforesaid vinyl resin (ix), yellow iron oxide (iv-a), thixotropic agent (x) and anti-settling agent (xi).

In the first concrete form plywood, the filler coat paint film (A) is excellent in adhesion with the substrate and the
10 middle coat paint film (B), hiding properties for substrate vessels, smoothing treatment (processing) properties for the substrate surface, alkali resistance, water resistance, depression filling properties and abrasion properties (abrasion resistance) of the dry paint film.

15 In the paint film, the calcium carbonate (ii-a) functions as "extender pigment" that is transparent and does not hide the coated surface (substrate surface), and also provides depression filling properties and reduction of the paint cost.

Commercially available calcium carbonates include:

20 NS-300 and 400 (manufactured by NITTO FUNKA KOGYO K.K.)

CaCO₃ SUPER SS (manufactured by Kyushu Calcium Co., Ltd.)

CaCO₃ SUN LIGHT No. 300 (manufactured by TAKEHARA KAGAKU KOGYO CO., LTD.)

Calcium carbonate NN-200 (manufactured by NITTO FUNKA

KOGYO K.K.)

The invention may employ an extender pigment other than the calcium carbonate (ii-a) and talc (ii-b), as long as it is inactive and is excellent in alkali resistance, water
5 resistance, heat stability and the like.

Other extender pigments include clay, barium sulfate, Bolus alba and kaolin, which are used in the same amount as the calcium carbonate (ii-a). When the calcium carbonate (ii-a) and the like are used in combination with another
10 extender pigment or the calcium carbonate (ii-a) is replaced with another extender pigment, the total amount of the extender pigments is as described above.

Similarly to the calcium carbonate (ii-a), the talc (ii-b) has excellent alkali resistance, filling properties and
15 abrasion properties (abrasion resistance) and is hardly adversely affected by contact with concrete. Accordingly, it is used as white pigment. Even if the talc remains attached to the hardened concrete, it is quite unnoticeable.

Yellow iron oxide (iv-a), titanium, iron oxide and
20 cyanine blue as well as the talc (ii-b) are preferably used as color pigments.

The yellow iron oxide (iv-a) is a yellow pigment that may be used according to need. There are naturally occurring and synthetic (by wet and dry processes) yellow iron oxides.

Of the synthetic products, yellow iron oxide synthesized by the wet process can be added in the sealing paint film (A) to show superior dispersibility, coloring power and hiding power, weathering resistance and acid and alkali resistance, and
5 contributes to improving the solvent resistance of the paint film. For example, TAROX LL-XLO (hydrated ferric oxide, manufactured by TITAN KOGYO KABUSHIKI KAISHA) and BAYFERROX 920 (hydrated ferric oxide, manufactured by Bayer) are employable yellow iron oxides. Similar effects can be
10 obtained by use of yellow-brown, red (ferric oxide) and black iron oxides produced by the wet process.

The composition (paint) for the filler coat paint film (A) preferably contains the curing hydroxyl-containing acrylic resin (i) in an amount such that the acrylic resin (i)
15 (solid content) preferably constitutes 0.5 to 60% by weight, more preferably 0.8 to 45% by weight, and particularly preferably 30 to 45% by weight of 100% by weight of the solids other than the volatile solvent of the composition for the filler coat paint film (A); and such that the acrylic resin
20 (i) (solid content) preferably constitutes 0.5 to 50% by weight, more preferably 0.8 to 45% by weight, and particularly preferably 15 to 45% by weight of the cured filler coat paint film (A).

The composition (paint) for the filler coat paint film

(A) preferably contains the extender pigments, typically the calcium carbonate (ii-a) and talc (ii-b), in an amount such that the extender pigments preferably constitute 20 to 85% by weight, and more preferably 30 to 75% by weight of the cured paint film; and also in a total amount of 70 to 800 parts by weight per 100 parts by weight of the acrylic resin (i) (solid content).

The isocyanate curing agent (iii) will be used in an amount such that the isocyanate group (-NCO) content is theoretically equal to the hydroxyl group (-OH) content in the acrylic resin (i). Desirably, the paint contains the isocyanate curing agent (iii) in an amount of 25 to 65 parts by weight per 100 parts by weight of the acrylic resin (i) (solid content), in other word, in an amount such that the isocyanate groups in the isocyanate curing agent (iii) and the hydroxyl groups in the curing hydroxyl-containing acrylic resin (i) have a numerical ratio ($[NCO]/[OH]$) of 0.8/1.0 to 1.2/1.0.

When the composition for the filler coat paint film (A) contains the curing hydroxyl-containing acrylic resin (i) in the above amount, sufficient pigment bonding strength and flowability can be achieved.

When the filler coat paint film (A) composition contains the calcium carbonate (ii-a), talc (ii-b) and the like in the above total amount, it exhibits sufficient filling properties

for the wooden surface vessels to provide a smooth paint film surface, and has good flowability to permit excellent application properties.

When the isocyanate curing agent (iii) is contained in the above amount in the filler coat paint, which is mixed for example immediately before application, the paint displays superior adhesion to the substrate (board), particularly a wooden material, and provides good water resistance and alkali resistance.

When the filler coat paint film (A) composition contains the vinyl resin (ix), yellow iron oxide (iv-a), thixotropic agent (x) and anti-settling agent (xi) according to need, the amounts thereof are, for example:

50 to 300 parts by weight for the vinyl resin per 100 parts by weight of the curing hydroxyl-containing acrylic resin (i) (solid content) in the filler coat paint;

10 to 65 parts by weight for the yellow iron oxide per 100 parts by weight of the acrylic resin (i) (solid content);

0.5 to 15 parts by weight for the thixotropic agent per 100 parts by weight of the acrylic resin (i) (solid content); and

0.1 to 8 parts by weight for the anti-settling agent per 100 parts by weight of the acrylic resin (i) (solid content).

The optional use of the vinyl resin (ix) in the above

amount is preferable from the viewpoint of good adhesion with wooden materials and flexibility of the paint film.

The yellow iron oxide (iv-a) used in the above amount is preferable from the viewpoint of sufficient hiding
5 properties.

The thixotropic agent (x) used in the above amount is preferable from the viewpoint of prevention of sagging of the paint from edges.

The anti-settling agent (xi) used in the above amount
10 is preferable from the viewpoint of prevention of settling of the pigment.

The composition (filler coat paint or agent) for the filler coat paint film (A) may be produced by the common procedure, and is generally used as a one-package or
15 two-package system depending on the curing agent used.

The filler coat paint is curable at room temperature (20 to 30°C) depending on the kind of the curing hydroxyl-containing acrylic resin (i), and is of one-package thermosetting type depending on the kind of the isocyanate
20 curing agent (iii) (for example, blocked isocyanate).

In the case of a room-temperature moisture curing filler coat paint of two-package system, the curing agent component which is isocyanate prepolymer having 2 or more isocyanate groups (e.g., tolylene diisocyanate derivative or

diphenylmethane diisocyanate itself) and the resin component which is the curing hydroxyl-containing acrylic resin (i) will be mixed immediately before application, and the paint will be applied to the substrate (board) and cured. The mixing is
5 performed such that the reaction ratio $[(\text{NCO})/(\text{OH})]$ of the isocyanate group (-NCO) in the isocyanate curing agent (iii) and the hydroxyl group (-OH) in the acrylic resin (i) is theoretically equal amount, and practically in the range of 0.8/1.0 to 1.2/1.0.

10 The filler coat paint is generally used in the form of solvent-type paint.

 The solvents used herein include organic solvents such as toluene, xylene, methyl ethyl ketone, methyl isobutyl ketone and butyl acetate. The amount of solvent is not
15 particularly limited, and may be in the range of 10 to 40% by weight in 100% by weight of the filler coat paint (including the solvent) from the viewpoint of, for example, controlling the viscosity to improve application properties.

 When the paint for the filler coat paint film (A) is a
20 two-package system, the ingredients reactive with each other are contained in separate components to avoid contact, namely, the curing hydroxyl-containing acrylic resin (i) is contained in the principal component (resin component), and the isocyanate curing agent (iii) in the curing agent component.

Other ingredients unreactive with the acrylic resin (i) or the isocyanate curing agent (iii), for example the extender pigments such as calcium carbonate (ii-a) and talc (ii-b) and the vinyl resin, may be compounded in either of the principal
5 (resin) component or the curing agent component. In general, such ingredients are compounded in the principal component. The thixotropic agent and the anti-settling agent as well are generally compounded in the principal component together with these settling and cohesive resin and pigment ingredients.
10 The above description of the compounding applies also to the middle coat paint and the topcoat clear paint.

Middle coat paint film (B)

The middle coat paint film (B) is formed on the filler coat paint film (A) by application of an middle coat paint
15 followed by curing. The middle coat paint comprises a curing acrylic resin composition including a curing hydroxyl-containing acrylic resin (i), at least one color pigment (iv) selected from yellow iron oxide, titanium oxide and carbon black, and an isocyanate curing agent (iii).

20 The composition for the middle coat paint film (B) may contain an organic solvent as described above, which is generally used, and at least one of the anti-settling agent (xi) and the anti-foaming agent (xii).

The curing hydroxyl-containing acrylic resin (i) and the

isocyanate curing agent (iii) used in the middle coat paint are the same as the corresponding ingredients in the filler coat paint film (A) or the filler coat paint.

In the concrete form plywood of the invention, the middle
5 coat paint film (B) from the middle coat paint includes the same film-forming ingredients, particularly resin ingredient, as those of the filler coat paint film (A) and the topcoat clear paint film (C). Accordingly, the concrete form plywood of the invention has excellent ply adhesion (bonding properties)
10 between the filler coat paint film (layer) (A) and the middle coat paint film (layer) (B) and between the middle coat paint film (layer) (B) and the topcoat clear paint film (C).

In the first concrete form plywood, the color pigment (iv) is at least one ingredient selected from yellow iron oxide,
15 titanium oxide and carbon black. The color pigment (iv) is contained in the middle coat paint film (B) and is not affected by the alkali or other ingredient in concrete to reduce the possibility of discoloration or other problem. The color pigment may be selected in conformity with a desired color tone
20 of the concrete form plywood. In the invention, the color pigment (iv) may be replaced with or be used in combination with other pigment (such as red iron oxide or cyanine blue) that is stable to alkali and the like.

The composition for the middle coat paint film (B)

preferably contains:

the acrylic resin (i) in an amount such that it constitutes 40 to 80% by weight, and more preferably 60 to 70% by weight of 100% by weight of the solid ingredients other than the solvent in the composition;

the at least one color pigment (iv) selected from yellow iron oxide, titanium oxide and carbon black in an amount such that it constitutes 5 to 20% by weight, and more preferably 7 to 13% by weight on the above basis, and further in an amount of 5 to 25 parts by weight per 100 parts by weight of the acrylic resin (i) (solid content); and

the isocyanate curing agent (iii) in an amount on the above basis such that the reaction ratio $[(\text{NCO})/(\text{OH})]$ of the isocyanate group $(-\text{NCO})$ in the isocyanate curing agent (iii) and the hydroxyl group $(-\text{OH})$ in the acrylic resin (i) is theoretically equal amount, and practically in the range of 0.8/1.0 to 1.2/1.0.

The curing hydroxyl-containing acrylic resin (i) used in the above amount is preferable from the viewpoint of that a viscosity appropriate for application and handling and good weathering resistance can be achieved.

The at least one color pigment (iv) selected from yellow iron oxide, titanium oxide and carbon black used in the above amount is preferable from the viewpoint of that satisfactory

hiding properties for the plywood surface can be obtained.

The isocyanate curing agent (iii) used in the above amount is preferable from the viewpoint of good adhesion with wooden materials and excellent paint film performance such as
5 water and alkali resistance.

When the composition for the middle coat paint film (B) contains the anti-settling agent (xi) and the anti-foaming agent (xii) according to need, the amounts thereof are, for example:

10 0.5 to 6 parts by weight for the anti-settling agent (xi) per 100 parts by weight of the acrylic resin (i) (solid content) in the composition; and

0.2 to 1.0 part by weight for the anti-foaming agent (xii) per 100 parts by weight of the acrylic resin (i) (solid content)
15 in the composition.

The use of the anti-settling agent (xi) in the above amount is preferable from the viewpoint of effectively prevention of the pigment from settling.

The anti-foaming agent (xii) contained in the above
20 amount is preferable from the viewpoint of prevention of foams from occurring in the film surface.

The composition (middle coat paint or agent) for the middle coat paint film (B) may be produced by the common procedure, and is generally used as a one-package or

two-package system depending on the curing agent used or the like.

Depending on the kind of the curing hydroxyl-containing acrylic resin (i), the middle coat paint is curable at room
5 temperature. The middle coat paint is a thermosetting type depending on the kind of the isocyanate curing agent (iii) (for example, blocked isocyanate). The middle coat paint is generally used in the form of solvent type paint. The amount of solvent is not particularly limited, and may be in the range
10 of 10 to 40% by weight in 100% by weight of the middle coat paint (including the solvent).

Topcoat clear paint film (C)

The topcoat clear paint film (C) is formed on the middle coat paint film (B) by application of a curing acrylic resin
15 composition (C1) or a moisture curing urethane resin composition (C2) followed by curing. (The compositions (C1) and (C2) will be collectively referred to as the topcoat clear paint or the topcoat paint, the compositions (C1) will be referred to as the topcoat paints (C1) and the compositions
20 (C2) will be referred to as the topcoat paints (C2).)

The curing acrylic resin composition (C1) contains the aforesaid curing hydroxyl-containing acrylic resin (i), polysiloxane compound (v) and isocyanate curing agent (iii).

The moisture curing urethane resin composition (C2)

contains the aforesaid moisture curing urethane resin (vi), polysiloxane compound (v), moisture absorbent (dehydrating agent) (vii) and curing catalyst (viii) for the moisture curing urethane resin (vi).

5 The composition (C1) or (C2) for the topcoat clear paint film (C) may contain an organic solvent as described above, which is generally used, and at least one of the anti-foaming agent (xii) and the leveling agent (xiii).

 Of the compositions (C1) and (C2), the curing acrylic
10 resin composition (C1) is the same as the curing acrylic resin topcoat paint composition for concrete form plywood described above.

 The topcoat clear paint film (C) made from the cured topcoat paint is excellent in adhesion (peel strength) with
15 the middle coat paint film (B), surface smoothness and form-release properties from hardened concrete. Accordingly, the concrete form plywood of the invention coated with the topcoat clear paint film (C) allows for production of hardened concrete having high surface smoothness without any hardened
20 concrete waste remaining attached to the form surface.

 Further, the form plywoods are unlikely to be damaged, and the form can be reused many times, for example 10 or more times, preferably 12 or more times, and particularly preferably 15 or more times. Moreover, the concrete form plywood of the

invention enables significant reduction of disposal cost after use as compared with the usual coated form plywoods.

Of the compositions (C1) and (C2), the curing acrylic resin composition (C), namely, the curing acrylic resin
5 topcoat paint composition for concrete form plywood according to the invention, provides excellent ply adhesion with the middle coat paint film (B) that contains the same resin ingredient and also excellent form-release properties from hardened concrete.

10 The use of the moisture curing urethane resin composition (C2) provides excellent form-release properties from hardened concrete similarly to the use of the composition (C1).

As described above, the moisture curing urethane resin composition (C2) contains the moisture curing urethane resin
15 (vi), at least one polysiloxane compound (v) selected from polysiloxane derivatives and silicone derivatives, moisture absorbent (dehydrating agent) (vii) and curing catalyst (viii) for the moisture curing urethane resin (vi). Of these ingredients, the moisture curing urethane resin (vi) and
20 curing catalyst (viii) are selected and used in amounts in accordance with general one-package (or two-package by the case) moisture curing urethane resin paints.

The polysiloxane compound (v) and moisture absorbent (vii) are the same as in the curing acrylic resin composition

(C1).

In the first concrete form plywood, the moisture curing urethane resin (prepolymer) (vi) may be one obtained by reacting the aforementioned glycol (polyol) with excess of the isocyanate curing agent (iii), for example diisocyanate, such that a free isocyanato group constitutes the molecule end. Examples of other moisture curing urethane resins include those obtained by reacting a polythiol, optionally together with the aforementioned glycol (polyol), with excess of the isocyanate curing agent (iii), for example diisocyanate, such that a free isocyanato group constitutes the molecule end. Because the polythiol is expensive and has sulfurous (mercaptan) smell, the invention preferably employs the glycol (polyol).

(Polythiol)

The polythiols (polymercapto compounds) used in the invention are compounds that possess 2 or more mercapto groups (-SH).

Examples of the polythiols include those described in the columns [0046] to [0051] of JP-A-2000-37659, such as 1,3-propanedithiol, 1,4-butanedithiol, 1,6-hexanedithiol and 2,3-dimethylcaptopropanol.

In the first concrete form plywood, the polyol and/or polythiol, and the polyisocyanate are reacted in amounts such

that a moisture curing isocyanate-terminated urethane polymer will result. That is, they are reacted such that the isocyanate groups will exceed in number the hydroxyl groups ($(-NCO) > (-OH) + (-SH)$). This moisture curing urethane resin (urethane prepolymer) (vi) generally has a ratio $[NCO / (OH + SH)]$ of more than 1, and preferably 1.5 or above, in which NCO is an equivalent of the isocyanate group in the polyisocyanate and $(OH + SH)$ is a total of equivalent of the hydroxyl group in the polyol and the thiol group in the polythiol. In view of negative results such as slow curing and increased foams during moisture curing, the reaction takes place such that the $[NCO / (OH + SH)]$ ratio is up to 10.0, and preferably up to 8.0.

For example, the above ratio can be achieved by reacting a hydroxyl-containing monomer or prepolymer (e.g., polyethylene glycol, polymethylene glycol, polybutylene glycol or a derivative thereof) with the isocyanate curing agent (iii) (e.g., tolylene diisocyanate or a prepolymer thereof) in a ratio in which the isocyanate groups exceed the hydroxyl groups.

The polymerization temperature and time in production of the moisture curing urethane resin (urethane prepolymer) (vi) are not particularly limited. For example, it is appropriate that the polyol and/or polythiol, and the polyisocyanate are mixed together in a stream of nitrogen gas

and the mixture is reacted at 60 to 100°C for 3 to 8 hours. In the reaction, an organometallic salt-based urethane catalyst, such as dibutyltin dilaurate, and the like may be added in an appropriate amount and at an appropriate stage as
5 needed.

The composition (C2) for the topcoat clear paint film (C) preferably contains:

the moisture curing urethane resin (vi) (solid content, namely, nonvolatile content other than the solvent) in an
10 amount of 30 to 99% by weight, and more preferably 40 to 98% by weight in 100% by weight of the solid ingredients other than the solvent in the composition (C2);

the polysiloxane compound (v) in an amount of 1.0 to 45% by weight, and more preferably 1.5 to 45% by weight of the
15 composition (C2) (solid content) on the above basis, and further in an amount of 1 to 50 parts by weight, and more preferably 1.5 to 10 parts by weight per 100 parts by weight of the urethane resin (vi) (solid content);

the moisture absorbent (vii) in an amount of 1.0 to 40
20 parts by weight, and more preferably 1.0 to 5 parts by weight per 100 parts by weight of the urethane resin (vi) (solid content); and

the curing catalyst (viii) in an amount of 0.05 to 5 parts by weight, and more preferably 0.1 to 2 parts by weight per

100 parts by weight of the urethane resin (vi) (solid content).

The moisture curing urethane resin (vi) contained in the above amount is preferable from the viewpoint of a viscosity appropriate for application and handling.

5 The polysiloxane compound (v) contained in the above amount is preferable from the viewpoint of imparting water repellency and slip properties to the paint film surface, and providing good drying properties of the paint.

10 The moisture absorbent (vii) contained in the above amount is preferable from the viewpoint of effective prevention of air moisture influence.

The curing catalyst (viii) contained in the above amount is preferable from the viewpoint of a drying time and working life appropriate for the application work.

15 When the composition for the topcoat clear paint film (C) contains the anti-settling agent (xi) and the anti-foaming agent (xii) according to need, the amounts thereof are, for example:

20 1 to 6 parts by weight for the anti-settling agent (xi) per 100 parts by weight of the urethane resin (vi) (solid content) in the composition; and

0.02 to 2.0 parts by weight for the anti-foaming agent (xii) per 100 parts by weight of the urethane resin (vi) (solid content) in the composition.

The anti-settling agent (xi) contained in the above amount effectively prevents the pigment from settling.

The anti-foaming agent (xii) contained in the above amount prevents foams from occurring during application.

5 The composition for the topcoat clear paint film (C) may be produced by the common procedure, and is generally used as a one-package system and sometimes as a two-package system depending on the composition of the paint, and paint storage and application environment such as temperature and humidity.

10 The topcoat clear paint is generally cured by the action of air humidity (moisture) at room temperature. The clear paint is a thermosetting type depending on the kind of the isocyanate curing agent (iii) (for example, blocked isocyanate). The topcoat clear paint is generally used in the
15 form of solvent type paint. The amount of solvent is not particularly limited, and may be in the range of 10 to 60% by weight in 100% by weight of the topcoat clear paint (including the solvent).

20 In the first concrete form plywood, the first filler coat paint film (A) and the second middle coat paint film (B) are colored to a sufficient level. Therefore, addition of a pigment is not necessary for the paint (C1) or (C2) for the third topcoat paint film; the paint is generally clear. In the case where the first and second paint films are

light-colored, a small amount of a color pigment may be added to the topcoat paint for the third film.

As described in detail hereinabove, the first concrete form plywood according to the present invention is composed
5 of a concrete form plywood having a surface coated with:

the first film which in a preferred embodiment is made from the acrylic urethane resin filler coat paint containing much inactive pigment and which smoothes the plywood surface;

the second film which is produced by applying the acrylic
10 urethane resin paint containing the above color pigment to form an middle coat paint film that favorably hides the substrate surface; and

the third film which is formed on the middle coat paint film by applying the acrylic urethane resin paint or the
15 moisture curing urethane resin paint that contains the polysiloxane compound in the above large amount and which permits easy release of the form board after concrete placement.

When the curing acrylic resin composition (C1) is used
20 for the third topcoat clear paint film (C), all the first, second and third films are preferably made from a two-package composition that is composed of the component containing the acrylic resin with two or more hydroxyl groups and the component containing the isocyanate prepolymer with two or more reactive

isocyanate groups, in which case excellent ply adhesion can be achieved.

Process for manufacturing first concrete form plywood

In the process for manufacturing the first concrete form
5 plywood according to the present invention, the
above-described paints for the films (A), (B) and (C) are
applied to a surface of the substrate and cured to form the
paint films in the order of (substrate/paint film (A)/paint
film (B)/paint film (C)).

10 Preferred embodiments are presented below.

(1) Application of the filler coat paint for the first film

To fill and smooth the unevenness of the plywood surface,
the application of the filler coat paint for the first film
involves a conveyer for conveying the form plywood, and a thin
15 steel-plate knife coater that is arranged perpendicularly
(orthogonally) to the traveling direction of the plywood. In
general, one application using the knife coater often results
in insufficient filling of the vessels with the filler coat
paint, and good smoothness cannot be obtained. Thus, the
20 knife-coater application will generally and desirably be
repeated 2 or 3 times using the same filler coat paint such
that 80 to 150 g in total of the paint (uncured) will be applied
per square meter.

(2) Application of the middle coat paint for the second film

The application of the middle coat paint for the second film involves, for example, a roll coater and is preferably repeated 2 or 3 times using the same middle coat paint such that 60 to 140 g in total of the paint (uncured) will be applied
5 per square meter.

(3) Application of the topcoat clear paint for the third film

The application of the topcoat clear paint for the third film involves, for example, a roll coater and is preferably performed 1 or 2 times using the same topcoat clear paint such
10 that 15 to 60 g in total of the paint (uncured) will be applied per square meter.

(4) Drying process

Room temperature drying is generally employed to dry the filler coat paint for the first film, middle coat paint for
15 the second film and topcoat clear paint for the third film. Depending on the ingredient composition and the like, forced drying may be performed at elevated temperatures of 60 to 80°C.

In the case of the room temperature drying, the drying time for the first film prior to the application of the second
20 film is in the range of 1 to 3 hours, and that for the second film before the application of the third film is in the range of 0 to 1 hour.

That is, the second film may be overcoated with the third film after the second film has been sufficiently dried for about

one hour or immediately after the second film has been applied (the drying time for the second film is 0 hours) and is in an uncured state (wet-on-wet process).

After the third film has been formed, the coated form
5 plywoods must be dried for at least 5 hours before stack storage or transportation to prevent sticking of wet paint films.

Although the above description is focused on the concrete form plywoods, the present invention is not limited to the aforementioned embodiments. The topcoat paint composition of
10 the invention can be applied to a surface of not only the form but also various items contacted with ready-mixed concrete to permit easy release of the item from hardened concrete. Therefore, the substrates to be coated with the topcoat paint of the invention are not limited to wooden and metal boards
15 and include other boards such as plastics.

Effects of the invention

The first concrete form plywood coated with the topcoat paint composition can be released easily from hardened concrete. Coating one time with the composition permits the
20 plywood to be reused many times (for example, 10 or more times) in concrete placement, more than twice the number of reusing times of the conventional coated form plywoods; therefore good workability and economic efficiency can be achieved. Accordingly, the invention allows for reduction of concrete

forms used in construction site, efficient building of a structure having a beautiful appearance, and resource saving.

The high reusability of the first concrete form plywoods enables 50% or more (relative to the conventional level)

5 reduction of disposal cost of form plywoods that are no longer usable in concrete work because of attached concrete or lime wash or that are to be junked with damages, peeled surface and cracks. Moreover, the use of the concrete form plywoods of the invention provides great effects of forest resource
10 conservation and effective utilization.

Second concrete form plywood

The second concrete form plywood according to the present invention comprises a concrete form substrate, and a filler coat paint film (A'); an middle coat paint film (B') and a
15 topcoat paint film (C') provided in the order named on the substrate.

Concrete form substrate

The substrate for the concrete form plywood may be the same as the substrate used in the first concrete form plywood.

20 Filler coat paint film (A')

The filler coat paint film (A') is formed on a surface of the above substrate (board) and has two embodiments:

a filler coat paint film (A'1) produced by application of a filler coat paint, that is, a solvent type curing acrylic

resin composition (a'1) followed by curing; and

a filler coat paint film (A'2) produced by application of a filler coat paint, that is, an aqueous emulsion composition (a'2) followed by curing.

5 In the second concrete form plywood, the filler coat paint film (A') is excellent in adhesion with the substrate (board) and the middle coat paint film (B'), hiding properties for substrate vessels, smoothing treatment (processing) properties for the substrate surface, alkali resistance, water
10 resistance, depression filling properties and abrasion properties (abrasion resistance) of the dry paint film.

Filler coat paint film (A'1)

The filler coat paint film (A'1) is formed from the solvent type curing acrylic resin composition (a'1) that
15 comprises the above-described curing hydroxyl-containing acrylic resin (i), the above-described isocyanate curing agent (iii), and at least one extender pigment (ii) selected from calcium carbonate, talc, clay and barium sulfate.

The acrylic resin composition (a'1) for the filler coat
20 paint film (A'1) may contain an organic solvent, which is generally used, and at least one of the aforesaid vinyl resin (ix), color pigment (iv), thixotropic agent (x) and anti-settling agent (xi).

Curing hydroxyl-containing acrylic resin (i)

The curing hydroxyl-containing acrylic resin (i) is as described above.

Isocyanate curing agent (iii)

The isocyanate curing agent (iii) has an isocyanate group
5 content such that its equivalent ratio (NCO/OH) to the hydroxyl
group content of the curing hydroxyl-containing acrylic resin
(i) is in the range of 0.8 to 1.6, and preferably 0.9 to 1.2.
The hydroxyl group content (hydroxyl value) refers to the
number of milligrams of potassium hydroxide corresponding to
10 the hydroxyl group contained in 1 g of a sample.

Extender pigment (ii)

The extender pigments (ii) include calcium carbonate,
talc, clay and barium sulfate.

In the paint film, the extender pigment is transparent
15 and does not hide the coated surface (substrate surface), and
has functions of depression-filling properties and reduction
of the paint cost.

The extender pigments may be used singly or in
combination of two or more kinds. When two or more extender
20 pigments are used in combination, the total amount should be
similar to the amount in single use.

Of the above extender pigments, calcium carbonate is
particularly preferable and is preferably used singly or in
combination with one of other extender pigments.

Commercially available calcium carbonates are as described above.

Examples of the talc include TALC MS (manufactured by NIPPON TALC CO., LTD.).

5 The extender pigment such as calcium carbonate may contain a small amount of other extender pigment that is inactive and is excellent in alkali resistance, water resistance and heat stability. Such additional extender pigments include Bolus alba and kaolin.

10 Arbitrary ingredients

In the second concrete form plywood, the color pigment (iv) may be used, with preferred examples including yellow iron oxide, titanium oxide, cyanine blue and carbon black.

15 The color pigment (iv) is not affected by the alkali or other ingredient in concrete to reduce the possibility of discoloration or other problem. The color pigment may be selected in conformity with a desired color tone of the concrete form plywood. Examples of the yellow iron oxide are as aforementioned.

20 In the invention, the color pigment (iv) may be replaced with or be used in combination with another pigment (such as red iron oxide) that is stable to alkali and the like.

The vinyl resin (ix) may be used as an adjuster of hardness and glass transition temperature of the curing

hydroxyl-containing acrylic resin (i) and can improve adhesion with wooden materials and crack resistance of the dry paint film.

The composition (paint) for the filler coat paint film

5 (A'1) preferably contains:

the curing hydroxyl-containing acrylic resin (i) in an amount such that the acrylic resin (i) (solid content) preferably constitutes 5 to 60% by weight, more preferably 10 to 45% by weight, and particularly preferably 15 to 40% by
10 weight of 100% by weight of the solids other than the volatile solvent of the composition; and such that the acrylic resin (i) (solid content) preferably constitutes 4 to 56% by weight, more preferably 10 to 45% by weight, and particularly preferably 15 to 40% by weight of the cured filler coat paint
15 film (A'1); and

the extender pigments (ii) such as calcium carbonate and the like in an amount such that the extender pigments preferably constitute 20 to 85% by weight, and more preferably 30 to 75% by weight of the cured paint film; and also in a total amount
20 of 70 to 800 parts by weight per 100 parts by weight of the acrylic resin (i) (solid content).

The isocyanate curing agent (iii) will be used in an amount such that the isocyanate group (-NCO) content is theoretically equal to the hydroxyl group (-OH) content in the

acrylic resin (i). Desirably, the paint contains the isocyanate curing agent (iii) in an amount of 25 to 150 parts by weight per 100 parts by weight of the acrylic resin (i) (solid content), in other word, in an amount such that the isocyanate groups in the isocyanate curing agent (iii) and the hydroxyl groups in the curing hydroxyl-containing acrylic resin (i) have a numerical ratio ($[NCO]/[OH]$) of 0.8/1.0 to 1.2/1.0.

When the composition for the filler coat paint film (A'1) contains the curing hydroxyl-containing acrylic resin (i) in the above amount, sufficient pigment bonding strength and flowability can be achieved.

When the filler coat paint is combined with the isocyanate curing agent (iii) in the above amount for example immediately before application, the paint displays superior adhesion to the substrate (board), particularly a wooden material, and provides good water resistance and alkali resistance.

When the extender pigments (ii) are contained in the above total amount, the paint exhibits sufficient filling properties for the wooden surface vessels to provide a smooth paint film surface, and also has good flowability to permit excellent application properties.

When the composition for the filler coat paint film (A'1) contains the color pigment (iv), vinyl resin (ix), thixotropic

agent (thixotropy regulator) (x) and anti-settling agent (xi) according to need, the amounts thereof are, for example:

10 to 70 parts by weight for the color pigment (iv) per 100 parts by weight of the acrylic resin (i) (solid content);

5 50 to 300 parts by weight for the vinyl resin (ix) per 100 parts by weight of the acrylic resin (i) (solid content);

0.5 to 15 parts by weight for the thixotropic agent (ix) per 100 parts by weight of the acrylic resin (i) (solid content); and

10 0.1 to 8 parts by weight for the anti-settling agent (xi) per 100 parts by weight of the acrylic resin (i) (solid content).

The color pigment (iv) used in the above amount is preferable from the view point of good hiding properties.

15 The vinyl resin (ix) used in the above amount is preferable from the view point of good adhesion with wooden materials and flexibility of the paint film.

The thixotropic agent (x) used in the above amount is preferable from the view point of prevention of sagging of the
20 paint from edges.

The anti-settling agent (xi) used in the above amount is preferable from the view point of prevention of settling of the pigment.

The composition (filler coat paint or agent) for the

filler coat paint film (A'1) may be produced by the common procedure, and is generally used as a one-package or two-package system depending on the curing agent used.

Depending on the kind of the curing hydroxyl-containing
5 acrylic resin (i), the filler coat paint is curable at room temperature (20 to 30°C). The filler coat paint is of one-package thermosetting type depending on the kind of the isocyanate curing agent (iii) (for example, blocked isocyanate).

10 The filler coat paint is generally used in the form of solvent type paint. The solvents used herein include organic solvents such as toluene, xylene, methyl ethyl ketone, methyl isobutyl ketone and butyl acetate. The amount of solvent is not particularly limited, and may be in the range of 2 to 40%
15 by weight in 100% by weight of the filler coat paint (including the solvent) from the viewpoint of controlling the viscosity to improve application properties.

When the paint for the filler coat paint film (A'1) is a two-package system, the ingredients reactive with each other
20 are contained in separate components to avoid contact, namely, the curing hydroxyl-containing acrylic resin (i) is contained in the principal component (resin component), and the isocyanate curing agent (iii) in the curing agent component. Other ingredients unreactive with the acrylic resin (i) and

the isocyanate curing agent (iii), for example the extender pigments such as calcium carbonate and talc, the color pigment such as yellow iron oxide and the vinyl resin, may be compounded in either of the principal (resin) component or the curing agent component. In general, such ingredients are compounded in the principal component. The thixotropic agent and the anti-settling agent as well are generally compounded in the principal component together with these settling and cohesive components such as resin and pigment ingredients. The above description of the compounding applies also to the middle coat paint and the topcoat paint.

Filler coat paint film (A'2)

The filler coat paint film (A'2) is formed from the aqueous emulsion composition (a'2) that comprises at least one extender pigment (ii) selected from calcium carbonate, talc, clay and barium sulfate.

The aqueous emulsion composition (a'2) for the filler coat paint film (A'2) may contain at least one of the isocyanate curing agent (iii) and the color pigment (iv).

20 Aqueous emulsion

The aqueous emulsion may contain any resin without limitation. Examples of the aqueous emulsions include acrylic emulsion, vinyl acetate emulsion, epoxy emulsion and urethane emulsion, with the acrylic emulsion and vinyl acetate emulsion

being preferable.

The polymer used in the form of the aqueous emulsion preferably has a functional group with active hydrogen, such as amino, hydroxyl or carboxyl group.

5 For example, the polymer for the acrylic emulsion may be synthesized by a process in which 2-hydroxyethyl acrylate or 2-ethylhexyl acrylate is added to a copolymer of (meth)acrylic acid or alkyl (meth)acrylate and another monomer such as styrene to produce a hydroxyl-terminated polymer.

10 The polymer for the vinyl acetate emulsion may be synthesized by a similar process in which polyvinyl alcohol is added to a vinyl acetate polymer or a vinyl acetate/ethylene copolymer to produce a hydroxyl-terminated polymer.

The acrylic resins for use as acrylic emulsion in the
15 invention are not particularly limited, and known acrylic homopolymers and copolymers with other monomers are employable. The acrylic monomers include:

(meth)acrylic acid;

alkyl (C1-10) (meth)acrylates such as methyl

20 (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, butyl (meth)acrylate, t-butyl (meth)acrylate and hexyl (meth)acrylate;

cycloalkyl (C3-12) (meth)acrylates such as cyclohexyl (meth)acrylate;

aryl (meth)acrylates such as phenyl (meth)acrylate;
aralkyl (meth)acrylates such as benzyl (meth)acrylate;
hydroxyalkyl (C2-6) (meth)acrylates such as
2-hydroxyethyl (meth)acrylate and 3-hydroxypropyl

5 (meth)acrylate;

alkylaminoalkyl (meth)acrylates such as
dimethylaminoethyl (meth)acrylate, diethylaminoethyl
(meth)acrylate and diethylaminopropyl (meth)acrylate;

(meth)acrylamide and derivatives thereof such as
10 (meth)acrylamide, N-methyl (meth)acrylamide, methylol
(meth)acrylamide and alkoxymethyl (meth)acrylamide;

epoxy-containing (meth)acrylates such as glycidyl
(meth)acrylate; and

(meth)acrylonitrile.

15 The monomers copolymerizable with the acrylic monomers
include:

aromatic vinyl monomers such as styrene,
 α -methylstyrene, p-t-butylstyrene and vinyltoluene;

aliphatic vinyl ester monomers such as vinyl propionate;

20 esters of unsaturated polycarboxylic acids such as
maleic anhydride, maleic acid, fumaric acid and itaconic acid,
and esters of unsaturated polycarboxylic acid derivatives such
as dimethyl maleate and diethyl fumarate;

N-substituted maleimides such as N-phenylmaleimide; and

olefin monomers such as ethylene and propylene.

These monomers may be used singly or in combination of two or more kinds.

The vinyl acetate resins for use as vinyl acetate
5 emulsion in the invention are not particularly limited, and known polyvinyl acetate and copolymers of vinyl acetate with other monomers are employable. The monomers copolymerizable with vinyl acetate include:

olefins such as ethylene;

10 (meth)acrylic monomers such as (meth)acrylic acid, methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, isopropyl (meth)acrylate, butyl (meth)acrylate, isobutyl (meth)acrylate, t-butyl (meth)acrylate, hexyl (meth)acrylate, octyl (meth)acrylate,
15 2-ethylhexyl (meth)acrylate, stearyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate and glycidyl acrylate;

maleic acid esters such as diethyl maleate, dipropyl maleate, dibutyl maleate, dihexyl maleate, dioctyl maleate and
20 2-ethylhexyl maleate;

fumaric acid esters corresponding to the above maleic acid esters;

vinyl esters such as vinyl propionate, vinyl caprylate, vinyl caproate and vinyl versatate;

carboxyl-containing monomers such as crotonic acid, itaconic acid, itaconic acid half esters, maleic acid and maleic acid half esters;

styrene, vinyl chloride, methyl vinyl ketone,
5 acrylonitrile, methacrylonitrile, acrolein and crotonaldehyde.

These monomers may be used singly or in combination of two or more kinds.

The epoxy resins for use as epoxy emulsion in the
10 invention are not particularly limited, and known epoxy resins are employable. Examples include glycidyl ether epoxy resins such as bisphenol epoxy resins; glycidyl ester epoxy resins such as glycidyl phthalate; glycidyl diamine epoxy resins such as tetraglycidyl-diaminodiphenylmethane; and cyclic oxirane
15 epoxy resins such as 3,4-epoxycyclohexylmethyl-3,4-epoxycyclohexane carboxylate. These epoxy resins may be used singly or in combination of two or more kinds.

The urethane resins for use as urethane emulsion in the
20 invention are not particularly limited, and known urethane resins are employable. Examples include cured urethane resins obtained by reaction between a first component being a polyol and/or a polyamine and a second component being a polyisocyanate that contains at least two isocyanate terminal

groups in the molecule.

The polyols include polyester polyol, polycarbonate polyol, polyester polycarbonate polyol and polyether polyol. The polyisocyanates include TDI (tolylene diisocyanate), MDI
5 (methyl diphenyl diisocyanate), IPDI (isophorone diisocyanate) and HMDI (hexamethylene diisocyanate). These may be used singly or in combination of two or more kinds.

The above-described aqueous emulsions may be used singly or in combination of two or more kinds.

10 The aqueous emulsion preferably contains the solids at 30 to 50% by weight, in which case stable properties can be obtained.

Commercially available aqueous emulsions include Boncoat EC-100 (aqueous acrylic emulsion, manufactured by
15 DAINIPPON INK AND CHEMICALS, INCORPORATED) and KR Bond F-29 (aqueous vinyl acetate emulsion, manufactured by Koyo Sangyo, Co., Ltd.).

Isocyanate curing agent (iii)

The aqueous emulsion composition (a'2) may be used as
20 a one-package paint containing the extender pigment (ii), and may further contain the isocyanate curing agent (iii). The isocyanate curing agent (iii) is similar to that contained in the filler coat paint film (A'1) and the solvent type curing acrylic resin composition (a'1).

The combined use of the isocyanate curing agent (iii) allows for improved adhesion of the filler coat paint film (A'2) with a wooden material. Furthermore, the isocyanate group of the isocyanate curing agent (iii) reacts with the active
5 hydrogen-containing functional group of the polymer used as the aqueous emulsion to form a crosslinked structure, leading to improved water and alkali resistance of the filler coat paint film (A'2).

The extender pigment (ii) and optional color pigment (iv)
10 are similar to those contained in the filler coat paint film (A'1) and the solvent type curing acrylic resin composition (a'1).

The composition for the filler coat paint film (A'2) preferably contains the resin in aqueous emulsion form in an
15 amount such that the resin preferably constitutes 10 to 40% by weight, more preferably 15 to 30% by weight, and particularly preferably 20 to 25% by weight of 100% by weight of the solids other than the solvent water of the aqueous emulsion composition (a'2); and such that the resin preferably
20 constitutes 10 to 40% by weight, more preferably 15 to 30% by weight, and particularly preferably 20 to 25% by weight of the cured filler coat paint film (A'2).

The filler coat paint film (A'2) composition preferably contains the extender pigment (ii) in an amount such that the

extender pigment preferably constitutes 20 to 85% by weight, and more preferably 30 to 75% by weight of 100% by weight of the cured paint film; and also in an amount of 70 to 800 parts by weight per 100 parts by weight of the resin (solid content) used as the aqueous emulsion.

The isocyanate curing agent (iii) is desirably added in excess in view of the fact that part of the isocyanate curing agent (iii) is consumed by water in the aqueous emulsion (paint) (A'2). The amount of the isocyanate curing agent (iii) is generally in the range of 10 to 40 parts by weight per 100 parts by weight of the resin (solid content) used as the aqueous emulsion.

The amount of the color pigment (iv), which is optional, is generally in the range of 10 to 70 parts by weight per 100 parts by weight of the resin (solid content) used as the aqueous emulsion.

When the composition for the filler coat paint film (A'2) contains the resin as the aqueous emulsion in the above amount (in terms of solid), sufficient pigment bonding strength and flowability can be achieved. When the composition contains the color pigment (ii) in the above amount, it exhibits sufficient filling properties for the wooden surface vessels to provide a smooth paint film surface, and has good flowability to permit excellent application properties.

The isocyanate curing agent (iii) contained in the above amount is preferable from the viewpoint of superior adhesion to the substrate (board), particularly a wooden material, and good water resistance and alkali resistance. The color
5 pigment (iv) contained in the above amount is preferable from the viewpoint of good hiding properties.

Middle coat paint film (B')

The middle coat paint film (B') is formed on the surface of the filler coat paint film (A') by application of an middle
10 coat paint followed by curing. The middle coat paint comprises a moisture curing urethane resin composition including the aforementioned moisture curing urethane resin (vi), curing catalyst (viii) and moisture absorbent (vii).

The composition for the middle coat paint film (B') may
15 further contain an organic solvent as described above, which is generally used, and at least one of the leveling agent (xiii) and the anti-foaming agent (xii).

The middle coat paint film (B') is formed by application of the middle coat paint containing the moisture curing
20 urethane resin composition, and imparts excellent crack resistance to the concrete form plywood.

Furthermore, excellent ply adhesion (bonding properties) is achieved between the filler coat paint film (layer) (A') and the middle coat paint film (layer) (B') and

between the middle coat paint film (layer) (B') and the topcoat paint film (C'). Thus, the form can be reused many times, for example 10 or more times, preferably 15 or more times, and particularly preferably 20 or more times. Moreover, the
5 concrete form plywood of the invention enables significant reduction of disposal cost after use as compared with the usual coated form plywoods.

Moisture curing urethane resin (vi)

In the second concrete form plywood, the moisture curing
10 urethane resin (prepolymer) (vi) may be one as described hereinabove. For example, the moisture curing urethane resin may be obtained by reacting a glycol (polyol) with excess of the isocyanate curing agent (iii), for example diisocyanate, such that a free isocyanato group constitutes the molecule end.
15 (Polyol)

The polyols are as described hereinabove.
(Isocyanate curing agent (iii))

In the second concrete form plywood, the polyol and the polyisocyanate are reacted in amounts such that a moisture
20 curing isocyanate-terminated urethane polymer will result. That is, they are reacted such that the isocyanate groups will exceed in number the hydroxyl groups ((-NCO)>(-OH)). This moisture curing urethane resin (urethane prepolymer) (vi) generally has a ratio $[(-\text{NCO})/(-\text{OH})]$ of more than 1, and

preferably 1.5 or above, in which (-NCO) is an equivalent of the isocyanate group in the polyisocyanate and (-OH) is an equivalent of the hydroxyl group in the polyol. In view of negative results such as slow curing and increased foams during
5 moisture curing, the reaction takes place such that the $[(-\text{NCO})/(-\text{OH})]$ ratio is up to 10.0, and preferably up to 8.0.

For example, this ratio can be achieved by reacting a hydroxyl-containing monomer or prepolymer (e.g., polyethylene glycol, polymethylene glycol, polybutylene glycol or a
10 derivative thereof) with the isocyanate curing agent (iii) (e.g., tolylene diisocyanate or a prepolymer thereof) in a ratio in which the isocyanate groups exceed the hydroxyl groups.

The polymerization temperature and time in production
15 of the moisture curing urethane resin (urethane prepolymer) (vi) are not particularly limited. For example, it is appropriate that the polyol and the polyisocyanate are mixed together in a stream of nitrogen gas and the mixture is reacted at 60 to 100°C for 3 to 8 hours. In the reaction, an
20 organometallic salt-based urethane catalyst such as dibutyltin dilaurate may be added in an appropriate amount and at an appropriate stage as needed.

The moisture absorbent (vii) removes the water content of the middle coat paint, and thereby prevents gelation of the

paint and contributes to superior storage stability of the paint.

In the second concrete form plywood, the composition for the middle coat paint film (B') preferably contains the
5 anti-foaming agent (xii) in view of smoothness of the resultant paint film, and prevention of foams on the film surface by bubbles caught in the paint during application.

The composition for the middle coat paint film (B') preferably contains:

10 the moisture curing urethane resin (vi) in an amount such that the urethane resin (vi) (solid content, namely, nonvolatile content other than the solvent) constitutes 30 to 99% by weight, and more preferably 40 to 98% by weight of 100% by weight of the solid ingredients other than the volatile
15 solvent in the composition (B');

the curing catalyst (viii) in an amount of 0.05 to 5 parts by weight, and more preferably 0.1 to 2 parts by weight per 100 parts by weight of the urethane resin (vi) (solid content); and

20 the moisture absorbent (vii) in an amount of 1.0 to 40 parts by weight, and more preferably 1.0 to 5 parts by weight per 100 parts by weight of the urethane resin (vi) (solid content).

The moisture curing urethane resin (vi) contained in the

above amount provides a viscosity appropriate for application and handling, and the resultant concrete form plywood shows excellent crack resistance.

The curing catalyst (viii) contained in the above amount
5 provides a drying time and working life appropriate for the application work.

The moisture absorbent (vii) contained in the above amount provides effective prevention of air moisture influence.

10 When the composition for the middle coat paint film (B') contains the leveling agent (xiii) and the anti-foaming agent (xii) according to need, the amounts thereof are, for example:

0.05 to 5.0 parts by weight for the leveling agent (xiii)
per 100 parts by weight of the urethane resin (vi) (solid
15 content); and

0.02 to 2.0 parts by weight for the anti-foaming agent (xii) per 100 parts by weight of the urethane resin (vi) (solid content).

The leveling agent (xiii) contained in the above amount
20 is preferable from the viewpoint of imparting a smooth surface to the resultant paint film.

The anti-foaming agent (xii) contained in the above amount is preferable from the viewpoint of preventing foams from occurring during application.

The composition for the middle coat paint film (B') may be produced by the common procedure, and is generally used as a one-package system and sometimes as a two-package system depending on the composition of the paint, and paint storage
5 and application environment such as temperature and humidity.

The middle coat paint is generally cured by the action of air humidity (moisture) at room temperature. The middle coat paint is generally used in the form of solvent type paint. The amount of solvent is not particularly limited, and may be
10 in the range of 10 to 60% by weight in 100% by weight of the middle coat paint (including the solvent).

In the second concrete form plywood, the first filler coat paint film (A') and the third topcoat paint film (C') are colored to a sufficient level. Therefore, addition of a
15 pigment is not necessary for the paint for the second middle coat paint film (B'); the paint is generally clear. In the case where the first and third paint films are light-colored, a small amount of a color pigment may be added to the middle coat paint for the second film.

20 Topcoat paint film (C')

The topcoat paint film (C') is formed on the surface of the middle coat paint film (B') by application of a topcoat paint followed by curing. The topcoat paint comprises a curing acrylic resin composition including a curing

hydroxyl-containing acrylic resin (i), an isocyanate curing agent (iii) and a color pigment (iv).

The composition for the topcoat paint film (C') may further contain an organic solvent as described above, which
5 is generally used, and at least one of the anti-settling agent (xi), the leveling agent (xiii) and the anti-foaming agent (xii).

In the second concrete form plywood, the topcoat paint film (C') made from the cured topcoat paint is excellent in
10 adhesion (peel strength) with the middle coat paint film (B'), surface smoothness and form-release properties from hardened concrete. Accordingly, the second concrete form plywood coated with the topcoat paint film (C') allows for production of hardened concrete having high surface smoothness without
15 any hardened concrete waste remaining attached to the form surface. Further, the formplywoods are unlikely to be damaged, and the form can be reused many times, for example 10 or more times, preferably 15 or more times, and particularly preferably 20 or more times. Moreover, the concrete form
20 plywood of the invention enables significant reduction of disposal cost after use as compared with the usual coated form plywoods.

The curing hydroxyl-containing acrylic resin (i), the isocyanate curing agent (iii) and the color pigment (iv)

contained in the topcoat paint are similar to those contained in the filler coat paint film (A') and the filler coat paint.

The composition for the topcoat paint film (C') contains:

the curing hydroxyl-containing acrylic resin (i) in an
5 amount such that the acrylic resin preferably constitutes 40
to 80% by weight, and more preferably 50 to 75% by weight of
100% by weight of the solids other than the solvent of the
composition; and such that the acrylic resin (i) preferably
constitutes 30 to 70% by weight, and more preferably 40 to 65%
10 by weight of the cured topcoat paint film (C');

the isocyanate curing agent (iii) in an amount on the
above basis such that the reaction ratio $[(\text{NCO})/(\text{OH})]$ of the
isocyanate group (-NCO) in the isocyanate curing agent (iii)
and the hydroxyl group (-OH) in the acrylic resin (i) is
15 theoretically equal amount, and practically in the range of
0.8/1.0 to 1.2/1.0; and

the color pigment (iv) in an amount such that the color
pigment preferably constitutes 1 to 30% by weight, and more
preferably 5 to 20% by weight on the above basis, and further
20 in an amount of 1 to 30 parts by weight per 100 parts by weight
of the acrylic resin (i) (solid content).

The curing hydroxyl-containing acrylic resin (i)
contained in the above amount is preferable from the viewpoint
of a viscosity appropriate for application and handling, and

good weathering resistance.

The color pigment (iv) being at least one of yellow iron oxide, titanium oxide, cyanine blue and carbon black that is contained in the above amount is preferable from the viewpoint
5 of good hiding properties for the plywood surface.

The isocyanate curing agent (iii) contained in the above amount is preferable from the viewpoint of good paint film properties such as water and alkali resistance.

When the composition for the topcoat paint film (C')
10 contains the anti-settling agent (xi), the anti-foaming agent (xii), the leveling agent (xiii) and the like according to need, the amounts thereof are, for example:

0.5 to 6 parts by weight for the anti-settling agent (xi)
per 100 parts by weight of the acrylic resin (i) (solid
15 content);

0.2 to 1.0 part by weight for the anti-foaming agent (xii)
per 100 parts by weight of the acrylic resin (i) (solid
content); and

0.05 to 5.0 parts by weight for the leveling agent (xiii)
20 per 100 parts by weight of the urethane resin (vi) (solid
content).

The anti-settling agent (xi) contained in the above amount is preferable from the viewpoint of effectively preventing the pigment from settling.

The anti-foaming agent (xii) contained in the above amount is preferable from the viewpoint of preventing foams from occurring in the film surface.

5 The leveling agent (xiii) contained in the above amount is preferable from the viewpoint of imparting a smooth surface to the resultant paint film.

The composition (topcoat paint or agent) for the topcoat paint film (C') may be produced by the common procedure, and is generally used as a one-package system or a two-package
10 system depending on the curing agent used.

The topcoat paint is curable at room temperature depending on the kind of the curing hydroxyl-containing acrylic resin (i) or the like. Stoving at 50 to 70°C permits reduction of the drying time. The topcoat paint is generally
15 used in the form of solvent type paint. The amount of solvent is not particularly limited, and may be in the range of 2 to 40% by weight in 100% by weight of the topcoat paint (including the solvent).

As described in detail hereinabove, the second concrete
20 form plywood according to the present invention is composed of a concrete form plywood having a surface coated with:

the first film which in a preferred embodiment is made from the acrylic urethane resin filler coat paint containing much extender pigment and which smoothes the plywood surface;

the second film which is produced by applying the moisture curing urethane resin paint to form an middle coat paint film that improves crack resistance of the concrete form plywood; and

5 the third film which is formed on the middle coat paint film by applying the acrylic urethane resin paint that contains the color pigment and which permits easy release of the form plywood after concrete placement.

Process for manufacturing second concrete form plywood

10 In the process for manufacturing the second concrete form plywood according to the present invention, the above-described paints for the films (A'), (B') and (C') are applied to a surface of the substrate and cured to form the paint films in the order of (substrate/paint film (A')/paint
15 film (B')/paint film (C')).

Preferred embodiments are presented below.

(1) Application of the filler coat paint for the first film

To fill and smooth the unevenness of the plywood surface, the application of the filler coat paint for the first film
20 involves a conveyer for conveying the form plywood, and a thin steel-plate knife coater that is arranged perpendicularly (orthogonally) to the traveling direction of the plywood. In general, one application using a knife coater often results in insufficient filling of the vessels with the filler coat

paint, and good smoothness cannot be obtained. Thus, the knife-coater application will generally and desirably be repeated 2 or 3 times using the same filler coat paint such that 80 to 150 g in total of the paint (uncured) will be applied
5 per square meter.

(2) Application of the middle coat paint for the second film

The application of the middle coat paint for the second film involves, for example, a roll coater and is preferably performed 1 to 3 times using the same middle coat paint such
10 that 20 to 90 g in total of the paint (uncured) will be applied per square meter.

(3) Application of the topcoat paint for the third film

The application of the topcoat paint for the third film involves, for example, a roll coater and is preferably
15 performed 1 or 2 times using the same topcoat paint such that 20 to 90 g in total of the paint (uncured) will be applied per square meter.

(4) Drying process

Room temperature drying is generally employed to dry the
20 filler coat paint for the first film, middle coat paint for the second film and topcoat paint for the third film.

Depending on the ingredient composition and the like, forced drying may be performed at elevated temperatures of 60 to 80°C.

In the case of the room temperature drying, the drying

time for the first film prior to the application of the second film is in the range of 1 to 3 hours, and that for the second film before the application of the third film is in the range of 0 to 3 hours.

5 That is, the second film may be overcoated with the third film after the second film has been sufficiently dried for about 3 hours or immediately after the second film has been applied (the drying time for the second film is 0 hours) and is in an uncured state (wet-on-wet process).

10 After the third film has been formed, the coated form plywoods must be dried for at least 5 hours before stack storage or transportation to prevent sticking of wet paint films.

Effects of the invention

 The second concrete form plywood is highly resistant to
15 cracks and can be released easily from hardened concrete. Coating one time with the topcoat paint composition permits the plywood to be reused many times (for example, 10 or more times) in concrete placement, more than twice the number of reusing times of the conventional coated form plywoods;
20 therefore good workability and economic efficiency can be achieved. Accordingly, the invention allows for reduction of concrete forms used in construction site, efficient building of a structure having a beautiful appearance, and resource saving.

The high reusability of the second concrete form plywood enables 50% or more (relative to the conventional level) reduction of disposal cost of form plywoods that are cracked during concrete work and are to be junked. Moreover, the use
5 of the concrete form plywoods of the invention provides great effects of forest resource conservation and effective utilization.

EXAMPLES

10 The present invention will be hereinafter described in greater detail by Examples, but it should be construed that the invention is in no way limited to those Examples.

Table 1 sets forth the composition and properties of the ingredients used in Examples.

Table 1 (Ingredient List)

Product Name	Manufacturer	Ingredient	Nonvolatile content (wt%)	Solvent
HITALOID 3083-70B*	Hitachi Chemical Co., Ltd.	Acrylic resin solution	70	Toluene, methyl ethyl ketone, isobutyl acetate
VINYLLITE VAGD	The Dow Chemical Company	Vinyl chloride/vinyl acetate copolymer resin	100	
APO-101*	Ohtake-Meishin Chemical Co., Ltd.	Acrylic resin solution	60	Toluene, methyl isobutyl ketone
APO-301*	Ohtake-Meishin Chemical Co., Ltd.	Acrylic resin solution	65	Xylene
Boncoat EC-100	DAINIPPON INK AND CHEMICALS, INCORPORATED	Aqueous acrylic emulsion	50	(Water)
KR Bond F-29	Koyo Sangyo, Co., Ltd.	Aqueous vinyl acetate emulsion	40	(Water)
MT OLESTER M95-50	MITSUI TAKEDA CHEMICALS, INC.	Moisture curing urethane resin solution	50	Toluene, xylene, ethyl acetate, 3-methoxybutyl acetate
MT OLESTER M37-50	MITSUI TAKEDA CHEMICALS, INC.	Moisture curing urethane resin solution	50	Toluene, xylene, ethyl acetate, 3-methoxybutyl acetate
CORONATE L-75	NIPPON POLYURETHANE INDUSTRY CO., LTD.	Tolylene diisocyanate prepolymer	75	Ethyl acetate
MILLIONATE MR-200	NIPPON POLYURETHANE INDUSTRY CO., LTD.	Diphenylmethane diisocyanate	100	
SUMIDULE 44V-20	Sumitomo Bayer Urethane Co., Ltd.	Diphenylmethane diisocyanate	100	
TAROX LL-XLO	TITAN KOGYO KABUSHIKI KAISHA	Yellow iron oxide	100	
NS-400	NITTO FUNKA KOGYO K.K.	Calcium carbonate	100	
TALC MS	NIPPON TALC CO., LTD.	Talc	100	
TIPAQUE CR-60	ISHIHARA SANGYO KAISHA, LTD.	Titanium oxide	100	

Table 1 (continued)

Product Name	Manufacturer	Ingredient	Nonvolatile content (wt%)	Solvent
MA-100	MITSUBISHI CHEMICAL CORPORATION	Carbon black	100	
DISPARLON 4200-20	KUSUMOTO CHEMICALS	Polyethylene wax	20	Xylene
AEROSIL 200	NIPPON AEROSIL CO., LTD.	Surface treated silica	100	
FLOWLEN AC-300	Kyoeisha Yushi Kagaku Kogyo Co., Ltd.	Acrylic resin solution	77	Xylene
FLOWLEN No. 7	Kyoeisha Yushi Kagaku Kogyo Co., Ltd.	Acrylic resin solution	72	Xylene
DC-57	Dow Corning Corporation	Dimethylpolysiloxane	100	
BYK-088	BYK Chemie	Organopolysiloxane solution	3.3	Isoparaffin
BYK-344	BYK Chemie	Organopolysiloxane solution	52	Xylene, isobutanol
ADDITIVE OF	Sumitomo Bayer Urethane Co., Ltd.	Trimethyl orthoformate	100	
U-CAT 651M	San-Apro Ltd.	Modified amine	100	

Notes (*) in the table Properties of acrylic resins

	Solid content (wt%)	Dilution solvent	Hydroxyl value (solid content)	Glass transition temperature (C°)	Weight-average molecular weight (Mw)
HITALOID 3083-70B	70	Toluene, methyl ethyl ketone, isobutyl acetate	100	46	4,500
APO-101	60	Toluene, methyl isobutyl ketone	50	9	21,000
APO-301	65	Xylene	70	56	30,000

[Example (I) (First concrete form plywood)]

[Preparation of paint composition]

Filler coat first-film paints A to C shown in Tables 3 to 5, middle coat second-film paints A and B shown in Tables 5 6 and 7, and topcoat third-film clear paints A to G shown in Tables 8 to 14 were prepared.

Reuse test (otherwise referred to as concrete placement test, form-release test or the like depending on the testing object) and JAS test were preformed as follows.

10 (Reuse test procedure)

A plurality of test pieces 15 cm long and 30 cm wide were cut from each of coated test plates, and they were built into a bottomed wooden box 15 cm in length, 15 cm in width and 30 cm in depth in which the coated surfaces of the test pieces 15 faced inward.

Into the wooden box was poured ready-mixed concrete consisting of cement, sand and gravel in a volume ratio of 1:3:6 (cement:sand:gravel) plus water in a volume ratio of 10/0.8-1.0 (cement+sand+gravel)/water). The concrete was 20 allowed to harden for 4 days.

Thereafter, the hardened concrete was removed from the wooden box, and the inside surfaces of the wooden box were washed with running water and dried.

After the inside surfaces of the wooden box had been dried,

similar ready-mixed concrete was poured and allowed to harden for 4 days.

Thereafter, the hardened concrete was removed from the wooden box, and the inside surfaces of the wooden box were
5 washed with running water and dried.

The cycle consisting of: pouring ready-mixed concrete into the wooden box; hardening the concrete; removing the concrete; washing the coated surfaces of the wooden box; and drying the wooden box; was repeated ten times (10 cycles), and
10 the coated surfaces were observed to check the concrete waste or lime wash attached to the coated surfaces. The term "lime wash" means a cement paste which is obtained by kneading cement with water and which is poor in strength but is very fine grained. The lime wash is mainly used to repair cracks in tile joints
15 and mortar faces and easily attaches to the form surface when the form is released from concrete.

(JAS test)

Table 2 below sets forth procedures of plane tensile test, repeated high and low temperature test and alkali resistance
20 test specified in Japanese Agricultural Standards on Concrete form plywoods, "4. Board Surface Quality".

Table 2

Testing item	Testing procedure
Plane tensile test	a. Preparation of test pieces Four (4) square test pieces with a side length of 50 mm shall be prepared from each sample plywood. b. Testing method On the center of test piece surface, a metal plate with a square gluing surface whose side length is 20 mm shall be glued by cyano-acrylate adhesives. After notching around the metal plate to the depth reaching its base plywood, the test piece and metal plate shall be fixed between the chucks as shown in the figure below and tensile force shall be applied in the right angle direction to the glued face at a loading speed of not more than 600 kg/min and the maximum load when a failure or delamination occurs shall be measured. c. Compliance criterion The average bonding strength of the test pieces prepared from one same sample plywood is not less than 10 kg/cm².

Table 2 (continued)

Testing item	Testing procedure
Repeated high and low temperature test	a. Preparation of test pieces Two (2) square test pieces with a side length of 150 mm shall be prepared from each sample plywood. b. Testing method The process in which the test piece is left in a thermostatic apparatus at a temperature of $60 \pm 3^\circ\text{C}$ for 2 hours and then left at a temperature of $-20 \pm 3^\circ\text{C}$ for 2 hours shall be repeated twice. After that, the test piece shall be left until attaining room temperature. c. Compliance criterion The test piece surface is free from cracks, blisters, wrinkles and separation.
Alkali resistance test	a. Preparation of test pieces Two (2) square test pieces with a side length of 75 mm shall be prepared from each sample plywood. b. Testing method The test piece shall be placed horizontally at room temperature and on the surface approx. 5 mL of one percent (1%) aqueous solution of sodium hydroxide shall be dropped. After keeping it sealed with a cover of watch glass for 48 hours, the test piece shall be washed with water and conditioned for 24 hours at room temperature. c. Compliance criterion The test piece surface is covered with the aqueous solution after the lapse of 48 hours, is free from cracks, blisters and separation, and is not remarkably discolored or changed in gloss as compared with the surface prior to the test.

Table 3

[Filler coat paint A]

((Note 1) amount: parts by weight, numbers in parentheses indicate parts by weight of each ingredient without the solvent, the same applies to Tables 4 to 14)

Ingredient	Product Name	Manufacturer	Amount (Note 1)
Acrylic resin varnish	HITALOID 3083-70B	Hitachi Chemical Co., Ltd.	60.0
Yellow iron oxide	TAROX LL-XLO	TITAN KOGYO KABUSHIKI KAISHA	5.0
Calcium carbonate	NS-400	NITTO FUNKA KOGYO K.K.	15.0
Talc	TALC MS	NIPPON TALC CO., LTD.	15.0
Anti-settling agent	DISPARLON 4200-20	KUSUMOTO CHEMICALS	1.0
Thixotropic agent	AEROSIL 200	NIPPON AEROSIL CO., LTD.	1.0
Organic solvent	Xylene		3.0
Curing agent	CORONATE L-75	NIPPON POLYURETHANE INDUSTRY CO., LTD.	24.0

Table 4

[Filler coat paint B]

Ingredient	Product Name	Manufacturer	Amount (Note 1)
Acrylic resin varnish	HITALOID 3083-70B	Hitachi Chemical Co., Ltd.	35.0
Yellow iron oxide	TAROX LL-XLO	TITAN KOGYO KABUSHIKI KAISHA	5.0
Calcium carbonate	NS-400	NITTO FUNKA KOGYO K.K.	40.0
Talc	TALC MS	NIPPON TALC CO., LTD.	15.0
Anti-settling agent	DISPARLON 4200-20	KUSUMOTO CHEMICALS	1.0
Thixotropic agent	AEROSIL 200	NIPPON AEROSIL CO., LTD.	1.0
Organic solvent	Xylene		3.0
Curing agent	CORONATE L-75	NIPPON POLYURETHANE INDUSTRY CO., LTD.	14.0

Table 5

[Filler coat paint C]

Ingredient	Product Name	Manufacturer	Amount (Note 1)
Organic solvent (Note A1)	Xylene (a)		10.0
Organic solvent	Methyl isobutyl ketone		10.0
Vinyl resin	VINYLLITE VAGD	The Dow Chemical Company	5.0 (5)
Acrylic resin varnish	HITALOID 3083-70B	Hitachi Chemical Co., Ltd.	11.0 (7.7)
Yellow iron oxide	TAROX LL-XLO	TITAN KOGYO KABUSHIKI KAISHA	5.0 (5)
Calcium carbonate	NS-400	NITTO FUNKA KOGYO K.K.	55.0 (55)
Anti-settling agent	DISPARLON 4200-20	KUSUMOTO CHEMICALS	1.0 (0.2)
Thixotropic agent	AEROSIL 200	NIPPON AEROSIL CO., LTD.	1.0 (1)
Organic solvent (Note A2)	Xylene (b)		2.0
Curing agent	MILLIONATE MR-200	NIPPON POLYURETHANE INDUSTRY CO., LTD.	5.0 (5)

Note A1: Xylene used in combination with methyl isobutyl ketone to dissolve VAGD at an early stage of paint preparation.

Note A2: Xylene used for regulating the paint viscosity at a late stage of paint preparation.

5 The total amount of Xylene is the sum of (a) and (b).

Table 6

[Middle coat paint A]

Ingredient	Product Name	Manufacturer	Amount (Note 1)
Acrylic resin varnish	HITALOID 3083-70B	Hitachi Chemical Co., Ltd.	80.0
Yellow iron oxide	TAROX LL-XLO	TITAN KOGYO KABUSHIKI KAISHA	10.0
Anti-settling agent	DISPARLON 4200-20	KUSUMOTO CHEMICALS	2.0
Anti-foaming agent	FLOWLEN AC-300	Kyoeisha Yushi Kagaku Kogyo Co., Ltd.	0.5
Organic solvent	Xylene		5.0
Organic solvent	Butyl acetate		2.5
Curing agent	MILLIONATE MR-200	NIPPON POLYURETHANE INDUSTRY CO., LTD.	13.0

Table 7

5 [Middle coat paint B]

Ingredient	Product Name	Manufacturer	Amount (Note 1)
Acrylic resin varnish	HITALOID 3083-70B	Hitachi Chemical Co., Ltd.	60.0
Acrylic resin varnish	AP0-101	Ohtake-Meishin Chemical Co., Ltd.	20.0
Titanium white	TIPAQUE CR-60	ISHIHARA SANGYO KAISHA, LTD.	4.8
Carbon black	MA-100	MITSUBISHI CHEMICAL CORPORATION	0.2
Anti-settling agent	DISPARLON 4200-20	KUSUMOTO CHEMICALS	2.0
Anti-foaming agent	FLOWLEN AC-300	Kyoeisha Yushi Kagaku Kogyo Co., Ltd.	0.5
Organic solvent	Xylene		5.0
Organic solvent	Butyl acetate		5.0
Curing agent	MILLIONATE MR-200	NIPPON POLYURETHANE INDUSTRY CO., LTD.	11.0

Table 8

[Topcoat clear paint A]

Ingredient	Product Name	Manufacturer	Amount (Note 1)
Acrylic resin varnish	AP0-301	Ohtake-Meishin Chemical Co., Ltd.	80.0
Anti-foaming agent	FLOWLEN AC-300	Kyoeisha Yushi Kagaku Kogyo Co., Ltd.	0.5
Leveling agent	FLOWLEN No. 7	Kyoeisha Yushi Kagaku Kogyo Co., Ltd.	0.5
Organic solvent	Xylene		5.0
Organic solvent	Butyl acetate		5.0
Curing agent	MILLIONATE MR-200	NIPPON POLYURETHANE INDUSTRY CO., LTD.	9.0

Table 9

5 [Topcoat clear paint B]

Ingredient	Product Name	Manufacturer	Amount (Note 1)
Acrylic resin varnish	AP0-301	Ohtake-Meishin Chemical Co., Ltd.	80.0
Anti-foaming agent	FLOWLEN AC-300	Kyoeisha Yushi Kagaku Kogyo Co., Ltd.	0.5
Leveling agent	FLOWLEN No. 7	Kyoeisha Yushi Kagaku Kogyo Co., Ltd.	0.5
Polysiloxane compound	DC-57	Dow Corning Corporation	1.0
Organic solvent	Xylene		15.0
Organic solvent	Butyl acetate		5.0
Curing agent	MILLIONATE MR-200	NIPPON POLYURETHANE INDUSTRY CO., LTD.	9.0

Table 10

[Topcoat clear paint C]

Ingredient	Product Name	Manufacturer	Amount (Note 1)
Acrylic resin varnish	APC-301	Ohtake-Meishin Chemical Co., Ltd.	80.0 (52)
Anti-foaming agent	FLOWLEN AC-300	Kyoeisha Yushi Kagaku Kogyo Co., Ltd.	0.5 (0.385)
Leveling agent	FLOWLEN No. 7	Kyoeisha Yushi Kagaku Kogyo Co., Ltd.	0.5 (0.36)
Polysiloxane compound	DC-57	Dow Corning Corporation	10.0 (10)
Organic solvent	Xylene		5.0
Organic solvent	Butyl acetate		5.0
Curing agent	MILLIONATE MR-200	NIPPON POLYURETHANE INDUSTRY CO., LTD.	8.0 (8)

Table 11

5 [Topcoat clear paint D]

Ingredient	Product Name	Manufacturer	Amount (Note 1)
Acrylic resin varnish	APC-301	Ohtake-Meishin Chemical Co., Ltd.	60.0 (39)
Anti-foaming agent	FLOWLEN AC-300	Kyoeisha Yushi Kagaku Kogyo Co., Ltd.	0.5 (0.385)
Leveling agent	FLOWLEN No. 7	Kyoeisha Yushi Kagaku Kogyo Co., Ltd.	0.5 (0.36)
Polysiloxane compound	DC-57	Dow Corning Corporation	30.0 (30)
Organic solvent	Xylene		5.0
Organic solvent	Butyl acetate		5.0
Curing agent	MILLIONATE MR-200	NIPPON POLYURETHANE INDUSTRY CO., LTD.	5.0 (5)

Table 12

[Topcoat clear paint E]

Ingredient	Product Name	Manufacturer	Amount (Note 1)
Moisture curing urethane resin varnish	MT OLESTER M95-50A	mitsui TAKEDA CHEMICALS, INC.	86.0 (43)
Moisture absorbent	ADDITIVE OF	Sumitomo Bayer Urethane Co., Ltd.	0.5 (0.5)
Anti-foaming agent	BYK-088	BYK Chemie	0.5 (0.0165)
Catalyst	U-CAT 651M	San-Apro Ltd.	0.5 (0.5)
Organic solvent	Xylene		10.0

Table 13

5 [Topcoat clear paint F]

Ingredient	Product Name	Manufacturer	Amount (Note 1)
Moisture curing urethane resin varnish	MT OLESTER M95-50A	mitsui TAKEDA CHEMICALS, INC.	86.0 (43)
Moisture absorbent	ADDITIVE OF	Sumitomo Bayer Urethane Co., Ltd.	0.5 (0.5)
Anti-foaming agent	BYK-088	BYK Chemie	0.5 (0.0165)
Catalyst	U-CAT 651M	San-Apro Ltd.	0.5 (0.5)
Polysiloxane compound	BYK-344	BYK Chemie	1.5 (0.78)
Organic solvent	Xylene		11.0

Table 14

[Topcoat clear paint G]

Ingredient	Product Name	Manufacturer	Amount	(Note 1)
Moisture curing urethane resin varnish	MT OLESTER M95-50A	mitsui TAKEDA CHEMICALS, INC.	82.0	(41)
Moisture absorbent	ADDITIVE OF	Sumitomo Bayer Urethane Co., Ltd.	0.5	(0.5)
Anti-foaming agent	BYK-088	BYK Chemie	0.5	(0.0165)
Catalyst	U-CAT 651M	San-Apro Ltd.	0.5	(0.5)
Polysiloxane compound	BYK-344	BYK Chemie	7.0	(3.64)
Organic solvent	Xylene		10.0	

Next, test examples will be presented to describe the invention.

In the test examples below, those that resulted in good form-release properties (Test Examples I-6, I-7 and I-10) correspond to preferred examples of the present invention.

The other test examples are Reference Example (Test Example I-5) and Comparative Examples (Test Examples I-1 to I-4, I-8 and I-9).

[Test Example I-1]

(Preparation of concrete form plywood)

The filler coat paint A for the first film, comprising the sufficiently mixed principal ingredients and curing agent shown in the above table, was applied to a concrete form plywood three times every hour at room temperature (25°C) using a knife coater, so that approximately 50 g of the paint (uncured) was applied per square meter. The filler coat paint A was dried for one hour.

Thereafter, the middle coat paint A for the second film, comprising the principal ingredients and curing agent shown in the above table, was applied two times consecutively at room temperature using a roll coater, so that approximately 50 g of the paint (uncured) was applied per square meter.

The coated form plywood was dried at room temperature for 48 hours. Thus, a concrete form plywood was prepared.

(Testing)

The concrete form plywood was tested by the reuse test and the JAS test.

The results are shown in Tables 15 and 16.

5 [Test Example I-2]

(Preparation of concrete form plywood)

A concrete form plywood was prepared in the same manner as in Test Example I-1, except that the filler coat first-film paint A and the middle coat second-film paint A were applied
10 so that approximately 90 g each of the paints were applied per square meter.

(Testing)

The concrete form plywood was tested by the reuse test and the JAS test.

15 The results are shown in Tables 15 and 16.

[Test Example I-3]

(Preparation of concrete form plywood)

A concrete form plywood was prepared in the same manner as in Test Example I-1, except that the filler coat first-film
20 paint A was replaced with the filler coat paint B, which was applied so that approximately 90 g of the paint was applied per square meter, and that the middle coat second-film paint A was replaced with the middle coat paint B, which was applied so that approximately 90 g of the paint was applied per square

meter.

(Testing)

The concrete form plywood was tested by the reuse test and the JAS test.

5 The results are shown in Tables 15 and 16.

[Test Example I-4]

(Preparation of concrete form plywood)

A concrete form plywood was prepared in the same manner as in Test Example I-1, except that:

10 the filler coat first-film paint A and the middle coat second-film paint A were applied so that approximately 90 g each of the paints were applied per square meter, and the paints were dried at room temperature for 2 hours; and

the topcoat clear paint A for the third film, comprising
15 the sufficiently mixed principal ingredients and curing agent shown in the above table, was applied one time using a roll coater so that approximately 20 g of the paint was applied per square meter, followed by drying at room temperature for 48 hours.

20 (Testing)

The concrete form plywood was tested by the reuse test and the JAS test.

The results are shown in Tables 15 and 16.

[Test Example I-5]

(Preparation of concrete form plywood)

A concrete form plywood was prepared in the same manner as in Test Example I-4, except that the topcoat third-film clear paint A was replaced with the topcoat clear paint B.

5 (Testing)

The concrete form plywood was tested by the reuse test and the JAS test.

The results are shown in Tables 15 and 16.

[Test Example I-6]

10 (Preparation of concrete form plywood)

A concrete form plywood was prepared in the same manner as in Test Example I-4, except that the topcoat third-film clear paint A was replaced with the topcoat clear paint C, which was applied so that 30 g of the paint was applied per square meter.

15 (Testing)

The concrete form plywood was tested by the reuse test and the JAS test.

The results are shown in Tables 15 and 16.

[Test Example I-7]

20 (Preparation of concrete form plywood)

A concrete form plywood was prepared in the same manner as in Test Example I-4, except that the topcoat third-film clear paint A was replaced with the topcoat clear paint D, which was applied so that 30 g of the paint was applied per square meter.

(Testing)

The concrete form plywood was tested by the reuse test and the JAS test.

The results are shown in Tables 15 and 16.

5 [Test Example I-8]

(Preparation of concrete form plywood)

A concrete form plywood was prepared in the same manner as in Test Example I-4, except that:

the filler coat first-film paint A was replaced with the
10 filler coat paint C, which was applied so that 90 g of the paint was applied per square meter;

the middle coat second-film paint A was replaced with the middle coat paint B, which was applied so that 90 g of the paint was applied per square meter; and

15 the topcoat third-film clear paint A was replaced with the topcoat clear paint E, which was applied so that 30 g of the paint was applied per square meter.

(Testing)

The concrete form plywood was tested by the reuse test
20 and the JAS test.

The results are shown in Tables 15 and 16.

[Test Example I-9]

(Preparation of concrete form plywood)

A concrete form plywood was prepared in the same manner

as in Test Example I-4, except that:

the filler coat first-film paint A was replaced with the filler coat paint C, which was applied so that 90 g of the paint was applied per square meter;

5 the middle coat second-film paint A was replaced with the middle coat paint B, which was applied so that 90 g of the paint was applied per square meter; and

the topcoat third-film clear paint A was replaced with the topcoat clear paint F, which was applied so that 30 g of
10 the paint was applied per square meter.

(Testing)

The concrete form plywood was tested by the reuse test and the JAS test.

The results are shown in Tables 15 and 16.

15 [Test Example I-10]

(Preparation of concrete form plywood)

A concrete form plywood was prepared in the same manner as in Test Example I-4, except that:

the filler coat first-film paint A was replaced with the
20 filler coat paint C, which was applied so that 90 g of the paint was applied per square meter;

the middle coat second-film paint A was replaced with the middle coat paint B, which was applied so that 90 g of the paint was applied per square meter; and

the topcoat third-film clear paint A was replaced with the topcoat clear paint G, which was applied so that 30 g of the paint was applied per square meter.

(Testing)

- 5 The concrete form plywood was tested by the reuse test and the JAS test.

The results are shown in Tables 15 and 16.

Table 15

Testing item	Testing method	Test Example I-1	Test Example I-2	Test Example I-3	Test Example I-4	Test Example I-5
Paint film structure (filler coat paint/middle coat paint /topcoat paint)		A/A/-	A/A/-	B/B/-	A/A/A	A/A/B
Surface state and appearance	Visual inspection	Nonsmooth	Smooth	Smooth	Smooth	Smooth
Hiding properties	Visual inspection	Bad	Good	Good	Good	Good
Plane tensile strength* (kg/cm ²)	JAS	Pass	Pass	Pass	Pass	Pass
Alkali resistance	JAS	Pass	Pass	Pass	Pass	Pass
Repeated high and low temperature test	JAS	Pass	Pass	Pass	Pass	Pass
Reuse test		Lime wash attached	Lime wash attached	Lime wash attached	Lime wash attached	Lime wash attached

*Plane tensile strength means paint film/plywood adhesive strength.

Table 16

Testing item	Testing method	Test Example I-6	Test Example I-7	Test Example I-8	Test Example I-9	Test Example I-10
Paint film structure (filler coat paint/middle coat paint /topcoat paint)		A/A/C	A/A/D	C/B/E	C/B/F	C/B/G
Surface state and appearance	Visual inspection	Smooth	Sticky	Smooth	Smooth	Smooth
Hiding properties	Visual inspection	Good	Good	Good	Good	Good
Plane tensile strength* (kg/cm ²)	JAS	Pass	Pass	Pass	Pass	Pass
Alkali resistance	JAS	Pass	Pass	Pass	Pass	Pass
Repeated high and low temperature test	JAS	Pass	Pass	Pass	Pass	Pass
Reuse test	(Note)	Good	Good	Lime wash attached	Lime wash attached	Good

*Plane tensile strength means paint film/plywood adhesive strength.

[Example (II) (second concrete form plywood)]

[Preparation of paint composition]

Filler coat first-film paints A' to D' (filler coat paints A' to D') shown in Tables 17 to 20, middle coat
5 second-film paints A' and B' (middle coat clear paints A' and B') shown in Tables 21 and 22, and topcoat third-film paints A' and B' (topcoat paints A' and B') shown in Tables 23 and 24 were prepared.

Crack resistance test was performed as described below.

10 The JAS testing method is as described in Table 2 above.

(Crack resistance test)

Test pieces 15 cm long and 15 cm wide were cut from each of coated test plates, and they were allowed to stand in a thermostatic apparatus at $80 \pm 3^\circ\text{C}$ for 2 hours and then in a
15 thermostatic apparatus at $-20 \pm 3^\circ\text{C}$ for 2 hours. This process was repeated two times, and the test pieces were allowed to stand at room temperature until the temperature of the test pieces reached ambient level. Cracks on the surface of the test pieces were counted. The test was repeated until many
20 cracks occurred on the test piece surfaces.

Table 17

[Filler coat paint A']

((Note 1) amount: parts by weight, numbers in parentheses indicate parts by weight of each ingredient without the solvent, the same applies to Tables 18 to 24)

Ingredient	Product Name	Manufacturer	Amount	(Note 1)
Acrylic resin varnish	HITALOID 3083-70B	Hitachi Chemical Co., Ltd.	35.0	(24.5)
Yellow iron oxide	TAROX LL-XLO	TITAN KOGYO KABUSHIKI KAISHA	5.0	(5)
Calcium carbonate	NS-400	NITTO FUNKA KOGYO K.K.	40.0	(40)
Talc	TALC MS	NIPPON TALC CO., LTD.	15.0	(15)
Anti-settling agent	DISPARLON 4200-20	KUSUMOTO CHEMICALS	1.0	(0.2)
Thixotropic agent	AEROSIL 200	NIPPON AEROSIL CO., LTD.	1.0	(1)
Organic solvent	Xylene		3.0	
Curing agent	CORONATE L-75	NIPPON POLYURETHANE INDUSTRY CO., LTD.	10.0	(10)

Table 18

[Filler coat paint B']

Ingredient	Product Name	Manufacturer	Amount (Note 1)
Organic solvent (Note 2)	Xylene (a)		10.0
Organic solvent	Methyl isobutyl ketone		
Vinyl resin	VINYLLITE VAGD	The Dow Chemical Company	10.0
Acrylic resin varnish	HITALOID 3083-70B	Hitachi Chemical Co., Ltd.	5.0
Yellow iron oxide	TAROX LL-XLO	TITAN KOGYO KABUSHIKI KAISHA	11.0
Calcium carbonate	NS-400	NITTO FUNKA KOGYO K.K.	(7.7)
Anti-settling agent	DISPARLON 4200-20	KUSUMOTO CHEMICALS	5.0
Thixotropic agent	AEROSIL 200	NIPPON AEROSIL CO., LTD.	55.0
Organic solvent (Note 3)	Xylene (b)		1.0
			1.0
			2.0
Curing agent	SUMIDULE 44V-20	Sumitomo Bayer Urethane Co., Ltd.	
			10.0
			(10)

Note 2: Xylene used in combination with methyl isobutyl ketone to dissolve VAGD at an early stage of paint preparation.

5 Note 3: Xylene used for regulating the paint viscosity at a late stage of paint preparation.
The total amount of xylene is the sum of (a) and (b).

Table 19

[Filler coat paint C']

Ingredient	Product Name	Manufacturer	Amount (Note 1)
Aqueous acrylic emulsion	Boncoat EC-100	DAINIPPON INK AND CHEMICALS, INCORPORATED	40.0
Yellow iron oxide	TAROX LL-XLO	TITAN KOGYO KABUSHIKI KAISHA	5.0
Calcium carbonate	NS-400	NITTO FUNKA KOGYO K.K.	50.0
Nonionic water			5.0

Table 20

5 [Filler coat paint D']

Ingredient	Product Name	Manufacturer	Amount (Note 1)
Aqueous vinyl acetate emulsion	KR Bond F-29	Koyo Sangyo, Co., Ltd.	40.0
Yellow iron oxide	TAROX LL-XLO	TITAN KOGYO KABUSHIKI KAISHA	5.0
Calcium carbonate	NS-400	NITTO FUNKA KOGYO K.K.	50.0
Nonionic water			5.0
Curing agent	MILLIONATE MR-200	NIPPON POLYURETHANE INDUSTRY CO., LTD.	5.0

Table 21

[Middle coat clear paint A']

Ingredient	Product Name	Manufacturer	Amount (Note 1)
Moisture curing urethane resin varnish	MT OLESTER M95-50A	MITSUI TAKEDA CHEMICALS, INC.	86.0
Moisture absorbent	ADDITIVE OF	Sumitomo Bayer Urethane Co., Ltd.	0.5
Anti-foaming agent	BYK-088	BYK Chemie	0.5
Catalyst	U-CAT 651M	San-Apro Ltd.	0.5
Organic solvent	Xylene		10.0

Table 22

5 [Middle coat clear paint B']

Ingredient	Product Name	Manufacturer	Amount (Note 1)
Moisture curing urethane resin varnish	MT OLESTER M37-50A	MITSUI TAKEDA CHEMICALS, INC.	86.0
Moisture absorbent	ADDITIVE OF	Sumitomo Bayer Urethane Co., Ltd.	0.5
Anti-foaming agent	BYK-088	BYK Chemie	0.5
Catalyst	U-CAT 651M	San-Apro Ltd.	0.5
Organic solvent	Xylene		10.0

Table 23

[Topcoat paint A']

Ingredient	Product Name	Manufacturer	Amount (Note 1)
Acrylic resin varnish	APC-301	Ohtake-Meishin Chemical Co., Ltd.	80.0 (52)
Yellow iron oxide	TAROX LL-XLO	TITAN KOGYO KABUSHIKI KAISHA	10.0 (10)
Anti-settling agent	DISPARLON 4200-20	KUSUMOTO CHEMICALS	2.0 (0.4)
Anti-foaming agent	FLOWLEN AC-300	Kyoeisha Yushi Kagaku Kogyo Co., Ltd.	0.5 (0.385)
Organic solvent	Xylene		5.0
Organic solvent	Butyl acetate		2.5
Curing agent	MILLIONATE MR-200	NIPPON POLYURETHANE INDUSTRY CO., LTD.	12.0 (12)

Table 24

5 [Topcoat paint B']

Ingredient	Product Name	Manufacturer	Amount (Note 1)
Acrylic resin varnish	HITALOID 3083-70B	Hitachi Chemical Co., Ltd.	60.0 (42)
Acrylic resin varnish	APC-101	Ohtake-Meishin Chemical Co., Ltd.	20.0 (12)
Titanium white	TIPAQUE CR-60	ISHIHARA SANGYO KAISHA, LTD.	4.8 (4.8)
Carbon black	MA-100	MTSUBISHI CHEMICAL CORPORATION	0.2 (0.2)
Anti-settling agent	DISPARLON 4200-20	KUSUMOTO CHEMICALS	2.0 (0.4)
Anti-foaming agent	FLOWLEN AC-300	Kyoeisha Yushi Kagaku Kogyo Co., Ltd.	0.5 (0.385)
Organic solvent	Xylene		5.0
Organic solvent	Butyl acetate		5.0
Curing agent	MILLIONATE MR-200	NIPPON POLYURETHANE INDUSTRY CO., LTD.	20.0 (20)

[Example II-1]

(Preparation of concrete form plywood)

The filler coat paint A' for the first film, comprising the sufficiently mixed principal ingredients and curing agent shown in the above table, was applied to a concrete form plywood three times every hour at room temperature (25°C) using a knife coater, so that approximately 90 g of the paint (uncured) was applied per square meter. The filler coat paint A' was dried for one hour.

10 Thereafter, the middle coat paint A' for the second film, comprising the principal ingredients and curing agent shown in the above table, was applied two times consecutively at room temperature using a roll coater, so that approximately 50 g of the paint (uncured) was applied per square meter. The
15 middle coat paint A' was dried for 2 hours.

Subsequently, the topcoat paint A' for the third film, comprising the principal ingredients and curing agent shown in the above table, was applied one time at room temperature using a roll coater so that approximately 50 g of the paint
20 was applied per square meter.

The coated form plywood was dried at room temperature for 48 hours. Thus, a concrete form plywood was prepared.

(Testing)

The concrete form plywood was tested by the crack

resistance test and the JAS test.

The results are shown in Table 26.

[Example II-2]

(Preparation of concrete form plywood)

5 A concrete form plywood was prepared in the same manner
as in Example II-1, except that the filler coat first-film paint
A', the middle coat second-film paint A' and the topcoat
third-film paint A' were replaced with the filler coat paint
B', the middle coat paint B' and the topcoat paint B',
10 respectively.

(Testing)

The concrete form plywood was tested by the crack
resistance test and the JAS test.

The results are shown in Table 26.

15 [Example II-3]

(Preparation of concrete form plywood)

A concrete form plywood was prepared in the same manner
as in Example II-1, except that the middle coat second-film
paint A' was replaced with the middle coat paint B'.

20 (Testing)

The concrete form plywood was tested by the crack
resistance test and the JAS test.

The results are shown in Table 26.

[Example II-4]

(Preparation of concrete form plywood)

A concrete form plywood was prepared in the same manner as in Example II-1, except that the filler coat first-film paint A' was replaced with the filler coat paint C'.

5 (Testing)

The concrete form plywood was tested by the crack resistance test and the JAS test.

The results are shown in Table 26.

[Example II-5]

10 (Preparation of concrete form plywood)

A concrete form plywood was prepared in the same manner as in Example II-1, except that the filler coat first-film paint A', the middle coat second-film paint A' and the topcoat third-film paint A' were replaced with the filler coat paint

15 D', the middle coat paint B' and the topcoat paint B', respectively.

(Testing)

The concrete form plywood was tested by the crack resistance test and the JAS test.

20 The results are shown in Table 26.

[Comparative Example II-1]

(Preparation of concrete form plywood)

A concrete form plywood was prepared in the same manner as in Example II-1, except that the filler coat first-film paint

A' was applied so that approximately 50 g of the paint (uncured) was applied per square meter, any middle coat second-film paint was not applied, and the topcoat third-film paint A' was applied so that approximately 50 g of the paint (uncured) was applied per square meter.

(Testing)

The concrete form plywood was tested by the crack resistance test and the JAS test.

The results are shown in Table 26.

10 [Comparative Example II-2]

(Preparation of concrete form plywood)

A concrete form plywood was prepared in the same manner as in Comparative Example II-1, except that the filler coat paint A' and the topcoat paint A' were applied so that approximately 90 g and approximately 40 g respectively of the paints (uncured) were applied per square meter.

(Testing)

The concrete form plywood was tested by the crack resistance test and the JAS test.

20 The results are shown in Table 26.

[Comparative Example II-3]

(Preparation of concrete form plywood)

A concrete form plywood was prepared in the same manner as in Comparative Example II-1, except that the filler coat

first-film paint A' was replaced with the filler coat paint B', which was applied so that approximately 90 g of the paint (uncured) was applied per square meter, and that the topcoat third-film paint A' was replaced with the topcoat paint B',
5 which was applied so that approximately 90 g of the paint (uncured) was applied per square meter.

(Testing)

The concrete form plywood was tested by the crack resistance test and the JAS test.

10 The results are shown in Table 26.

[Comparative Example II-4]

(Preparation of concrete form plywood)

A concrete form plywood was prepared in the same manner as in Example II-1, except that the filler coat first-film paint
15 A' was applied and dried, thereafter the topcoat third-film paint A' was applied and dried, and subsequently the middle coat second-film paint A' was applied.

(Testing)

The concrete form plywood was tested by the crack
20 resistance test and the JAS test.

The results are shown in Table 26.

[Comparative Example II-5]

(Preparation of concrete form plywood)

A concrete form plywood was prepared in the same manner

as in Comparative Example II-1, except that the filler coat first-film paint A' was replaced with the filler coat paint C', which was applied so that approximately 90 g of the paint (uncured) was applied per square meter, and that the topcoat third-film paint A' was applied so that approximately 90 g of the paint (uncured) was applied per square meter.

(Testing)

The concrete form plywood was tested by the crack resistance test and the JAS test.

10 The results are shown in Table 26.

[Comparative Example II-6]

(Preparation of concrete form plywood)

A concrete form plywood was prepared in the same manner as in Comparative Example II-1, except that the filler coat first-film paint A' was replaced with the filler coat paint D', which was applied so that approximately 90 g of the paint (uncured) was applied per square meter, and that the topcoat third-film paint A' was replaced with the topcoat paint B'.

(Testing)

20 The concrete form plywood was tested by the crack resistance test and the JAS test.

The results are shown in Table 26.

Table 25

	Overcoating
Example II-1	Filler coat paint A'/Middle coat paint A'/Topcoat paint A'
Example II-2	Filler coat paint B'/Middle coat paint B'/Topcoat paint B'
Example II-3	Filler coat paint A'/Middle coat paint B'/Topcoat paint A'
Example II-4	Filler coat paint C'/Middle coat paint A'/Topcoat paint A'
Example II-5	Filler coat paint D'/Middle coat paint B'/Topcoat paint B'
Comparative Example II-1	Filler coat paint A'/Topcoat paint A'
Comparative Example II-2	Filler coat paint A'/Topcoat paint A'
Comparative Example II-3	Filler coat paint B'/Topcoat paint B'
Comparative Example II-4	Filler coat paint A'/Topcoat paint A'/Middle coat paint A'
Comparative Example II-5	Filler coat paint C'/Topcoat paint A'
Comparative Example II-6	Filler coat paint D'/Topcoat paint B'

Table 26

Testing item	Testing method	Ex. II-1	Ex. II-2	Ex. II-3	Ex. II-4	Ex. II-5
Plane tensile strength (kg/cm ²)	JAS	Pass	Pass	Pass	Pass	Pass
Alkali resistance	JAS	Pass	Pass	Pass	Pass	Pass
Repeated high and low temperature test	JAS	Pass	Pass	Pass	Pass	Pass
Crack resistance	2 cycles	0	0	0	0	0
	4 cycles	0	0	0	0	0
	6 cycles	0	0	0	0	0
	8 cycles	0	0	0	0	0
	10 cycles	0	0	0	3	1
	12 cycles	1	2	1	5	2

Table 26 (continued)

Testing item	Testing method	Comp. Ex. II-1	Comp. Ex. II-2	Comp. Ex. II-3	Comp. Ex. II-4	Comp. Ex. II-5	Comp. Ex. II-6
Plane tensile strength (kg/cm ²)	JAS	Pass	Pass	Pass	Pass	Pass	Pass
Alkali resistance	JAS	Pass	Pass	Pass	Pass	Pass	Pass
Repeated high and low temperature test	JAS	Pass	Pass	Pass	Pass	Pass	Pass
Crack resistance	2 cycles	4	0	0	0	2	0
	4 cycles	21	2	4	0	5	0
	6 cycles	(Dscont [*])	12	17	0	10	7
	8 cycles		(Dscont [*])	(Dscont [*])	4	(Dscont [*])	9
	10 cycles				12		(Dscont [*])
	12 cycles				(Dscont [*])		

(Note: Dscont means discontinued.)

INDUSTRIAL APPLICABILITY

The concrete form plywood according to the present invention is excellent in water repellency, slip properties, mar resistance, crack resistance and the like, has a coated surface excellent in ply adhesion, and possesses far improved releasability from hardened concrete than achieved by the conventional plywoods. The concrete form plywood can be reused greatly increased times without recoating in building concrete structures such as condominiums, buildings and bridges. The invention enables reduction of costs of construction and industrial waste disposal.

WHAT IS CLAIMED IS:

1. A concrete form plywood comprising a substrate and paint films (A), (B) and (C) provided in the order of (substrate/paint film (A)/paint film (B)/paint film (C)), wherein:

the paint film (A) is a filler coat paint film formed

from a curing acrylic resin composition that comprises a curing hydroxyl-containing acrylic resin (i), calcium carbonate (ii-a), talc (ii-b), and an isocyanate curing agent (iii);

the paint film (B) is an middle coat paint film formed from a curing acrylic resin composition that comprises a curing hydroxyl-containing acrylic resin (i), at least one color pigment (iv) selected from yellow iron oxide, titanium oxide and carbon black, and an isocyanate curing agent (iii); and

the paint film (C) is a topcoat clear paint film formed from a curing acrylic resin composition (C1) that comprises a curing hydroxyl-containing acrylic resin (i), a polysiloxane compound (v) and an isocyanate curing agent (iii), or a moisture curing urethane resin composition (C2) that comprises a moisture curing urethane resin (vi), a polysiloxane compound (v) , a moisture absorbent (vii) and a curing catalyst (viii) .

2. The concrete form plywood according to claim 1, wherein the filler coat paint film (A) is formed from the curing acrylic resin composition that further comprises a vinyl resin (ix).

3. The concrete form plywood according to claim 1 or 2, wherein the filler coat paint film (A) is formed from the curing acrylic resin composition that further comprises yellow iron oxide (iv-a).

4. The concrete form plywood according to any one of claims 1 to 3, wherein the filler coat paint film (A) is formed from the curing acrylic resin composition that further comprises a thixotropic agent (x).

5. The concrete form plywood according to any one of claims 1 to 4, wherein the filler coat paint film (A) is formed from the curing acrylic resin composition that further comprises an anti-settling agent (xi).

6. The concrete form plywood according to any one of claims 1 to 5, wherein the middle coat paint film (B) is formed from the curing acrylic resin composition that further comprises an anti-settling agent (xi) .

7. The concrete form plywood according to any one of claims 1 to 6, wherein the middle coat paint film (B) is formed from the curing acrylic resin composition that further comprises an anti-foaming agent (xii).

8. The concrete form plywood according to any one of claims 1 to 7, wherein the topcoat clear paint film (C) is formed from the curing acrylic resin composition (C1) or the moisture curing urethane resin composition (C2) that further comprises an anti-foaming agent (xii).

9. The concrete form plywood according to any one of claims 1 to 8, wherein the topcoat clear paint film (C) is formed from the curing acrylic resin composition (C1) or the moisture curing urethane resin composition (C2) that further comprises a leveling agent (xiii).

10. The concrete form plywood according to any one of claims 1 to 9, wherein the composition (C1) for the topcoat clear paint film (C) contains the polysiloxane compound (v) in an amount of 1 to 100 parts by weight per 100 parts by weight of the curing hydroxyl-containing acrylic resin (i) (nonvolatile content).

11. A process for manufacturing the concrete form plywood of any one of claims 1 to 10, which process comprises forming the paint films (A), (B) and (C) on a surface of a substrate in the order of (substrate/paint film (A) /paint film (B)/paint film (C)).

12. A concrete form plywood comprising a substrate and paint films (A'), (B') and (C) provided in the order of (substrate/paint film (A')/paint film (B') /paint film (C)), wherein:

the paint film (A') is a filler coat paint film (A'1) formed from a solvent type curing acrylic resin composition (a'1) that comprises a curing hydroxyl-containing acrylic resin (i), an isocyanate curing agent (iii) and at least one extender pigment (ii) selected from calcium carbonate, talc, clay and barium sulfate, or a filler coat paint film (A'2) formed from an aqueous emulsion composition (a'2) that comprises at least one extender pigment (ii) selected from calcium carbonate, talc, clay and barium sulfate;

the paint film (B') is an middle coat paint film formed from a moisture curing urethane resin composition that comprises a moisture curing urethane resin (vi) , a curing catalyst (viii) and a moisture absorbent (vii); and

the paint film (C) is a topcoat paint film formed from a curing acrylic resin composition that comprises a curing hydroxyl-containing acrylic resin (i) , an isocyanate curing agent (iii) and at least one color pigment (iv) selected from titanium oxide, yellow iron oxide, cyanine blue and carbon black.

13. The concrete form plywood according to claim 12, wherein the filler coat paint film (A') is formed from the solvent type curing acrylic resin composition (a'1) or the aqueous emulsion composition (a'2) that further comprises at least one color pigment (iv) selected from titanium oxide, yellow iron oxide, cyanine blue and carbon black.

14. The concrete form plywood according to claim 12 or 13, wherein the filler coat paint film (A'1) is formed from the solvent type curing acrylic resin composition (a'1) that further comprises a vinyl resin (ix).

15. The concrete form plywood according to any one of claims 12 to 14, wherein the filler coat paint film (A'1) is formed from the solvent type curing acrylic resin composition (a' 1) that further comprises a thixotropic agent (x).

16. The concrete form plywood according to any one of claims 12 to 15, wherein the filler coat paint film (A'1) is formed from the solvent type curing acrylic resin composition (a'1) that further comprises an anti-settling agent (xi).

17. The concrete form plywood according to claim 12 or 13, wherein the filler coat paint film (A'2) is formed from the aqueous emulsion composition (a'2) that further comprises at least one resin selected from an acrylic resin, a vinyl

acetate resin, an epoxy resin and a urethane resin.

18. The concrete form plywood according to claim 12, 13 or 17, wherein the filler coat paint film (A'2) is formed from the aqueous emulsion composition (a'2) that further comprises an isocyanate curing agent (iii).

19. The concrete form plywood according to any one of claims 12 to 18, wherein the middle coat paint film (B') is formed from the moisture curing urethane resin composition that further comprises a leveling agent (xiii).

20. The concrete plywood according to any of claims 12-19, wherein the middle coat paint film (B') is formed from the moisture curing urethane resin composition that further comprises an anti-foaming agent (xii).

21. The concrete form plywood according to any one of claims 12 to 20, wherein the topcoat paint film (C) is formed from the curing acrylic resin composition that further comprises an anti-settling agent (xi).

22. The concrete form plywood according to any one of claims 12-21, wherein the topcoat paint film (c) is formed

from the curing acrylic resin composition that further comprises a leveling agent (xiii).

23. The concrete form plywood according to any one of claims 12 to 22, wherein the topcoat paint film (C') is formed from the curing acrylic resin composition that further comprises an anti-foaming agent (xii).

24. A process for manufacturing the concrete form plywood of any one of claims 12 to 23, which process comprises forming the paint films (A') , (B') and (C) on a surface of a substrate in the order of (substrate/paint film (A')/paint film (B')/paint film (C)).

ABSTRACT

The invention provides a concrete form plywood reusable many times, a manufacturing process thereof, and a topcoat paint composition favorably applied to a form board. The topcoat paint composition includes a curing hydroxyl-containing acrylic resin, a polysiloxane compound, and an isocyanate curing agent. A concrete form plywood according to one embodiment of the invention includes a substrate having a surface coated with a filler coat paint film (A) from a curing acrylic resin composition, an middle coat paint film (B) from another curing acrylic resin composition, and a topcoat paint film (C) from the above topcoat paint composition. A process for manufacturing is also disclosed.

15 A concrete form plywood according to another embodiment includes a substrate having a surface coated with a filler coat paint film (A') from a curing acrylic resin composition, an middle coat paint film (B') from a moisture curing urethane resin composition, and a topcoat paint film (C') from a curing acrylic resin topcoat paint composition. A process for manufacturing is also disclosed.