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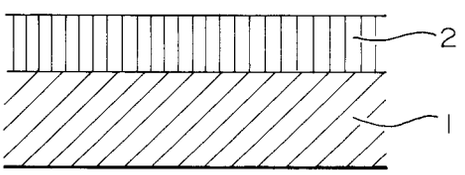
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(54) **WATER-PERMEABLE CONCRETE FORMWORK.**

(57) A water-permeable concrete formwork of thermo-plastic resin characterized in that a thermoplastic resin layer having water permeability is provided on at least one of the surfaces of a basic thermoplastic resin layer, whereby removal of moisture from placed concrete is promoted by absorption and/or permeation of moisture of said concrete by and/or through said water-permeable thermoplastic resin layer, thereby making it possible to significantly reduce the curing time of concrete.

FIG. 2



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TECHNICAL FIELD

This invention relates to a water permeable concrete shuttering made of a thermoplastic resin having a water permeable surface layer.

BACKGROUND TECHNIQUE

As a concrete shuttering, shutterings made of wood such as South Sea wood or the like have heretofore been used in large amounts. However, in view of the recent earth environmental problems, development of concrete shutterings made of other materials than wood material has been required, and concrete shutterings made of thermoplastic resins have been proposed as typical ones.

This concrete shuttering made of a thermoplastic resin is usually such that the panel surface of the shuttering is composed of a thermoplastic resin sheet or a fiber-reinforced thermoplastic resin sheet whose strength has been enhanced with a fiber such as glass fiber or the like, and said sheet is prepared by melting a thermoplastic resin or a mixture thereof with glass fiber or the like and forming it into a sheet, and the surface of the sheet has the structure that it is completely covered with a resin.

Such a concrete shuttering having a panel surface made of a thermoplastic resin has such many advantages that it does not cause any earth environmental problem resulting from the use of a large amount of wood, is lighter in weight than a concrete shuttering made of wood and is also excellent in releasability from concrete after the concrete has been poured using the shuttering.

On the other hand, however, the panel surface contacting concrete does not absorb water content nor is permeated by water content, so that there has been such a disadvantage that the so-called curing time from the pouring of concrete to the complete hardening of concrete becomes long.

DISCLOSURE OF THE INVENTION

Under such circumstances, the present inventors have made research for the purpose of developing a concrete shuttering made of a thermoplastic resin which satisfies the characteristics required as concrete shuttering and can shorten the concrete-curing time, and have consequently reached this invention.

That is, this invention provides a water-permeable concrete shuttering made of a thermoplastic resin composed of a thermoplastic resin layer and a thermoplastic resin layer having water-permeability provided on at least one of the surfaces thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a sectional structure of the water-permeable concrete shuttering of this invention in which the base thermoplastic resin layer is a flat plate having a water-permeable thermoplastic resin layer on both surfaces thereof.

Fig. 2 shows a sectional structure of the water-permeable concrete shuttering of this invention in which the base thermoplastic resin layer is a flat plate having a water-permeable thermoplastic resin layer on one surface thereof.

Fig. 3 shows a sectional structure of the water-permeable concrete shuttering of this invention in which the base thermoplastic resin layer is a ribbed flat plate having a water-permeable thermoplastic resin layer on the flat plate side thereof.

Fig. 4 shows a sectional structure of the water-permeable concrete shuttering of this invention in which the base thermoplastic resin layer is a ribbed flat plate having a water-permeable thermoplastic resin layer on the rib side thereof.

Fig. 5 shows a sectional structure of the water-permeable concrete shuttering of this invention in which the base thermoplastic resin layer has a plastic corrugated board structure and has water-permeable thermoplastic resin layers on both surfaces thereof.

Fig. 6 shows a sectional structure of the water-permeable concrete shuttering of this invention in which the base thermoplastic resin layer has a plastic corrugated board structure with pores and has water-permeable thermoplastic resin layers on both surfaces thereof.

Fig. 7 shows a sectional structure of the water-permeable concrete shuttering in which the base thermoplastic resin layer is a flat plate provided with water-introducing grooves and having a water-permeable thermoplastic resin layer on the water-introducing groove side flat plate thereof.

Incidentally, the numbers in the Figures have the following meanings:

1: Base thermoplastic resin layer

2: Water-permeable thermoplastic resin layer
3: Rib
4: Pore
5: Water-introducing groove

BEST MODES FOR CARRYING OUT THE INVENTION

This invention is explained in detail below.

The water-permeable concrete shuttering made of a thermoplastic resin of this invention is composed of a thermoplastic resin layer 1 which becomes the base of a concrete shuttering (base thermoplastic resin layer) and a thermoplastic resin layer having water-permeability 2 (water-permeable thermoplastic resin layer) provided on the surface thereof.

The structure of the base thermoplastic resin layer is not particularly limited, and may be of a flat plate (Figs. 1 and 2), a structure having so many ribs 3 that the cross section thereof is in the form of a comb (Figs. 3 and 4) or of a plastic corrugated board shape whose cross section is in the form of a ladder (Fig. 5). Also, as modifications thereof, it is possible to provide, for example, grooves 5 for introducing water on the surface of the base thermoplastic resin layer (Fig. 7) and provide pores 4 in the resin layer (Fig. 6) to lead the water content from the poured concrete to the back of the water-permeable thermoplastic resin layer or the spaces between the ribs through the grooves and pores via the water-permeable resin layer, thereby accelerating the removal of the water content and shortening the curing time of concrete.

The material constituting such a base thermoplastic resin layer is not particularly limited as far as it satisfies the strength as a concrete shuttering, and there are mentioned thermoplastic resins, for example, polyethylene, polypropylene, ABS resin, vinyl chloride resin, PMMA, nylon, polycarbonate resin and the like; however, polypropylene is preferred from aspects of heat resistance, strength, economy and the like.

Such a base thermoplastic resin layer is composed of such a thermoplastic resin, and in order to enhance the mechanical and physical strengths as concrete shuttering, it is very effective to use a fiber-reinforced thermoplastic resin in which about 10 to 70% by weight of various reinforcing fibers, for example, glass fiber, are blended with the resin.

It is needless to say that regardless of the presence or absence of such a reinforcing fiber, the thermoplastic resin may, of course, have blended therewith various compounding agents such as stabilizer, coloring agent, filler and the like which are usually blended with thermoplastic resins.

The water-permeable thermoplastic resin layer is provided on the surface of the base thermoplastic resin layer, and the surface of the base thermoplastic resin layer refers to the surface on the side on which the base thermoplastic resin, when used as a concrete shuttering, contacts the concrete, and generally, said surface is smooth in many cases. However, as shown in Fig. 4, said surface may be the rib side, and the water-permeable resin layer may be provided not only on one surface but also on both surfaces of the base thermoplastic resin layer.

In this invention, the water-permeable thermoplastic resin layer has a function of accelerating the removal of the water content in concrete by allowing it to contact with the surface of concrete poured to absorb the water content in the concrete or pass the water content through the layer, and any thermoplastic resin layer having water-permeability may be used. However, usually, an expanded fiber-filled thermoplastic resin sheet obtained by expansion-molding a fiber-filled thermoplastic resin sheet (stampable sheet) in the thickness direction is preferably used.

As the fibers with which the stampable sheet is to be filled, glass fibers are usually used; however, other fibers such as carbon fiber, alumina fiber and the like may be used, and there is no particular limit.

The thermoplastic resin is not particularly limited, and any thermoplastic resin can be used which is compatible with these fibers and has a strength and chemical resistance which are characteristics required for the shuttering materials. Such resins include specifically the same thermoplastic resins as those constituting the above base thermoplastic resin layer, for example, polypropylene, polyethylene, ABS resin, vinyl chloride resin, PMMA, nylon, polycarbonate resin and the like, and polypropylene is particularly preferably used.

The fiber content in the stampable sheet is usually 10 to 70% by weight, preferably 20 to 50% by weight.

As typical examples of such stampable sheets, there are known a sheet obtained by blending continuous glass fibers with a polypropylene resin which is called as a dry method stampable sheet and a sheet obtained by blending glass fibers having a length of several millimeters to about 30 millimeters with a polypropylene resin or a polyethylene terephthalate resin which is called as a wet method stampable sheet, and usually, these sheets are commercially available as melt-pressed sheets.

Such sheets can all be used as the starting materials for expanded fiber-filled thermoplastic resin sheet; however, there is preferably used a wet method stampable sheet by which a larger expansion ratio is obtained and a sheet having excellent water-permeability is easily obtained without extremely reducing the mechanical strength.

The expanded fiber-filled thermoplastic resin sheet suitable as the water-permeable thermoplastic resin layer is obtained by subjecting the stampable sheet mentioned above to expansion-molding in the thickness direction, and before the expansion-molding, the sheet has little water-permeability.

The expansion-molding method includes various methods such as a method by which the stampable sheet is simply heated and expanded and then cooled, a method by which the sheet is heated and expanded in such a space that the predetermined expansion ratio is obtained and then cooled and other like methods; however, a method is most preferable which comprises previously heating and expanding the stampable sheet, compressing the same to the predetermined expansion ratio and cooling the same in this state because according to this method, the desired expansion ratio can be exactly confirmed and the method is excellent in workability.

In this case, the expansion ratio is indicated by the ratio of the thickness of the stampable sheet after the expansion to the thickness of the sheet before the expansion. When the thickness of the sheet after the expansion is, for example, two times the thickness of the sheet before the expansion, the expansion ratio is 2 times.

The higher this expansion ratio the more desirable for enhancing the water-permeability; however, when the expansion ratio is too high, it becomes impossible to secure the surface strength as a concrete shuttering, and hence, the expansion ratio is usually 3 times or less, preferably 2.5 times or less.

The lower limit is not particularly limited since when the expansion ratio exceeds 1, water-permeability appears. However, in order to obtain good water-permeability, the expansion ratio is usually 1.05 times, preferably 1.1 times.

The method in which a water-permeable thermoplastic resin layer is provided on the surface of the base thermoplastic resin layer and the two are integrated includes various methods such as a method in which the previously produced water-permeable thermoplastic resin layer and the base thermoplastic resin layer are bonded with an adhesive, a method in which the two are bonded by an ultrasonic bonding method, a method in which the interface to be bonded between the two resin layers is melted to heat-fusion-bond the two layers, a method in which the stampable sheet in the heated and expanded state is placed on the base thermoplastic resin sheet and the two are pressed to form an expanded fiber-filled thermoplastic resin sheet and simultaneously heat-fusion-bond the two, a method in which the previously prepared expanded fiber-filled thermoplastic resin sheet is placed in the upper and lower molds, feeding a molten thermoplastic resin to between the sheet and the mold surface, the molds are thereafter closed, pressed and cooled to form the base thermoplastic resin layer and simultaneously heat-fusion-bond, to the surface thereof, the expanded fiber-filled thermoplastic resin sheet, thereby producing a water-permeable concrete shuttering made of a thermoplastic resin and other like methods.

Also, as a modification of this, when a thermoplastic resin filled with a fiber such as glass fiber or the like is used as the base, it is possible to heat and expand only the surface layer portion of the base on its side contacting the concrete and thereafter compress or cool without compressing the base to convert the surface layer portion of the base thermoplastic resin layer to a water-permeable thermoplastic resin layer, thereby providing the water-permeable thermoplastic resin layer without being accompanied by any bonding work.

In the water-permeable concrete shuttering made of a thermoplastic resin of this invention, when the resin for forming the water-permeable thermoplastic resin layer is the same as the resin for forming the base thermoplastic resin layer, the bonding between the two resin layers becomes more strong, and not only is the strength as a concrete shuttering enhanced but also the workability becomes good, and in addition, the reproduction and reuse of the used concrete shutterings become possible, and hence, said case is very effective in practice.

In the water-permeable concrete shuttering made of a thermoplastic resin of this invention, the total thickness of the shuttering may be such a thickness that the necessary strength as shuttering is obtained and there is no particular limit. It is usually about 10 to 70 mm. However, from the viewpoint of workability during use, particularly its relation to conventional wood concrete shutterings, the thickness is preferably 10 to 15 mm when the shuttering is composed only of such a flat plate as shown in Figs. 1, 2 and 7 and 62 to 65 mm when the base thermoplastic resin layer has a ribbed structure as shown in Figs. 3 to 6.

Also, the thickness of the water-permeable thermoplastic resin layer is usually 15 mm or less, preferably 10 mm or less because even when the thickness is larger no effect corresponding to the increased thickness can be expected and the total thickness of the shuttering becomes too large. The lower

limit is not particularly limited as far as the layer has water-permeability. It is, however, usually 0.5 mm, preferably 1 mm.

When concrete is poured using the water-permeable concrete shuttering made of a thermoplastic resin of this invention, such effects are obtained that the water content in the concrete is absorbed by or passes through the water-permeable thermoplastic resin layer, so that the removal of the water content in the concrete is accelerated, and as a result, the curing time for the poured concrete is greatly shortened.

WORKING EXAMPLES

This invention is further explained in detail below referring to Examples; however, this invention should not be construed to be limited thereto.

Incidentally, the test methods in the Examples are as follows.

Flexural test: Conducted according to JIS K7203 by the three points-supporting method.

Appearance evaluation: Evaluated by the number of pin holes (3 mm or more in diameter) per 0.25 m^2 of the concrete surface after release from the shuttering. The relation between the number of pin holes and evaluation is as follows:

The number of pin holes

less than 150: ⓞ (good)

150 - 300: ○ (same grade as wood shuttering)

301 - 500: × (inferior to wood shuttering)

Curing time: The time required until the compression strength of the concrete after the pouring of concrete became 60 kg/cm^2(water content disappearance time) was measured.

Compression strength: A cylindrical sample of 100 mm in diameter and 200 mm in height was taken from the concrete wall poured and pressure was applied to the upper surface thereof to measure the load at which the cylinder was broken.

Repulsion strength: The surface of concrete was measured by a Schmitt hammer (unit: RO).

Example 1

A stampable sheet (Keipla Sheet manufactured by Keipla Sheet Co., Ltd., basis weight: 1,750 g/m^2, thickness: 1.5 mm) which contained 30% by weight of glass fiber having an average fiber length of 12 mm and an average glass fiber diameter of 10 μ and in which the matrix resin was polypropylene was heated in heating oven until the surface of the sheet became 210 °C. A heat-expanded sheet which had been expanded about 3 times in the thickness direction was set in a flat plate mold, and pressed with cooling at a pressure of 10 kg/cm^2 so that the thickness became 3 mm to obtain an expansion-molded sheet of the stampable sheet having an expansion ratio of 2 times.

The expansion-molded sheet obtained above was bonded with an adhesive to both the surfaces of an article having a plastic corrugated board-like structure in which the top thickness was 0.5 mm, the rib thickness was 0.5 mm, the rib interval was 5 mm and the total thickness was 5 mm to obtain a concrete shuttering having a sectional structure as shown in Fig. 5 in which the width was 600 mm, the height was 900 mm and the thickness was 11 mm.

Physical properties of the concrete shuttering thus obtained are shown in Table 1.

This concrete shuttering was applied to the front and rear surfaces, and a wood veneer board having a width of 300 mm was applied to both side surfaces to fabricate a concrete shuttering having a size of 600 x 900 x 300 mm, and a concrete consisting of cement/water/sand/pebble = 3/2/8/10 (weight ratio) was poured thereinto to conduct a concrete-pouring experiment.

The results are shown in Table 2.

Example 2

A stampable sheet (Keipla Sheet manufactured by Keipla Sheet Co., Ltd., basis weight: 4,000 g/m^2, thickness: 3.4 mm) which contained 30% by weight of glass fiber having an average fiber length of 12 mm and an average glass fiber diameter of 10 μ and in which the matrix resin was polypropylene was heated, and the resulting heat-expanded sheet was pressed with cooling to obtain an expansion-molded sheet of the stampable sheet having a width of 600 mm, a length of 900 mm and a thickness of 4 mm. The expansion ratio of this sheet was 1.2 times.

Using an upright press-molding machine having a clamping force of 1,000 tons consisting of an upper mold and a lower mold which was so designed that ribs each having a thickness of 5 mm and a height of 10 mm could be formed at an interval of 54 mm, a ribbed concrete shuttering was produced by the following method: The above expansion-molded sheet was placed between the upper and lower molds, and a molten polypropylene resin (Sumitomo Noblen manufactured by Sumitomo Chemical Co., Ltd.) containing 20% by weight of glass fiber was fed to between the sheet and the lower mold through a molten resin path provided in the lower mold, after which the molds were closed and then pressed and cooled to obtain a ribbed concrete shuttering having a sectional structure as shown in Fig. 3 in which the plate-like portion had a thickness of 7 mm (the upper layer portion was an expansion-molded sheet having a thickness of 4 mm) and ribs each having a thickness of 5 mm and a height of 10 mm were integrally bonded thereto at an interval of 54 mm.

Physical properties of the concrete shuttering obtained are shown in Table 1.

Using this concrete shuttering, a concrete pouring experiment was conducted in the same manner as in Example 1.

The results are shown in Table 2.

Example 3

A stampable sheet (Keipla Sheet manufactured by Keipla Sheet Co., Ltd., basis weight: 2,000 g/m^2, thickness: 1.7 mm) which contained 30% by weight of glass fiber having an average fiber length of 12 mm and an average glass fiber diameter of 10 μ and in which the matrix resin was polypropylene was heated, and the resulting heat-expanded sheet was pressed with cooling to obtain an expansion-molded sheet of the stampable sheet having a width of 600 mm, a length of 900 mm and a thickness of 3 mm. The expansion ratio of this sheet was 1.8 times.

This expansion-molded sheet was bonded with an adhesive to one surface of a polymethyl methacrylate plate (Sumipex manufactured by Sumitomo Chemical Co., Ltd.) having a thickness of 8 mm to obtain a concrete shuttering having a sectional structure as shown in Fig. 2.

Physical properties of the concrete shuttering obtained are shown in Table 1.

Using this concrete shuttering, a concrete pouring experiment was conducted in the same manner as in Example 1.

The results are shown in Table 2.

Comparative Example 1

Two sheets of the same starting stampable sheets as in Example 1 were bonded with an adhesive to each of both surfaces of the same plastic corrugated board having a thickness of 5 mm as in used in Example 1 to obtain a concrete shuttering having a thickness of 11 mm and having the structure shown in Fig. 5.

Physical properties of the concrete shuttering obtained are shown in Table 1.

Using this concrete shuttering, a concrete pouring experiment was conducted in the same manner as in Example 1.

The results are shown in Table 2.

Table 1

	Flexural strength (kg/cm^2)	Flexural modulus (kg/cm^2)
Example 1	320	35,500
Example 2	450	55,000
Example 3	390	38,000
Comp. Ex. 1	365	40,500

Table 2

	Appearance		Curing time (hrs)	Compression strength (after 14 days from p-ouring) (kg/cm^2)	Repulsion strength (RO)
	Number of pin holes	Evaluation			
Ex. 1	125	ⓞ	18	207	21
Ex. 2	110	ⓞ	21	216	24
Ex. 3	118	ⓞ	16	195	23
Comp. Ex. 1	425	×	65	205	18

CAPABILITY OF UTILIZATION IN INDUSTRY

Such an advantage is obtained that by providing a water-permeable thermoplastic resin layer on a base thermoplastic resin layer, the curing time can be greatly shortened as compared with that of the conventional concrete shuttering without impairing the advantage of plastic concrete shuttering.

Claims

1. A water-permeable concrete shuttering made of a thermoplastic resin consisting of a base thermoplastic resin layer and a thermoplastic resin layer having water-permeability provided on at least one of the surfaces of the base thermoplastic resin layer.

2. A water-permeable concrete shuttering according to Claim 1, wherein the thermoplastic resin layer having water-permeability is an expansion-molded sheet of a fiber-filled thermoplastic resin sheet.

3. A water-permeable concrete shuttering according to Claim 2, wherein the expansion ratio is 1.05 to 3 times.

4. A water-permeable concrete shuttering according to Claim 2 or 3, wherein the fiber is glass fiber.

FIG. 1

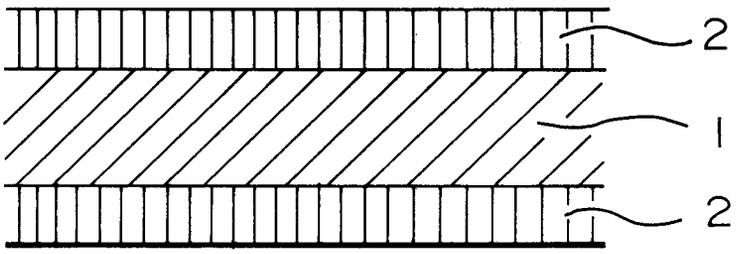


FIG. 2

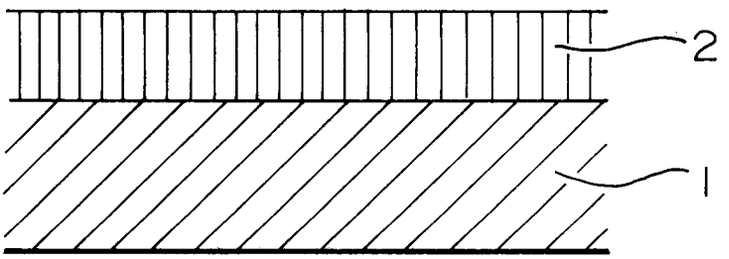


FIG. 3

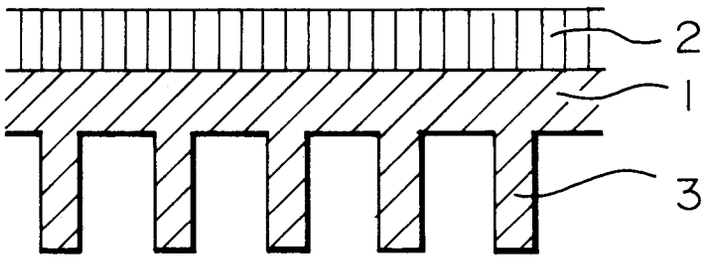


FIG. 4

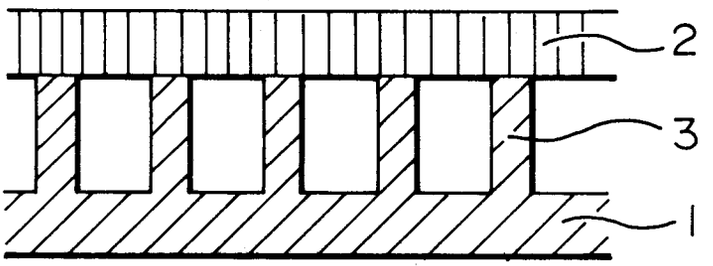


FIG. 5

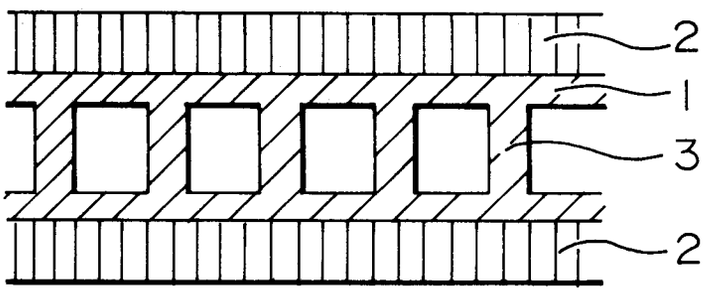


FIG. 6

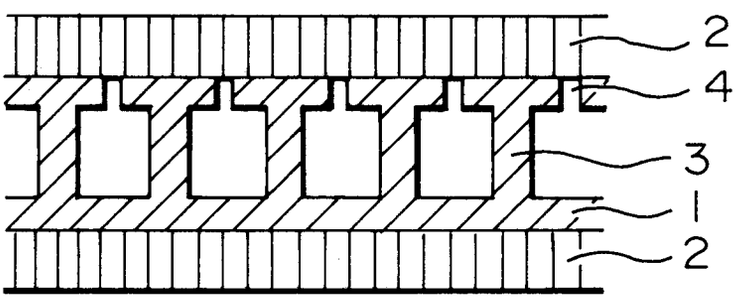
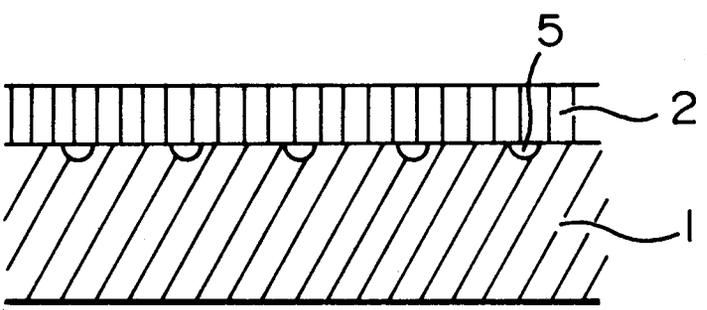


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP94/00316

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl^5 E04G9/10, E04G9/05

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl^5 E04G9/00-10

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP, A, 4-347261 (Unitika Ltd., Nakayama Seikosho K.K.), December 2, 1992 (02. 12. 92), Lines 34 to 46, right column, page 3, lines 1 to 36, left column, lines 38 to 48, right column, page 4, (Family: none)	1-4
Y	JP, A, 2-8459 (Idemitsu NSG K.K., Shiroyama Kosan K.K.), January 11, 1990 (11. 01. 90), Line 11, upper right column to line 5, lower left column, page 2, (Family: none)	1-4
Y	JP, A, 61-188104 (Showa Denko K.K. Kase Denko K.K.), August 21, 1986 (21. 08. 86), Line 9, lower right column, page 1 to line 1, upper left column, page 2, (Family: none)	1-4

☑ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
April 15, 1994 (15. 04. 94)	May 10, 1994 (10. 05. 94)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)