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(54) **Fibre reinforced inorganic body.**

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Description

This invention relates to a process for manufacturing a fibre-reinforced inorganic body.

Hitherto, there is known a process for manufacturing a fibre-reinforced inorganic body, as disclosed in JP-A-55-85480, in which a fibre body composed of threads is impregnated with an inorganic composite mainly composed of cement, that is the same in kind of material as an inorganic composite to be moulded by extrusion. The fibre body is then embedded in the inorganic composite to be moulded by extrusion, thereafter the inorganic composite including the fibre body is extruded, and thereafter the resulting extruded body is subjected to a hardening treatment.

The foregoing conventional process is, however inconvenient in that the bending strength of the fibre-reinforced inorganic body obtained thereby is not substantially improved as compared with that of a moulded inorganic body not reinforced with the fibre body.

In GB-A-592890, there is disclosed a process for manufacturing a fibre-reinforced inorganic body wherein a fibre body comprising a plurality of threads is impregnated with a bonding agent and is embedded in an inorganic composite, the inorganic composite including the fibre body is moulded, and the inorganic composite and the bonding agent of the resulting moulded body are hardened.

This invention has for its purpose to provide a process which produces a fibre-reinforced inorganic body which is improved in its bending strength.

According to the present invention, there is provided a process for manufacturing a fibre-reinforced inorganic body, wherein at least one fibre body comprising a plurality of threads is impregnated with a bonding agent and is embedded in an inorganic composite, the inorganic composite including the fibre body is moulded, and the inorganic composite and the bonding agent of the resulting moulded body are hardened, characterised in that the inorganic composite including the fibre body is moulded by extrusion, and in that the fibre body is a braided body formed by interweaving a plurality of threads.

The present invention also provides fibre-reinforced inorganic body comprising a moulded inorganic composite, at least one fibre body comprising a plurality of threads embedded in the moulded inorganic composite, and a hardened bonding agent included in the fibre body and forming a bond between the moulded inorganic composite and the fibre body, characterised in that the fibre body is a braided body formed by interweaving a plurality of the threads.

Preferably, the inorganic composite is composed of cement, sand, and water and, if desired, may contain any other kind of inorganic material such as plaster. As for the cement there is preferably used Portland cement, aluminium cement, Portland blast-furnace cement, silica cement, fly-ash cement, etc. In the inorganic composite there may be optionally present any desired additive such as milling aids, retarders, accelerators, water reducing agents, coagulants, thickness, builders such as an air entraining agent, etc., and aggregate of a suitable size. Also in the inorganic composite, there may be mixed uniformly short fibres for improving the toughness of the fibre-reinforced inorganic body to be produced.

As for the short fibre, there may be used one or more of inorganic fibres such as carbon fibre, glass fibre, ceramic fibre, etc.; organic fibres such as aromatic polyamide fibre such as of straight coordinated aromatic polyamide, aromatic polyether amide, aromatic polysulphide amide, aromatic polysulphone amide, aromatic polymethylene amide, aromatic polyketone amide, aromatic polyamine amide and copolymers thereof, polyester fibre, polyolefin fibre, polyvinyl alcohol fibre, etc.; and metallic fibres such as cold drawn steel wire, steel wire for prestress, or the like. Such short fibres are in general several microns to several tens of microns in diameter and 5 to 15 mm in length. These are preferably mixed in the inorganic composite in an amount of up to 2% by volume relative to the inorganic composite.

The thread can be not only any type of yarn (preferably selected from roving, multifilaments, strand and sliver) but also a monofilament. Thus, more generally, the "thread" is an elongated flexible member.

The material of the thread is in general the same as that of the short fibre, but may be different therefrom.

The plurality of threads (of the same kind or of two or more different kinds) are formed into a braided body by interweaving the plurality of threads. The braided fibre body may be a cord which is round or square in section, a flat body or a body of other desired shape, for instance, so that the combined integrality of the individual threads thereof can be heightened. In this case, if the thread has protrusions in the longitudinal direction thereof, the frictional resistance between the threads of the braid becomes large, and consequently it becomes easy to transmit to the fibre body a stress applied to the threads, and at the same time the close contact between the fibre body and the inorganic composite is improved.

In general, there may be used thread which is several microns to several tens of microns, and the amount of these threads in the inorganic composite is preferably up to 5% by volume relative to the inorganic composite.

In the inorganic composite, there may be embedded at least one braided fibre body, and in the case of the use of a plurality of braided fibre bodies it is preferable that they are so embedded therein as to be distributed uniformly.

As for the bonding agent, there may be used a coldsetting or thermosetting resin such as of epoxy type, polyester type, vinylester type, phenolic type, polyimide type, etc.; a coldsetting

or thermosetting inorganic bonding agent such as of alkali metal silicate type, colloidal silica type, or phosphate type; or a mixture of a coldsetting or thermosetting organic resin and an inorganic bonding agent.

Embodiments of this invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a diagram illustrating one embodiment of a process for manufacturing a fibre-reinforced inorganic body according to this invention;

Figure 2 is an enlarged plan view of one embodiment of a braided fibre body used in the embodiment of Figure 1; and

Figure 3 is a perspective view of part of a fibre-reinforced inorganic body obtained by the embodiment of Figure 1.

Figure 1 is a diagram explaining one embodiment of a process for manufacturing a fibre-reinforced inorganic body according to this invention.

Referring to the drawing, there is shown a vacuum extruder 1 having an upper screw cylinder 3 and a lower screw cylinder 4 in communication with each other via a vacuum chamber 2. There is provided at one end portion of the upper screw cylinder 3 a hopper 6 for supplying an inorganic composite 5. One end of the lower screw cylinder 4 is in communication with a die 10 having a die opening 9 of a predetermined shape, via an adapter 8 for introducing a fibre body 7.

Short fibres 21 are mixed in the inorganic composite 5 and there is used as the fibre body a braided fibre body 7 (as shown in Figure 2) formed by interweaving a plurality of strand-like threads 22 of total aromatic polyamide fibre and a plurality of braided fibre bodies, each supplied from a corresponding supply source 23.

In more detail, in the first place, the inorganic composite 5 composed of Portland cement, sand and water, mixed with the short fibres 21 of total aromatic polyamide, is supplied to the hopper 6. The supplied inorganic composite 5 is moved forwards, while being kneaded, in the upper screw cylinder 3 and is conveyed to the vacuum chamber 2. After being degassed in that chamber 2, it is moved forwards in the lower screw cylinder 4 and is then introduced into the adapter 8.

In the meanwhile, a plurality of the braided fibre bodies 7, each formed by interweaving the plurality of strands 22 of total aromatic polyamide, are passed through a dipping tank 12 containing a bonding agent 11 of thermosetting epoxy resin so as to be impregnated therewith, and are then introduced into the adapter 8 so as to be embedded at their predetermined disposed positions in the foregoing inorganic composite 5. Thereafter, the inorganic composite 5, which has the short fibres 21 dispersed therein and the disposed fibre bodies 7 embedded therein, is extruded through the opening 9 of the die 10, so as to be moulded into a desired shape, for instance, a hollow square shape as shown in Figure 3. The resulting extruded body 15 is moved forwards by a conveyor 14 and is cut by a cutter 16 to pieces of a predetermined length in sequence. The bodies 15 thus cut are placed on a pallet 17 ahead of the conveyer 14 and are introduced into an autoclave (not shown). The bodies 15 are heated in the autoclave so that the inorganic composite 5 including the fibre bodies 7 and the bonding agent 11 existing inside and outside each of the fibre bodies 7 are both cured, and thus there is obtained a fibre-reinforced inorganic body.

In the foregoing embodiment, the curing is carried out in the autoclave, but any other curing means such as steaming curing may be used. The bonding agent is not limited to a thermosetting one, since a coldsetting bonding agent may also be used.

The invention will now be illustrated by the following Example.

Example

A sectionally-round braided fibre body of about 3 mm in diameter, formed by interweaving 36 strands each made of total aromatic polyamide fibre, namely "Kevlar 49" (the word "Kevlar" is a Registered Trade Mark), of 1420 denier, was impregnated with a bonding agent composed of 100 parts by weight of bisphenol A/epichlorohydrin type epoxy resin ("DER 332, Dow Chemical") and 14 parts by weight of triethylenetetramine in an impregnating ratio of 40 parts thereof to 100 parts of the foregoing fibre body. Eight braided fibre bodies, each thus impregnated with the bonding agent, were embedded in an inorganic composite composed of a mixture of 911 mg/m^3 of Portland cement, 310 kg/m^3 of water, 962 kg/m^3 of sand and 13.67 kg/m^3 of thickener, and mixed with 1.5% by volume of short fibres, namely "Kevlar 49" (the word "Kevlar" is a Registered Trade Mark) each 1420 denier in diameter and 15 mm in length, such that two lines of the four fibre bodies thereof were disposed above and below in the inorganic composite. The inorganic composite including such disposed fibre bodies was extruded into a rod having a rectangular sectional form of 50 mm by 100 mm. Thereafter the extruded body was cured for 14 days at 20°C to produce a fibre-reinforced inorganic body. The bending strength of the body thus obtained was 215 kg/cm^2.

Thus, according to this invention, after a braided fibre body comprising a plurality of interwoven threads is impregnated with a bonding agent, the same is embedded in an inorganic composite, and the inorganic composite including the braided fibre body is extruded and the inorganic composite and the bonding agent of the resulting extruded mould are hardened, so that the inorganic composite and the fibre body are strongly bonded together through the bonding agent, and consequently there can be obtained easily a fibre body reinforced inorganic body which is improved in its bending strength.

Claims

1. A process for manufacturing a fibre-reinforced inorganic body, wherein at least one fibre body (7) comprising a plurality of threads (13) is impregnated with a bonding agent (11) and is embedded in an inorganic composite (5), the inorganic composite (5) including the fibre body (7) is moulded, and the inorganic composite (5) and the bonding agent (11) of the resulting moulded body are hardened, characterised in that the inorganic composite (5) including the fibre body (7) is moulded by extrusion, and in that the fibre body (7) is a braided body formed by interweaving a plurality of threads (22).

2. A process as claimed in claim 1, wherein the threads (22) have a large tensile strength.

3. A process as claimed in claim 1 or 2, wherein the inorganic composite (5) contains short fibres (21).

4. A fibre-reinforced inorganic body comprising a moulded inorganic composite (5), at least one fibre body (7) comprising a plurality of threads (22) embedded in the moulded inorganic composite (5), and a hardened bonding agent (11) included in the fibre body (7) and forming a bond between the moulded inorganic composite (5) and the fibre body (7), characterised in that the fibre body (7) is a braided body formed by interweaving a plurality of the threads (22).

5. A body as claimed in claim 4, wherein the moulded inorganic composite (5) has short fibres (21) dispersed therein.

Patentansprüche

1. Verfahren zur Herstellung eines faserverstärkten anorganischen Körpers, wobei wenigstens ein aus einer Vielzahl von Fäden (13) bestehender Faserkörper (7) mit einem Bindemittel imprägniert und in einen anorganischen Werkstoff (5) eingebettet wird, der anorganische Werkstoff (5) einschließlich des Faserkörpers (7) verformt wird sowie der anorganische Werkstoff (5) und das Bindemittel (11) im erhaltenen verformten Körper gehärtet werden,

dadurch gekennzeichnet,

daß der anorganische Werkstoff (5) einschließlich des Faserkörpers (7) durch Extrusion verformt wird und daß der Faserkörper (7) ein durch Verweben einer Vielzahl von Fäden (22) gebildeter geflochtener Körper ist.

2. Verfahren gemäß Anspruch 1, worin die Fäden (22) eine große Zugfestigkeit aufweisen.

3. Verfahren gemäß Anspruch 1 oder 2, worin der anorganische Werkstoff (5) kurze Fasern (21) enthält.

4. Faserverstärkter anorganischer Körper aus einem verformten anorganischen Werkstoff (5), wenigstens einem Faserkörper (7), der aus einer Vielzahl von Fäden (22) gebildet und in dem verformten anorganischen Werkstoff (5) eingebettet ist, sowie einem im Faserkörper (7) enthaltenen gehärteten Bindemittel (11) zur Bildung einer Bindung zwischen verformtem anorganischen Werkstoff (5) und Faserkörper (7),

dadurch gekennzeichnet,

daß der Faserkörper (7) ein durch Verweben einer Vielzahl von Fäden (22) gebildeter geflochtener Körper ist.

5. Körper gemäß Anspruch 4, wobei der verformte anorganische Werkstoff (5) kurze Fasern (21) darin fein verteilt enthält.

Revendications

1. Procédé de fabrication d'un objet inorganique renforcé par des fibres, dans lequel au moins un ensemble de fibres (7) comprenant une pluralité de fils (13) est imprégné d'agent adhésif (11) et noyé dans un composé inorganique (5), le composé inorganique (5) incluant l'ensemble de fibres (7) est moulé, et le composé inorganique (5) et l'agent adhésif (11) de l'objet moulé en résultant sont durcis, caractérisé en ce que le composé inorganique (5) incluant l'ensemble de fibres (7) est moulé par extrusion, et en ce que l'ensemble de fibres (7) est un ensemble tressé formé par entrelacement d'une pluralité de fils (22).

2. Procédé tel que revendiqué dans la revendication 1, dans lequel les fils (22) ont une grande résistance à la traction.

3. Procédé tel que revendiqué dans les revendications 1 ou 2, dans lequel le composé inorganique (5) contient des fibres courtes (21).

4. Objet inorganique renforcé par des fibres, comprenant un composé inorganique moulé (5), au moins un ensemble de fibres (7) comprenant une pluralité de fils (22) noyés dans le composé inorganique moulé (5), et un agent adhésif durci (11) inclus dans l'ensemble de fibres (7) et formant un lien entre le composé inorganique moulé (5) et l'ensemble de fibres (7), caractérisé en ce que l'ensemble de fibres (7) est un ensemble tressé formé par entrelacement d'une pluralité des fils (22).

5. Objet tel que revendiqué dans la revendication 4, dans lequel le composé inorganique moulé (5) comprend des fibres courtes (21) dispersées.

FIG. 3

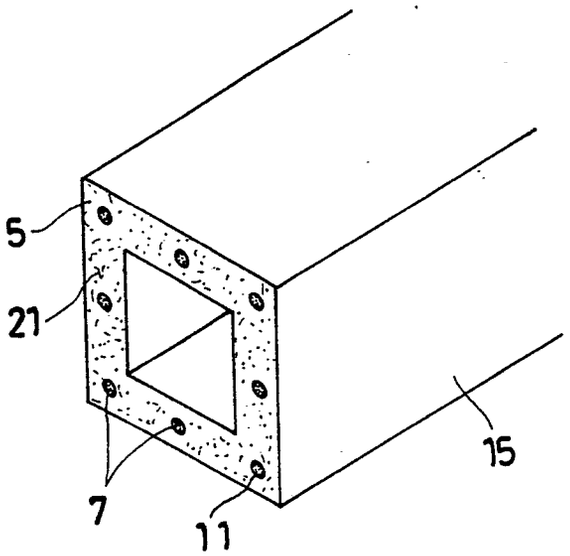

FIG. 2

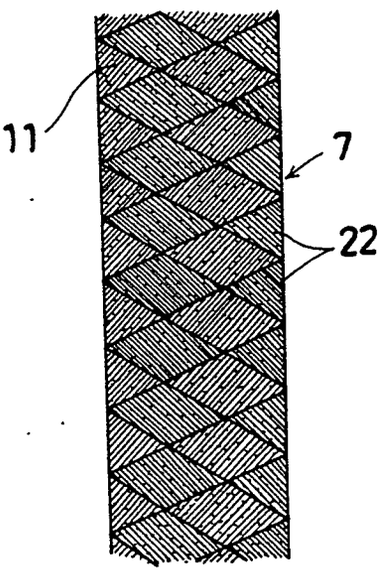

FIG. 1