

BAMBOO FIBER-REINFORCED INORGANIC MOLDED PRODUCT

The present invention relates to a woody inorganic molded product, and particularly to a bamboo fiber-reinforced inorganic molded product formed by using as a woody raw material bamboo fibers.

Woody inorganic molded products are generally produced by kneading a woody raw material such as wood flakes, excelsior, wood fibers or the like, a hydraulic inorganic binder selected from various kinds of cement, hydraulic gypsum and the like and water, molding the kneaded product and then curing the thus-obtained molded product.

Various coniferous trees and broad-leaved trees are widely used as woody raw materials, and it has been proposed that bamboo materials also be used as a woody raw material. Since bamboo grows at a higher speed than coniferous trees and broad-leaved trees, bamboo is a promising resource. In addition, bamboo materials are also promising since they are tough and highly elastic. However, the prior art has simply used bamboo fibers in place of wood fibers or wood flakes, without any concrete form and made insufficient use of the toughness and high elasticity of bamboo materials.

The inventors previously proposed techniques in which bamboo material is used as a woody raw material for woody inorganic molded products (Japanese Patent Laid-Open Nos. 2-26854 and 2-48446). However, the techniques were proposed

for the purpose of improving moldability and preventing spring back when an inorganic plate is produced using bamboo fiber as a raw material. The techniques therefore do not make use of the characteristics of bamboo materials, such as the toughness and high elasticity thereof.

The inventors investigated making sufficient use of the characteristics, i.e., the toughness and high elasticity, of a bamboo material to be used as a woody raw material for a woody inorganic molded product and which is a promising resource. As a result, the inventors found a means for solving the above-described problems. This finding led to the achievement of the present invention.

The present invention provides a bamboo fiber-reinforced inorganic molded product comprising woody raw material, a hydraulic inorganic binder and water, characterized in that said woody raw material comprises fibers, which are a split bamboo material, the fibers having an average length of 20 cm or more and an average diameter of 3 mm or less.

The present invention further provides a bamboo fiber-reinforced inorganic molded product comprising a woody raw material, a hydraulic inorganic binder and water, characterized in the said woody raw material comprises fibers which comprise a split bamboo material and which contain 60% or more by dry weight of long

fiber component having a length of 20 cm or more and an average diameter of 3 mm or less and 5% or more by dry weight of short fiber component having a length of 1 cm or less and an average diameter of 2 mm or less.

The present invention also extends to processes for making such a bamboo fiber-reinforced inorganic molded product.

In a first embodiment of the present invention, fibers, which are obtained by splitting a bamboo material and which have an average length of 20 cm or more and an average diameter of 3 mm or less, are used as a main woody raw material for a woody inorganic molded product. This permits the formation of a bamboo fiber-reinforced inorganic molded product having strength and toughness, which are higher than those of the woody inorganic molded products obtained by using conventional wood fibers. Namely, in order to impart all of these characteristics to a woody inorganic molded product, the woody raw material used preferably has a fibrous form and it must comprise as a main component long fibers which have high strength and high toughness. However, it is difficult to obtain long fibers having high strength from conventional wood fibers. For example, although the excelsior cement and the like consists of woody long fibers, since the excelsior is obtained by planing a woody material and thus not very

strong itself, high strength cannot be easily obtained in the product.

When high pressure molding is performed for increasing the strength, portions where excelsior components are superposed over each other are easily broken, and there is thus a problem in that strength is increased very little by increasing the specific gravity. However, since long fibers having high strength can be easily obtained by splitting a bamboo material, the disadvantages of conventional wood fibers can be improved. Further, in order to obtain a bamboo fiber-reinforced inorganic molded product having high strength and excellent impact resistance, it is necessary that the bamboo fibers used have an average length of 20 cm or more and an average diameter of 3 mm or less. If the average length is less than 20 cm, both the strength and the impact resistance are deteriorated. If the average fiber diameter exceeds 3 mm, the moldability and the surface precision and the quality of the molded product obtained are undesirably deteriorated.

In a second embodiment of the present invention, fibers, which are obtained by splitting a bamboo material and contain fibers having a fiber length of 20 cm or more and an average fiber diameter of 3 mm or less and fibers having a fiber length of 1 cm or less and an average fiber diameter of 2 mm or less, are used as a main woody raw material for a woody inorganic molded product.

Although the first embodiment of the present invention is capable of producing a bamboo fiber-reinforced inorganic molded product having excellent performance at low material cost, it cannot be said that moldability is always good. In the second invention, therefore, the moldability is further improved while maintaining the low material cost and high performance, which are achieved by the first invention. Namely, when fibers containing 60% or more by dry weight of long fiber components having a fiber length of 20 cm or more (an average fiber diameter of 3 mm or less) and 5% or more by dry weight of short fiber components having a fiber length of 1 cm or less (an average fiber diameter of 2 mm or less) are used as a woody raw material, a molded product having high strength and excellent impact resistance can be obtained owing to the reinforcing effect of the long fiber component and the filling effect of the short fiber components. A molded product having a high level of uniformity can be also easily obtained owing to the filling effect of the short fiber components.

In the second embodiment of the present invention, the fibers may contain fiber components having a length between 1 cm and 20 cm, without producing any problem. so far as the condition that the fibers contain 60% or more of the long fiber components and 5% or more of short fiber components is satisfied. However, it is necessary that the average fiber diameter of these fibers having a length between 1 cm and 20 cm be 3 mm or less. If the proportion of the long fiber components in the woody raw material is

less than 60%, strength and impact resistance are deteriorated. If the average fiber diameter of the long fiber component exceeds 3 mm, not only the moldability but also the surface precision and the performance of the molded product obtained are undesirably deteriorated. If the proportion of the short fiber components in the woody raw material is less than 5% or if the average fiber diameter of the short fiber components exceeds 2 mm, the filling effect cannot be sufficiently obtained, and will not lead to an improvement in moldability.

Any kind of bamboo material can be used in the present invention.

Fibers can be formed by splitting a bamboo material by any one of several known splitting methods such as an impact splitting method, a roll splitting method, a burst splitting method, a cutting splitting method and the like.

Although various hydraulic inorganic binders can be used in the present invention, various kinds of cement and hydraulic gypsum are preferably used. The compounding ratio between the bamboo fibers and the hydraulic inorganic binder is preferably within the range of 1/20 to 1/1 in terms of weight.

The inventors have previously proposed a technique of treating a bamboo material (Japanese Patent Laid-Open No. 2-26354) in which the water content of a bamboo material is increased to 100% or more by letting the bamboo material absorb water and then decreased to 50% or less by

dehydration. A combination of the present invention with this technique permits the effective prevention of spring back of the molded product formed.

Although the method of molding the bamboo fiber-reinforced inorganic molded product in accordance with the present invention is not particularly limited, a press molding method is most preferable.

In the present invention, the substances given below can be added to the necessary components comprising the above bamboo fibers, hydraulic inorganic binder and water within a range which has no influence on the physical properties of the bamboo fiber-reinforced inorganic molded product and the moldability of the kneaded product.

(1) Other woody raw material from such as broad-leaved trees or coniferous trees.

Although the ratio between bamboo fibers and other woody raw material is not limited, it is preferable that the ratio of the bamboo fibers be as high as possible from the point of the invention that the bamboo material is used as a woody raw material.

(2) Plate crystal such as mica and the like

(3) Needle crystal such as wollastonite and the like

(4) Inorganic fine powder such as silica fume, diatomaceous earth, fly ash and the like

(5) Inorganic extender such as calcium carbonate, perlite and the like

(6) Clay mineral such as bentonite, kaolin, vermiculite and the like

(7) Fibrous mineral such as palygorskite, sepiolite and the like

(8) Porous mineral powder such as zeolite and the like

(9) Synthetic resin emulsion

(10) Additives such as a coloring agent, a water-proofing agent, a curing accelerator, a curing retarder and the like

Components (2) to (8) can be used in a total within a range to 35% by weight of the total of the raw materials excluding water. The amount of component (9) is preferably less than 10% by weight of the total of the raw materials excluding water. Further, a coloring agent and a water-proofing agent of components (10) can be added in an amount less than 5% by weight of the total of the raw material excluding water. A curing accelerator and a curing retarder can be added in an amount less than 5% by weight of the hydraulic inorganic binder used, as occasion demands.

(Examples)

Example 1

Bamboo fibers having an average length of 25 cm and an average diameter of 2.5 mm were obtained by impact-splitting a bamboo material. The water content of the bamboo fibers was increased to 300% by letting the fibers absorb tap water and then decreased by 100% to 200% by dehydration at a pressure of 5 kg/cm² to form a fiber raw material.

30% of the thus-formed fiber raw material in an absolute dry state and 70% of normal Portland cement were kneaded to form a kneaded product. The thus-formed kneaded product was then formed into a uniform mat having a width of 50 cm and a length of 250 cm on an iron plate. The mat formed was then subjected to press compression at a pressure of 20 kg/cm^2 using a spacer having a thickness of 15 mm, and the iron plate was fixed by a turn buckle. The mat was then removed from a pressing machine, and the iron plate was separated from the mat, followed by curing for 2 weeks. After the completion of curing, the mat was dried at 105°C to obtain a specimen. The physical properties of the specimen were measured.

As a result, the specimen showed a bulk specific gravity of 1.1, flexural strength of 145 kg/cm^2 and a Charpy impact value of $8.2 \text{ kg}\cdot\text{cm/cm}^2$.

Example 2

Bamboo fibers containing 75% by dry weight of long fiber components having a length of 25 cm or more and an average diameter of 2.5 mm and 25% by dry weight of fiber components having a length of 1 cm or less and an average diameter of 1.5 mm were formed by impact-splitting a bamboo material. The bamboo fibers were then subjected to water absorption and dehydration in the same way as that employed in Example 1. A specimen was obtained by further compounding raw materials, molding, curing and drying in the

same way as that employed in Example 1. The physical properties of the specimen were measured.

As a result, the specimen showed a bulk specific gravity of 1.1, flexural strength of 150 kg/cm^2 and a Charpy impact value of $8.0 \text{ kg}\cdot\text{cm/cm}^2$.

Example 3

30% by dry weight of bamboo fibers, which were the same as those used in Example 1 and which were subjected to water absorption and dehydration, 50% of normal Portland cement and 20% of wollastonite were kneaded. The thus-formed kneaded product was then molded, cured and then dried by the same method as that employed in Example 1 too form a specimen. The physical properties of the specimen formed were measured.

As a result, the specimen showed a bulk specific gravity of 1.1, flexural strength of 142 kg/cm^2 and a Charpy impact value of $8.3 \text{ kg}\cdot\text{cm/cm}^2$.

Comparative Example

Bamboo fibers having an average length of 15 mm and an average diameter of 2.5 mm were obtained by impact-splitting a bamboo material.

The thus-formed bamboo fibers were subjected to water absorption and dehydration in the same way as that employed in Example 1. A specimen was obtained by further compounding raw materials, molding, curing and drying in the same way as that employed in Example 1. The physical properties of the thus-formed specimen were measured.

As a result, the specimen showed a bulk specific gravity of 1.1, flexural strength of 110 kg/cm² and a Charpy impact value of 6.5 kg·cm/cm².

The bamboo fiber-reinforced inorganic molded product in accordance with the present invention is formed by making use of the toughness and high elasticity of a bamboo material, which is a promising woody resource, and thus exhibits high strength and excellent impact resistance.



CLAIMS:

1. A bamboo fiber-reinforced inorganic molded product comprising a woody raw material, a hydraulic inorganic binder and water, characterized in that said woody raw material comprises a split bamboo material, the fibers having an average length of 20 cm or more and an average diameter of 3 mm or less.
2. A bamboo fiber-reinforced inorganic molded product according to claim 1, wherein said hydraulic inorganic binder is selected from the group comprising cement and hydraulic gypsum.
3. A bamboo fiber-reinforced inorganic molded product according to claim 1 or 2, wherein the compounding ratio of the bamboo fibers relative to the hydraulic inorganic binder is within the range of 1/20 to 1/1 in terms of weight.
4. A bamboo fiber-reinforced inorganic molded product comprising a woody raw material, a hydraulic inorganic binder and water, characterised in that the said woody raw material comprises fibers which comprise a split bamboo material and which contain 60% or more by dry weight of long fiber components having a length of 20 cm or more and an average diameter of 3 mm or less and 5% or more by dry



weight of short fiber components having a length of 1 cm or less and an average diameter of 2 mm or less, and optionally, 35% or less by dry weight of intermediate length fiber larger than 1 cm and shorter than 20 cm provided that the average fiber diameter of the said intermediate length fiber is 3 mm or less.

5. A bamboo fiber-reinforced inorganic molded product according to claim 4, wherein said hydraulic inorganic binder is selected from the group comprising cement and hydraulic gypsum.

6. A bamboo fiber-reinforced inorganic molded product according to claim 4 or 5, wherein compounding ratio of between the bamboo fibers and the hydraulic inorganic binder is within the range of 1/20 to 1/1 in terms of weight.

7. A process of making a bamboo fiber-reinforced inorganic molded product, said process comprising kneading a woody raw material, a hydraulic inorganic binder and water, molding the kneaded product and then curing, characterized by obtaining fibers by splitting a bamboo material said fiber having an average length of 20 cm or more and an average diameter of 3 mm or less and using the fibers as said woody raw material.

8. A process according to claim 7, wherein said hydraulic inorganic binder is selected from the group comprising cement and hydraulic gypsum.



9. A process according to claim 7 or 8, wherein the compounding ratio of the bamboo fibers and the hydraulic inorganic binder is within the range of 1/20 to 1/1 in terms of weight.

10. A process according to claim 9, wherein said bamboo fiber is treated in a manner that the water content of a bamboo is increased to 100 weight % or more by letting the bamboo material absorb water and then decreased by 50 weight % or less by dehydration.

11. A process of making a bamboo fiber-reinforced inorganic molded product, said process comprising kneading a woody raw material, a hydraulic inorganic binder and water, molding the kneaded product and then curing, characterized by obtaining fibers, which are by splitting a bamboo material said fibers containing 60% or more by dry weight of long fiber components having a length of 20 cm or more and an average diameter of 3 mm or less and 5% or more by dry weight of short fiber components having a length of 1 cm or less and an average diameter of 2 mm or less, and using the fibers said woody raw material.

12. A process according to claim 11, wherein said hydraulic inorganic binder is selected from the group comprising cement and hydraulic gypsum.



13. A process according to claim 11 or 12, wherein the compounding ratio of the bamboo fibers relative to the hydraulic inorganic binder is within the range of 1/20 and 1/1 in terms of weight.

14. A process according to claim 13, wherein said bamboo fiber is treated in a manner that the water content of a bamboo is increased to 100 weight % or more by letting the bamboo material absorb water and then decreased by 50 weight % or less by dehydration.

15. A bamboo fiber-reinforced inorganic molded product substantially as hereinbefore described.

16. A process of making bamboo fiber-reinforced inorganic molded product, said process being substantially as hereinbefore described.
