

METHOD OF FORMING BAMBOO FIBERS AND A
RESIN MOLDING REINFORCED WITH BAMBOO FIBER

Field of the Invention

The present invention relates to a method of forming fibers of bamboo rapidly and efficiently, and also to a durable resin molding reinforced with such bamboo fiber.

Description of the Related Art

Since bamboo is easy to be split along the grain (in the direction of growth), bamboo can easily be fibrillated by mechanical processes. There have been proposed various methods of fibrillating bamboo, such as a striking method and an explosive method.

For example, Japanese Patent Laid Open No. 63-7903 discloses a method of fibrillating bamboo, in which specified lengths of bamboo are put in a high pressure atmosphere for a certain period of time before they are abruptly taken out into a normal pressure atmosphere where they explode into fibers. However, this method, utilizing sudden air expansion to fibrillate bamboo, requires a batch process, and thus efficiency is not favorable. Also, the diameters and lengths of the produced bamboo fibers

substantially vary depending on the explosive conditions. Therefore, such a method is not very suitable for producing fibers for industrial raw material.

Resin moldings formed of a mixture of resin and a reinforcement of fibrillated or flaked wood are used in a wide range of products, such as particle board and fiber board. Plant materials other than wood are also used for reinforcement, and bamboo is one of such plant materials. Particularly these days, when conservation of forest resources is a crucial issue, bamboo is drawing much attention because of its rapid growth. Bamboo has favorable characteristics as a material, e.g. high strength and flexibility. However, those characteristics have not been fully utilized because, in the conventional art, bamboo is simply broken into fibers or flakes and then used in the same way as wood reinforcement.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a method of easily and economically forming bamboo fibers of a desired size.

It is another object of the present invention to provide a method of easily and economically forming bamboo fibers whose average diameter is less than 0.4mm.

It is still another object of the present invention to provide a resin molding reinforced with bamboo fiber which utilizes the favorable characteristics of bamboo and thus

provides good durability, i. e. an important characteristic of a resin molding.

According to the present invention, a method of forming bamboo fibers comprises:

a first step in which lengths of bamboo are crushed in the direction of growth or along the grain;

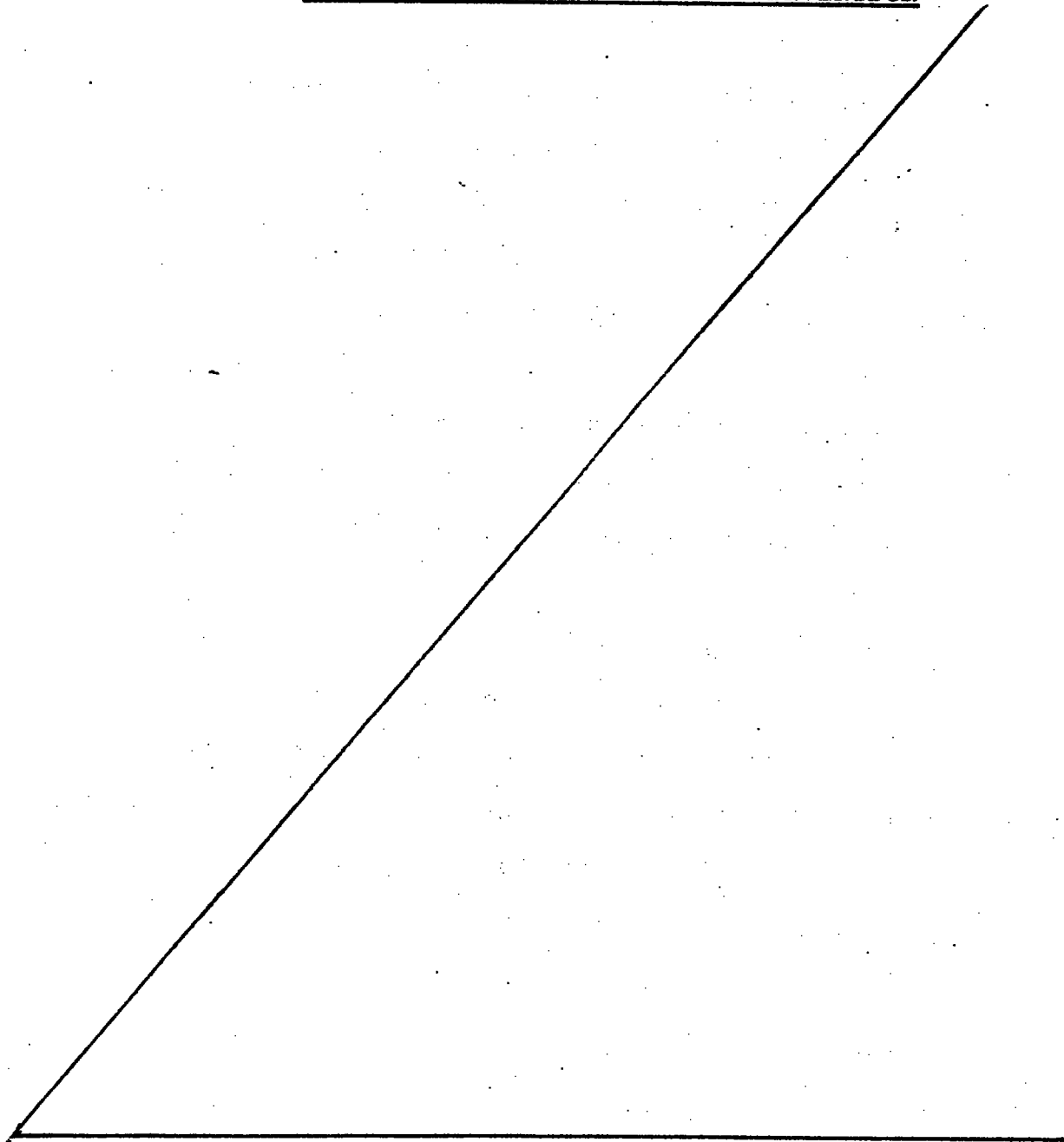
a second step in which the bamboo processed in the first step is fed by a conveying roller into a fibrillating device which includes a drum having many teeth and which is rotated at a high speed, the bamboo being fibrillated by said device; and

a third step in which the bamboo processed in the second step is refined by a turbo-mill to make fine fibers having an average diameter of 0.4 mm or less.

Optionally, after one end portion of the bamboo is fibrillated in the second step, the conveying roller is rotated in reverse to move the bamboo back, then the bamboo is turned the other way round and the second step is repeated to fibrillate the bamboo from the non-yet fibrillated end portion.

Still another aspect of the present invention provides a hardened resin-molding molded with compression and heat from a mixture of 5 to 60 weight % of modified melamine resin and 40 to 95 weight % of the bamboo fibers obtained as above, such bamboo fibers having an average diameter of 0.01 to 0.4mm and an average length of 10 to 300mm.

DETAILED DESCRIPTION OF THE INVENTION



The present invention will be described in detail hereinafter.

After being stripped of leaves, length of bamboo are cut into a certain size if necessary and then are fed into a crushing apparatus, splitting along the direction of growth. The crushing apparatus used in the first step of the method according to the present invention does not have to be a particular type, as long as it is a common type, such as rolling or a stamping mill. Since bamboo has a characteristic of being easily split along the grain, crushing apparatus as above can split the bamboo easily along the grain.

In a method according to the present invention, it is not necessary to severely control the water content of bamboo to be processed. Bamboo stems must be cut longer than the desired length of the fibers.

The length of bamboo split in the first step are conveyed by a conveying rollers to an opening machine including a rotary drum having many teeth, by which the bamboo is fibrillated. Such an opening machine used in the second step may be a pickering machine. The length and diameter of bamboo fibers can be varied by adjusting the size or number of teeth, or the rotational speed of the pickering machine. Thus, bamboo fibers of desired length and diameter can be easily formed.

However, in the above described method, occasionally rear end portions of split bamboo are not sufficiently

fibrillated but become bundled up. In such a case, the following method may be performed: after a portion of split bamboo is fibrillated, rotation of the convey rollers are reversed to move the bamboo back out, and then the bamboo is turned end for end before it is again fed into the pickering machine. In this method, the entire bamboo can be fibrillated.

The bamboo fibers obtained as described above have an average diameter of roughly 0.4 to 1.5mm. However, finer fibers may be required in some cases.

Although the diameter of fibers can be adjusted by changing the size or number of teeth, or the rotational speed of the pickering machine, the range of such adjustment is not wide enough for forming fine fibers whose average diameter is less than 0.4mm.

Also, though repeated fibrillation by the pickering machine will produce finer fibers, such a process will also produce more dust; in other words, the yield will decrease. Thus, such a process is not very efficient.

In order to provide fine fibers, a turbo-mill may be employed as a third step to refine coarse bamboo fibers obtained in the second step. Before being refined by the turbo-mill, coarse bamboo fibers may be cut into a specific length. Naturally, such a specific length must be greater than the desired length of refined fibers.

The turbo-mill mentioned above can be the one used for powdering or grinding a variety of materials, i.e. both

organic and inorganic materials, or even for opening asbestos. However, if a turbo-mill is used to finely fibrillate bamboo immediately after the first step, such a process will require a long time and result in a poor yield. Thus, such a process is not efficient for forming fine fibers.

The three serial steps described above will easily and efficiently provide fine bamboo fibers having an average diameter less than 0.4mm.

The bamboo fibers thus obtained have a wide range of uses, such as for building materials, as filler or reinforcement, and as feed for livestock. The bamboo fibers may be added as a reinforcement to cement mortar, thus providing a structural part of cement board of an architectural structure. Also, the fibers may be mixed with a hardening resin, forming a value added reinforced hardened resin-molding.

Experiments on the bamboo fibers according to the present invention show that bamboo fibers having an average diameter of 0.01 to 2mm and an average length of 10 to 30mm are preferable as reinforcing fibers for a resin molding. A resin to be used for the hardened resin molding reinforced with the bamboo fibers is preferably a modified melamine resin. The modified melamine resin is melamine-formaldehyde condensate modified with phenol, such as SM-510, SM-607, SM-800 and SM-850 manufactured by Showa High Polymer Co.

The mixing ratio of the bamboo fibers and the modified melamine resin is 40 to 95% by weight bamboo fibers and 5 to 60% by weight resin, and preferably 80 to 90% bamboo fibers and 10 to 20% resin. Hardening of the mixture may be carried out at an elevated temperature such as 120 - 180°C. A hardening catalyst such as a high grade amine-hydrochloride may also be used if required.

A hardened resin molding reinforced with bamboo fiber may contain a filler as long as such a filler does not obstruct the molding process or degrade the property of the product. Such a filler may be any one of the following: wood fibers; pigments; powder of inorganic substances such as silica powder, calcium carbonate powder and calcium silicates powder, e.g. wollastonite, xonotlite and tobermorite. The total weight of added filler is preferably 30 parts or less to 100 parts of the total weight of the bamboo fibers and resin. The added wood fiber is preferably 20 parts or less to 100 parts of the bamboo fibers.

A mixture of the bamboo fibers, a resin and other materials as mentioned above is molded under compression and heat into a hardened resin molding reinforced with bamboo fiber according to the present invention.

EXAMPLES

Methods of the present invention are illustrated with reference to the following examples, but the invention is not intended to be limited only to these following examples.

EXAMPLE 1

(the first step in which lengths of bamboo are roughly crushed along the grain by a rolling mill):

the first step by rolling

material of roller: carbon steel (S45C)

diameter of roller: 150mm,

length of roller (effective length) : 500mm

Lengths of bamboo were stripped of leaves and cut into about 1m lengths. Such lengths of bamboo were processed by the rolling mill described above under a pressure of 25 kg/cm², at a conveying speed of 15m/min and a processing rate of 180kg/h.

The bamboo was crushed along the grain into long pieces. Each piece had many cracks along the grain with intervals of about 1.0 to 3mm.

(the second step in which bamboo is fibrillated by a pickering machine):

The bamboo roughly crushed in the above mentioned first step was fed by way of conveying rollers into a pickering machine having a 500mm diameter drum and an effective length of 900mm with many teeth and which was rotated at 1000 rpm, to thus fibrillate the bamboo.

By the process described above, bamboo fibers having an average length of 25cm and an average diameter of 0.5mm were obtained. The dry-weight ratio of the yielded fibers to the

original bamboo was 75 to 100. However, about 5% of the bamboo fibers were still in bundles at end portions.

Therefore, after one end portion of bamboo was fibrillated by the pickering machine, the conveying roller was reversed to draw the bamboo out of the pickering machine, the bamboo was then turned the other way around and fed into the drum of the pickering machine with the not-yet fibrillated end portion being ahead. In this manner, the bamboo was entirely fibrillated, and no bundle portions remained.

(the third step in which bamboo is finely fibrillated by a turbo-mill)

The coarse bamboo fibers obtained through the first and second steps were cut into lengths of 40mm or less. Using a T-400 TURBOMILL manufactured by Turbo Kogyo Co., the cut coarse fibers were refined by rotating the turbomill at about 4000 r.p.m. into bamboo fibers having an average length of 30mm and an average diameter of 0.07mm. The dry weight ratio of the yielded fine fibers to the original bamboo was 70 to 100.

EXAMPLE 2

(forming of hardened resin-molding reinforced with bamboo fibers)

The bamboo fibers obtained through the first to third steps were mixed with a resin and a filler as described in Table 1. The mixtures were molded under a pressure of 5kg/

cm² at 150°C for 3 hours, and after being cooled, the resin moldings reinforced with bamboo fiber were removed from the molds. The properties of the moldings (specimens) were measured and the results are shown in Table 2.

TABLE 1 (mixture)

	<u>spec. 1</u>	<u>spec. 2</u>	<u>comp. 1</u>	<u>comp. 2</u>
Bamboo Fibers	50	42	30	50
Resin	50	50	70	50
Filler (wollastonite)		8		

NOTE: "spec." and "comp." refer to specimen and comparison specimen respectively.

All values are in weight percent.

The resin used for spec. 1, spec. 2 and comp. 1 was a modified melamine resin SM-510 grade made by Showa High Polymer Co., and the resin used for comp. 2 is a styrene-acryl resin AM-2300 made Showa High Polymer Co.

TABLE 2 (properties)

	<u>spec. 1</u>	<u>spec. 2</u>	<u>comp. 1</u>	<u>comp. 2</u>
Specific Gravity(*1)	0.66	0.67	0.76	0.68
Flexural Strength				
(kg/cm ²) (*1)	86	83	53	67
Durability (*2)	0	0	Δ	X

NOTE: (*1) were measured according to JIS A 5908.

(*2): Specimens were soaked in boiling water for 2 hours and then cooled in water at 20°C for 1 hour. This

procedure was repeated three times before the exteriors thereof were observed. In the table, 0 indicates little change observed in the exterior, Δ indicates some change observed, and x indicates great change observed.



CLAIMS:

1. A method of forming bamboo fibers, comprising:

a first step in which lengths of bamboo are crushed in the direction of growth or along the grain;

a second step in which the bamboo processed in the first step is fed by a conveying roller into a fibrillating device which includes a drum having many teeth and which is rotated at a high speed, the bamboo being fibrillated by said device; and

a third step in which the bamboo processed in the second step is refined by a turbo-mill to make fine fibers having an average diameter of 0.4 mm or less.

2. A hardened resin molding reinforced with bamboo fiber obtained by a method according to claim 1, which is molded under compression and heat from a mixture of 5 to 60 weight % of a modified melamine resin and 40 to 95 weight % of the bamboo fibers having an average diameter of 0.01 to 0.4mm and an average length of 10 to 30mm.

3. A hardened resin molding reinforced with bamboo fiber according to claim 2, wherein said mixture contains by weight 80 to 90% bamboo fibers and 10 to 20% resin.

4. A hardened resin molding reinforced with bamboo fiber according to claim 2 or 3, wherein 30 weight parts or



less of a filler other than bamboo fibers is added to 100 weight parts of total weight of the bamboo fibers and resin.

5. A method of forming bamboo fibers, the method being substantially as hereinbefore described.

6. A hardened resin moulding substantially as hereinbefore described.