UNIVERSITI PUTRA MALAYSIA

THE MOISTURE CONTENT EFFECT ON FULL CELL PROCESS OF BAMBOO PRESERVATION

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ABSTRACT

The retention, penetration and also the distribution of CCA preservative in three different conditions (fresh, partially dry and dry) of bamboo of Gigantochloa scortechinii were studied.

The study also were done in different portions (bottom and top) and different part of culms (inner and outer) of bamboo. Treating process applied was full cell process with one, two and three hours pressure period. The results indicated that Preservative retention were affected by moisture content and portions of the bamboo, while preservative penetration only affected by moisture content. The lower the moisture content the higher the retention and the deeper the penetration of preservative. Preservative solution enter the culms, besides from the axial directions also from inner to outer part of the culms. It makes the preservative retention in the inner part of the culms were higher than in the outer part. Preservative penetration and retention in fresh bamboo, even though lower than dry and partially dry bamboo but can reach Malaysian Standard (MS.360 : 1986) for interior purposes. Moreover the dried bamboo, where the moisture content is below 15 % and partially dried bamboo, where the moisture content are between 40 to 50 % can reach Malaysian Standard for both interior and exterior purposes.

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I. INTRODUCTION

Bamboo is a material for many purposes. It is used widely and plays a big role in rural day to day life, especially in Southeast Asian region. In modern life, bamboo is also important as a structural and ornamental material. This is because of its strength, elasticity, straightness, lightness properties and its ease in processing to different products.

The potential of bamboo to supply a number of industries is more than sufficient. Preecha (1987) reported that the commercial bamboo stands are about one fourth of the world forest and the annual bamboo output is estimated at about seven million tons. Furthermore, Masathoshi (1986) mention that 80 percent of the total bamboo resources of the world is distributed in Southeast Asia.

In Malaysia, the wild growing bamboo covers about five percent of the country's forest. This is about 729,000 hectares with an estimated standing stocks of about 7.0 million tons (Mohmod, 1987 ; Sabri, 1987). The main species belong to the genus <u>Gigantocloa</u> representing also the most useful group of species. They are generally found in the state of Kedah and there are about 27 million stocks which are almost equivalent to 179,000 metric tons of air dried bamboo. Other species reach a figure of around 185,000 metric tons (Mohd Nor and Wong,1985).

With the abundance of bamboo culm products and its usefulness in the rural areas, it is close to the people. Practically, it is evident in all their daily needs from bridge building to cooking equipment in the kitchen. It is also widely used for building construction, scaffolding, fencing, piping, handicrafts and numerous valuable products.

As of the present, it is more widely utilized in decorative housing, furniture and handicraft applied, hence it is very popular. But like other similar materials, bamboo is easily prone to attack by organisms like insects and fungi, making its service life short. Therefore, to prolong its usefulness, preservative treatment must be applied.

It is worth noting that there are several existing methods in preserving bamboo. Traditionally, the methods commonly used are leaching, smoking and whitewash coatings, but all of them were not effective enough and consume a lot of time. Due to these disadvantages, it is no longer economical to apply them in the industry.

On the other hand, chemicals are also being used, which are more effective. They are either applied in fresh or dried bamboos. Preserving fresh bamboo is preferable to dried bamboo because the drying process needs to be done only once. This means a reduction in the cost of production.

Full cell process, one of the methods of preservation, is known for its good penetration and retention of preservatives in the timber. It is a fast process, yet controllable. Until now this process is known to be good only for timber dried below fiber saturation point (FSP). There has been no research on the application of this method on fresh bamboo. However, there is still a chance to consider this method for preserving the fresh bamboo, because the bamboo culm is not too thick which full cell process suits well.

Objectives :

To determine the effects of moisture content of fresh, partially dried and dried bamboos on parameters such as preservative penetration and retention,

To identify the appropriate period of pressure application with the full cell process of preserving fresh, partially dried and dried bamboos,

To evaluate the preservative penetration and retention between the bottom and top portions of fresh, partially dried, and dried bamboos, and

To analyze the distribution of preservative in the outer and inner part of the bamboo culm.

II. LITERATURE REVIEW

A. BAMBOO

A.1. Potential and Uses

Bamboo, a member of the grass family (Graminae), is considered to be a fast growing and high yielding renewable resource. It occurs as elements in the natural vegetation of the tropical, subtropical and mild temperate regions of the world. It can grow from sea level to altitudes of more than 13,000 feet (McClure, 1953).

Bamboo is known as a minor forest product in several countries. Even though it is not so popular as rattan, bamboo is abundant. About 75 genera and 1250 species occur in the different countries of the world. Mostly they come from the east with 80 percent in the Southeast Asia region (Sharma, 1980 ; Preecha, 1987).

More than ten million tons of bamboos are produced annually in the world of which the commercial ones amount to seven millions tons. They are in the form of many products like cooking utensils, tool handles, piping, scaffolding, ladders, construction components, furniture, musical instruments, agricultural implements and so many other products (Sharma, 1980).

Mostly the utilization of bamboo is for construction or housing. In Indonesia for example about 70 percent of bamboo is used for that purpose (Felix Yap, 1978 ; Widjaya, 1980).

According to Siopongco and Munandar (1987), bamboo is demanded for construction purpose in rural areas because of relatively low cost and being easy to get. It is also light weight, easy to handle, to transport and it is erect. It can be worked on to produce a number of basic housing components like posts, beams, flooring, walls, roof trusses, doors and windows. Its pliable property makes it resistant to extremely strong winds and earthquakes.

A.2. Characteristic

Bamboos that can reach 36 meters in length and 30 cm diameter, generally have culms which are cylindrical and smooth. They are usually hollow inside and have transverse dividing walls at the nodes, which completely separates the cavity of one internode from the next. The tissue of the bamboo culm is built up of parenchyma cells and vascular bundles consisting of vessels, thick-walled fibers and sieve tubes. The movement of water in the culm takes place through the vessels. The orientation of all the cells is in the vertical direction.

The culm is covered outside and inside by hard waxy cuticles which offer considerable resistance to the absorption of water or other liquids, particularly when dry. This characteristic is of importance when impregnation by chemicals is required (Anonymous, 1972).

According to Liese (1980a), parenchyma tissue percentage is highest in the bottom internodes and gradually decreases towards the top. Similarly, the percentage is reduced towards the periphery and shows marked increase towards inside.

The vessels occupy only about 15 percent of the culm. In the internodes all vessels are oriented parallel to the culm axis without any branching or contact. Inside the nodes, an intensive branching takes place making the horizontal transportation of liquids possible. In the nodes the vessels are connected with each other by pits.

A.3. Moisture Content of Bamboo

Moisture content of bamboo varies with so many factors. The fresh bamboo has moisture content 80-160%. The moisture content decreases with the height of culm from the ground. It also varies with the age of the culm and the season.

Liese (1980a) mentioned that the moisture content at the bottom of the culm was about twice that at the top portion in the dry season and 1.3 times in rainy season. The moisture content in the internodes showing two to seven percent higher than the nodes.

Older culms (6 to 9 years) contain less moisture than younger (3 to 4 years) ones. The youngest culms (6 months to 1 year) show the highest moisture content. The differences due to age, however, are not as great as the differences due to seasons (Anonymous, 1972).

The moisture content of the bamboo has a great influences on its treatibility with preservative (Anonymous, 1972)

A.4. Durability

Bamboos are highly susceptible to destruction by insects, fungi and fire. There is variation in durability from species to species. Within the culm, the middle and top portions are less resistant than the bottom portions (Anonymous, 1972).

When the bamboo is still wet,the organisms which attack are fungi, while when it is dry the insects like Bostrychidae and Lyctidae beetles will attack very fast.

The durability of untreated bamboo is generally poor, it depends on the climatic conditions and environment. Untreated bamboo may have an average service life of fewer than 1 - 3 years when it is exposed to atmosphere and soil, and it may be expected to last 4 - 7 years or more under covered conditions. In the sea water it is destroyed by marine organism in less than a year (Liese, 1980).

It was also reported that bamboo posts embedded in the ground are destroyed in 6 months to 2 years and if it stored above the ground can reach 22 to 41 months useful life (Anonymous, 1972).

B. BAMBOO TREATMENT

Bamboo is easily prone to biodeterioration and the people have known that for a long time. Due to that, people have tried in so many ways to prevent bamboo from biodeteriation attack. Plenty of research also has been done to get the best treatment.

People use many methods to treat bamboo, from traditional ones where chemicals are not involved to the chemical methods.

B.1. Traditional Method

The traditional method is the treatment where the chemicals are not used. George (1984) mentions that the traditional methods such as leaching in water, smoking, and whitewashing cost little and can be carried out without special equipment or technical skill. However, the effectiveness of these methods is not so great.

Leaching is done by submerging a freshly cut bamboo in water. It can remove the starch and sugars from the bamboo, where those are attracting insects such as powder post beetles.

The disadvantage of this method is in taking a long time to remove starch and sugars completely from the bamboo. George (1984) mentions 15 weeks is needed to leach the partially dry culms, and Gracia and Tessoro (1979) mention that leaching for 8 weeks did not produce any resistance to the attack of powder post beetle. Another problem is that leaching in stagnant water may lead to staining of the bamboo (Anonymous, 1972 ; George 1984). Liese (1980b) also mention that soaking bamboo in the water does not increase the durability against termites and fungi.

B.2. Chemical Methods

The methods using chemicals as preservative for preservation are generally more effective than non-chemicals methods. In the application, there are two types, first is non-pressure treatment and the second is pressure treatment.

2.1. Non-Pressure Treatment

There are several methods that people usually do, like brushing, spraying, dipping, soaking, Boucherie process and open tank treatment.

Liese (1980) mentions that brushing and spraying are rarely done except for prophylactic purposes because these methods have only a temporary effect, reflecting the very low penetration of preservative.

Immersion in the preservative solution for a longer time gives a better result. Abdurrochim (1982) reported that bamboo can be soaked with good result in water soluble preservative for two or three days. Barly and Permadi (1987) also mentioned that one day soaking in BFCA preservative give high retention and penetration of preservative in bamboo. The moisture content of the bamboo in those experiment were air dry.

The Boucherie method is known as an effective treatment for freshly cut material. The preservative is forced by gravity from a container placed higher than the culm, so the preservative will move from one end of culm to another. This method could give good results. The only drawback of this process is that it needs several days of treatment and is difficult for mass productions.

The other problem for such a method of preservation is usually the preservatives used for that purpose are leachable, therefore, easily washed or leach out after treatment (Dickinson, 1989), which makes them not suitable for outdoor purposes.

2.2. Pressure Treatment

Pressure treatment of bamboo is carried out in some countries, both with water-borne preservative and with creosote. Full cell process is applied to preserve bamboo using water-borne preservative and creosote, while empty cell process is being applied using creossote. the full cell process is noted by the presence of initial vacuum, pressure period and final vacuum, while in the empty cell process, the initial vacuum is absent.

According to Richardson (1978) the full cell process is normally employed when it is required to achieve the highest possible loading of preservative within material.

Generally it is employed to achieve very high retentions of creosote or rapid fixing water-borne salts, particularly CCA types.

Tack (1979) mentions that the main advantage of a pressure process is that deeper and more uniform penetration is obtained together with higher absorption of preservative, giving more effective protection. It can also be controlled to suit the specific requirements of the timber in use.

III. MATERIALS AND METHODS

The bamboo as materials used in this experiment is the most abundant species in Malaysia. It belongs to Gigantochloa scortechinii and it is commonly used by most bamboo industries in Malaysia for several purposes.

The specimens were collected from Ulu Langat, Selangor State, Malaysia.

A. SAMPLE COLLECTION AND PREPARATION

Thirty (30) culms of Gigantochloa scortechinii with diameter breast height values of 6 - 9 cm and around 13 - 15 m height were identified. The selected bamboos were about 5 - 6 years old.

The bamboo stands were cut about 30 cm from the ground and were then cut into 8 meters length from the original cut. These were further cut into two equal 4 m sections, representing the bottom and top of the stem. The total number of specimens was 60 culms which consisted of 30 culms of bottom portion and 30 culms of top portion.

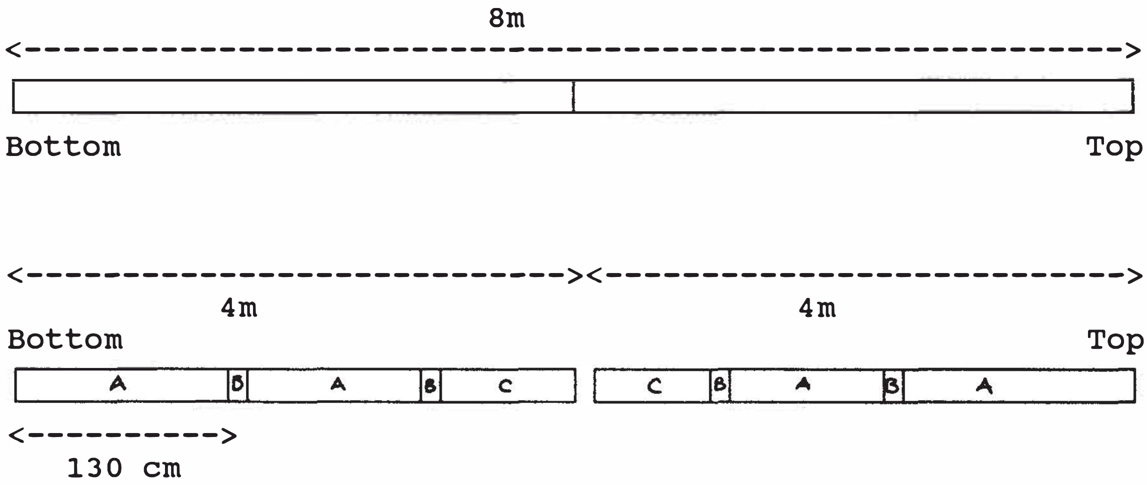
Those 60 specimens were subjected to three different conditions. Ten culms from each portion (total 20 specimens) were placed in a cool room to keep them in fresh condition of about 93 - 112 % moisture content.

The second ten culms each from top and bottom portions also were placed in a kiln (dehumidifier system) for two weeks until the moisture content reached below 15 %. The remaining twenty culms from top and bottom portion were placed in an ordinary room and let dry naturally (air drying) until the moisture content was 40 - 50 %.

In the process of obtaining the desired moisture content, the moisture content of bamboo was checked by using moisture sample culms. The initial weight and moisture content of the sample culms were taken first and then regular daily weighings were done until the target of moisture content for each conditions was reached.

After the desired moisture content was obtained, all the culms from each condition were further cut into two pieces for preservation samples and also one piece for moisture content sample (as shown in Figure 1). The length of the preservation sample was 130 cm, while moisture content sample was 2 cm. The diagram of the cutting pattern for each culm is shown in Figure 1.

The actual moisture content of the preservation sample was determined from a moisture content sub-sample.



Remarks : A = Preservation sample
B = Moisture content sample
C = Not used

Figure 1. Cutting pattern of the sample

B. MONITORING THE MOISTURE CONTENT

In the kiln drying and air drying process, the moisture content of the culms was monitored by using sample culms. The sample culms were cut into 150 cm long pieces. For every condition, five (5) samples were prepared. All of the sample culms were end coated by Shellkote to prevent evaporation from longitudinal directions. The initial moisture contents of the sample culms were measured using oven dry method (as described in para C.), while the initial weights of the test culm were also determined.