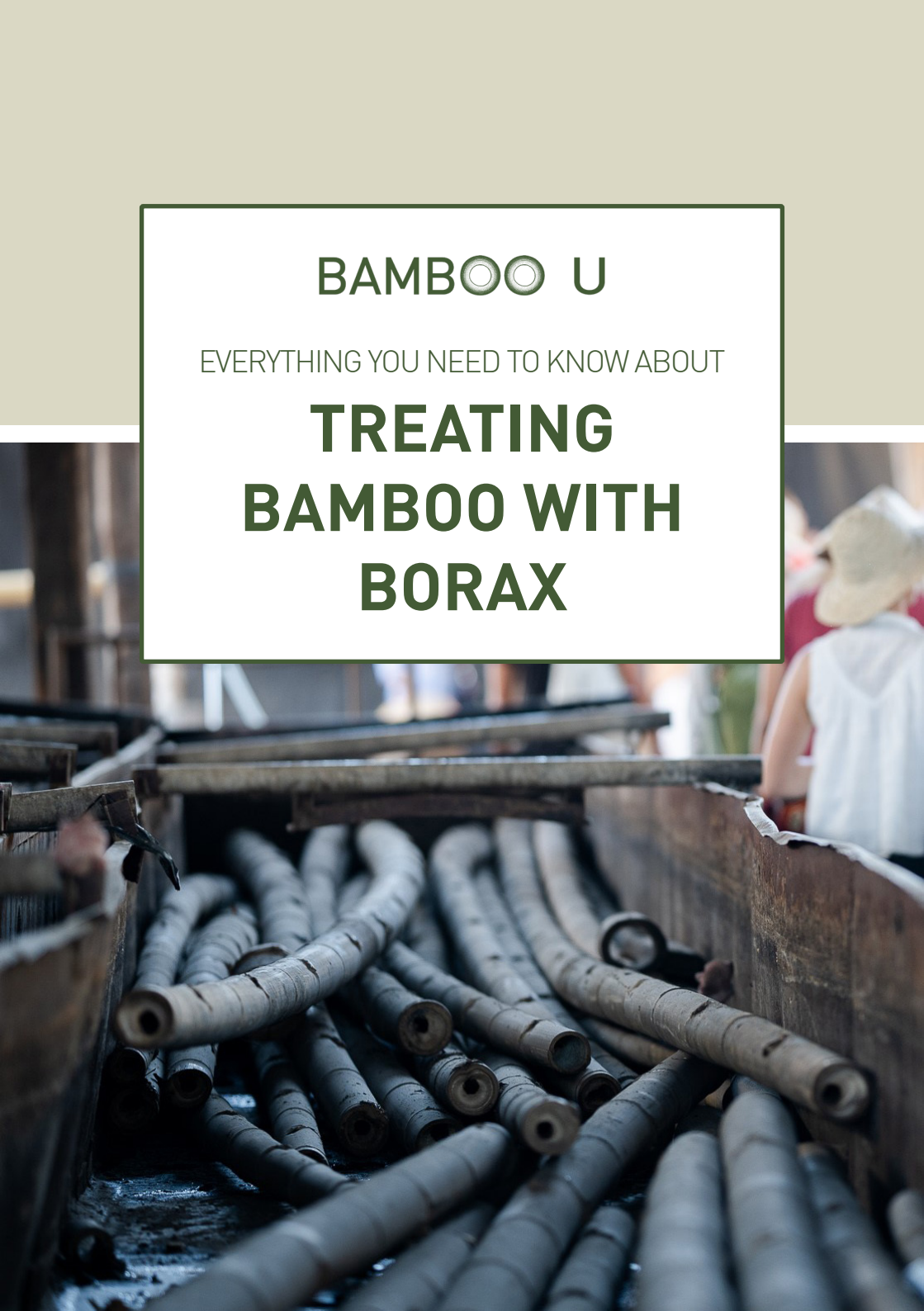




BAMBOO U

EVERYTHING YOU NEED TO KNOW ABOUT

TREATING BAMBOO WITH BORAX

The most important part of building structures out of bamboo is Treatment. Why?

Bamboo's natural strength and mechanical properties make it an amazing construction material, but it is also a low-durability material – if used untreated – because of its starch content. The sugary parenchyma that holds together the fibers in bamboo makes it vulnerable to termites, insects, borers, and fungal attacks. In fact, bamboo is a major food source for people and animals due to the high starch content in young bamboo shoots.

The main idea of treating bamboo is to inject the parenchyma with preservatives, which will keep it away from termites, insects, borers, and also help with resistance to certain types of mold and fungus. So the first step to building with bamboo is treating it properly to make it a durable building material.

Below: A bamboo split ravaged by wood borers.



How to treat bamboo & Why a boron-based method is best to use

There are many different techniques and methods to treat bamboo, from traditional practices which lack reliability and consistency to industrialized treatment techniques that can be very toxic to the environment and people. One of the most popular bamboo treatment techniques is the boron-based technique that was introduced by Prof. Walter Liese who adapted it from the wood preservation industry. Its consistency and assurance of treatment quality make it the most environmentally and reliable bamboo treatment technique that is currently available.



What are borates?

Borates are chemical compounds that contain boron. In the case of treating bamboo, we use both borax (a salt-based borate) and Boric acid.

Borax ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$), as well as Boric acid (H_3BO_3) are widely used in home products such as soaps, stain removers, disinfectants, deodorizers, and mold-killers. They are also used in cosmetic and pharmaceutical products.

Although they are mildly toxic to humans if ingested, they are a major poison for small insects who would otherwise eat bamboo if left untreated.

Once your bamboo has been treated it is effectively harmless for humans but extremely effective at repelling insects.

Normally borax and boric acid are used together with water to prepare the treatment solution. It is advisable to use them together because when boric acid is mixed with borax, the borax acts as a catalyst to increase the solubility of the solution helping to ensure that the chemicals become fully dissolved in the water.

Borax (sodium borate) and boric acid (hydrogen borate) are often available in farm supply stores and hardware stores as well as from large chemical companies.



Simple methods to treat bamboo with borax and boric acid

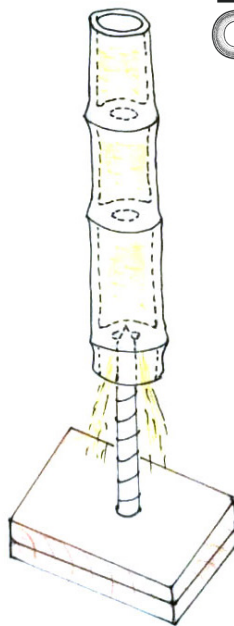
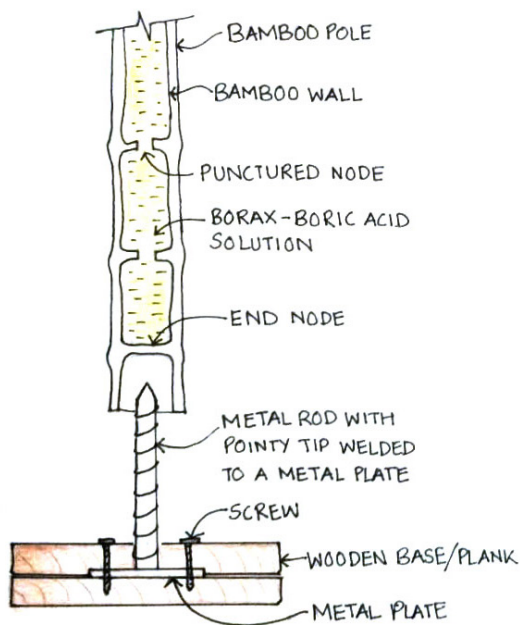
There are different methods to get borates into the bamboo's parenchyma. But the simplest effective methods are Vertical Soak Diffusion (VSD) and Full Immersion; both cold and hot soak.

Vertical Soak & Diffusion (VSD)

Vertical soak and diffusion is a low-tech treatment method developed by Linda Garland and the environmental bamboo foundation in the 1990s. It has advantages over other methods for people who want to treat bamboo quickly without investing in too much infrastructure. Particularly in the backyard or village environment.

In this method, the solution is inserted into the bamboo by filling it up like a cup of water. This helps get the solution into the bamboo without needing to have it fully submerged. The logic is that you only need to treat the internal part of the bamboo, which is vulnerable to insect attacks, since the skin is harder and full of silica and is rarely preyed upon by wood borers.

A 10% concentration solution is advisable in treating bamboo reliably with the VSD method. The solution is made up of 6% borax and 4% boric acid. The remaining 90% of the solution is water.



Once the solution is prepared, then bamboo culms are made into a vessel by piercing all the nodal diaphragms except the last one. After that, bamboo is placed vertically, then the solution is poured into the bamboo from the top and filled to the brim.

The solution in the bamboo culms seeps into bamboo tissues and makes the bamboo toxic to insects. **It takes 14 days for the culm to be fully treated.** Throughout the 14 days, it is crucial to keep adding the solution to the poles so that they are full, and treatment is done effectively. After 14 days, the last nodal diaphragm is punctured to remove the solution from the bamboo.

This treatment requires more attention throughout the process. It needs to be protected from weather conditions like extreme sun and rain that could disrupt the solution or damage the bamboo.

Full Immersion

Full immersion or soak immersion is a good system if you plan on treating larger quantities of bamboo regularly. It is accomplished by putting the entire pole in a treatment solution. This method is very similar to how wood treatment is accomplished in low-tech environments.

With the full immersion technique, bamboo must be fully submerged in a tank making sure the solution soaks into the bamboo tissues completely. Before the bamboo poles are put into the tank all the nodes of the bamboo must be pierced. To do this we drill small holes on the culm walls near the nodes or run a metal pole through the entire pole breaking all the internal inter-nodes. This allows the solution to enter the inside of the bamboo easily.

There are two different ways of treating your poles with the full soak immersion technique. Either Cold Soak, or Hot Soak.

Below: Bamboo poles after being placed into the soaking tanks just before the solution is put in.



Cold Soak needs an open tank system under a roof to protect the poles from the elements, and to keep your solution from getting diluted from rainfall. In the cold soak method, bamboo needs to soak for between 7-14 days. This assumes a tropical environment. In cold conditions, it may be even longer.

Hot Soak needs an open tank system that is raised from the ground to make an accessible fireplace underneath the tank. The heat helps to encourage the borates to enter the bamboo's woody mass faster. Bamboo needs to soak for around 24 hours with a constant heating temperature of approximately 60 degrees Celsius. There is more possibility of treating bamboo in just 8hrs with a constant heating temperature of 100 degrees Celsius. Timing may also differ depending on the type of bamboo you are treating

It is advisable to use a borax/boric acid solution of 5-6% concentration in this system. Within the 5%, 3% should be borax and 2% should be boric acid to 95% of fresh water for both hot and cold soak immersion.

Left: During the process of Hot Soak Immersion, heat is generated by adding fire under the raised tank. Right: Flattened bamboo bundles are being added to the tank.





VSD vs. Full Immersion

VSD and the full immersion technique are the most effective and simplest bamboo treatment methods using borates, but both have their advantages and limitations.

The VSD method is usually only suitable for small-scale construction projects. It doesn't require very much infrastructure and large space requirements but requires a lot of labor, attention, and care throughout the process.

It is only possible to treat hollow and relatively straight bamboo species using the VSD method. Solid bamboo, thin bamboo, and curvy poles can't be treated by this method. There also can't be any leaks through culm walls, bamboo that is slightly cracked can not be treated through the VSD method.

10% is a higher concentration solution of borates compared to other techniques but it is recommended to treat efficiently because it is often harder to ensure even penetration of the solution in this system.

Soak immersion methods are the simplest reliable bamboo treatment techniques to treat bamboo for larger-scale construction purposes. All kinds of bamboo materials can be treated by soak immersion methods from full poles, to splits, and flattened bamboo.

In a large-scale treatment facility with proper monitoring and control of borax and boric acid levels in the solution can be reused over and over again, by simply adding more water and chemicals to the tanks as needed thus reducing waste and lowering costs.

Other methods using borates

There are also other methods to inject borates into bamboo, these require more equipment and technical understanding to treat the bamboo effectively.

Boucherie

This is a simple sap displacement method; the prepared solution is inserted into bamboo tissues without any pressure application. One end of the bamboo culm is immersed in the solution for 24-48 hrs. Later culms are upturned and the other end is immersed in the solution for the same amount of time.

The bamboo needs to be treated immediately within a few hours of harvest while the poles' natural capillary actions are still active. There are challenges to bringing the treatment solution into the forest and avoiding contamination in a natural environment or in getting the bamboo to a treatment facility within the needed time frame.

Modified Boucherie

In this method, the prepared solution is inserted into bamboo tissues by air pressure application. An air-tight nozzle is fixed to one end of the culm which allows the solution to be forced through the pole, often replacing existing sugars and starches in the poles' living tissue. Like the traditional Boucherie method, it must be done soon after harvest but it is much more effective in terms of time. You can treat bamboo in under an hour!

Vacuum Pressure Impregnation

In this method, bamboos are placed in a pressure tank, and through a combination of dry and wet vacuum pressure cycles, the borates are inserted into the bamboo by displacing the sugars and fixing the treatment inside the cells of the bamboo.

It is effective in treating a set of bamboo culms in just 6 hours, but this requires heavy equipment and machinery as well as technical knowledge to operate the system.



Other chemicals vs Borax

There are many other chemicals we can use to treat bamboo. Most are more toxic and often harmful to the environment. Copper chromium arsenate (CCA), Copper chromium boron (CCB), permethrins, and pyrethroids are some common examples. While they are very effective, the usage and disposal of these chemicals is a big challenge and a high risk for people and for nature. While they can greatly increase the versatility and durability of bamboo in outdoor environments, care must be taken before using these techniques. If the production and disposal of these chemicals, as well as the treated material at end-of-life, can be managed there are limited circumstances where such options are appropriate with the correct supervision and understanding.

Borates have an extremely low level of toxicity that is just slightly higher than common table salt. It is also a natural earth mineral needed by most plants, so disposal is accomplished by deluding in water till it can be applied to soil as a fertilizer, rather than a pollutant. So using borates is environmentally friendly and safe for human health, thus making it much more appropriate for wider applications.

Traditional practices in treating bamboo

Bamboo has been used for buildings since ancient times, and people followed traditional practices to increase the bamboo's durability using a few different practices. These traditional methods did not use any chemicals to treat bamboo, but they have issues with consistency and lack of assurance in treating bamboo effectively. These include harvesting time, water leaching, fermentation, smoking and heating, saltwater and seawater.

There is a logic behind all the traditional practices to treat bamboo and these practices are usually not environmentally harmful, but they are often not very practical or reliable in the modern context of the construction industry.

This is why borax and boric acid treatments are one of the best solutions to treat bamboo. They are reliable, safe, and have a low impact on the environment. They are also relatively accessible and affordable. With some basic training anyone can begin to treat bamboo poles to create a durable building material.

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