Memorandum

ARUP

To	Shelter & NFI Sector, Cox's Bazar, Bangladesh	Date	04 November 2019
Copies		Reference number	
From	Sebastian Kaminski, Clare Perkins	File reference	
Subject	Recommendations on how to verify adequate treatment of bamboo		

1 Introduction

The Shelter and NFI Sector in Cox's Bazar, Bangladesh have asked Arup to provide guidance on how to verify that bamboo has been adequately treated with boron. This is because many suppliers are now independently providing "treated" bamboo to site, and the Shelter and NFI Sector require a way to independently review whether or not these have in fact been treated properly. This Memo provides these recommendations. This Memo should be read in conjunction with previously published Arup guidance on durability and treatment of bamboo (Arup, 2018).

2 Aim

For boron treatment to be effective, it must:

1. Have penetrated the full-thickness of the culm.
2. Be present in sufficient quantities throughout the thickness.

Several different methods are available to determine these, with varying complexity.

The simple method only gives an indicative idea of the effectiveness of the treatment by showing whether the boron has penetrated through the thickness of the culm. It does not give a clear idea of the % retention of the active chemical – the detailed method is required for this.

It is recommended to test both the simple and detailed methods simultaneously first, as this allows the simpler method to be calibrated, such that it can be used later instead of the detailed. If the simple method shows no penetration, the detailed method will confirm this, and possibly the % retention at which the yellow-orange colour change occurs.

3 Method

3.1 Steps

The following method is recommended for testing whether bamboo from a single supplier has been effectively treated with boron:

Step 1: Take 20 samples ~200mm long of bamboo treated with boron. Each sample to be from a different culm, and to be taken at least 100mm from the end of the treated culm. Samples should be taken from at least 2 different treatment batches. The supplier, batch and treatment method (chemical, time in treatment etc) should be noted for each sample.

Step 2: Samples to be sent to lab. Two tests are required on each sample:

a) Simple method (turmeric indicator) – see Section 3.2.

b) Detailed method (spectroscopic or wet titration) – see Section 3.3.

The 200mm samples can be cut into two, and each part used for one of the tests above.

Step 3: Test results to be reviewed and compared against minimum % retention of chemical – see Section 4.0. If the % is adequate for all samples, the treatment can be considered successful. The colours obtained in the simple method can then be recorded photographically and used for future reference.

Step 4: Treated samples from the same supplier should be re-tested periodically to determine whether the treatment remains adequate. At first, ideally each batch should be tested using at least the simple method on at least 5 samples. This can be reduced if the treatment supplier is found to provide an adequate and consistent product.

If the treatment method varies in any significant way, testing should begin again from Step 1.

3.2 Simple method

The following method is recommended, as proposed in the Bamboo Preservation Compendium (Liese & Kumar, 2003). This method can be conducted in many school labs. It does not give a clear idea of the % retention of the active chemical – the complex method is required for this.

Reagents

Solution 1: mix 10g turmeric powder with 90mm ethyl alcohol. Decant or filter to obtain clear solution.

Solution 2: dilute 20ml of concentrated hydrochloric acid to 100ml with ethyl alcohol and then saturate with salicylic acid (about 13g per 100mm).

Sample

Cut the bamboo through the entire section using a fine clean saw blade. A smooth surface shows the results of the spot test better than a rough surface. The surface must be dry and clean otherwise the test will not be satisfactory.

Method

Solution 1 is applied preferably by spraying or with a dropper to the cut face of the section. The surface is then allowed ~10 minutes to dry.

Solution 2 is then applied in a similar manner to the area that has been coloured yellow by the application of solution 1. The colour changes should be observed carefully and will show up a few minutes after application of the second solution.

In the presence of boron, the yellow colour of the turmeric solution is turned red (see Figure 1).

After reagent application, placing bamboo in a warm oven accelerates and intensifies the colour reaction to better differentiate between treated and untreated bamboo.

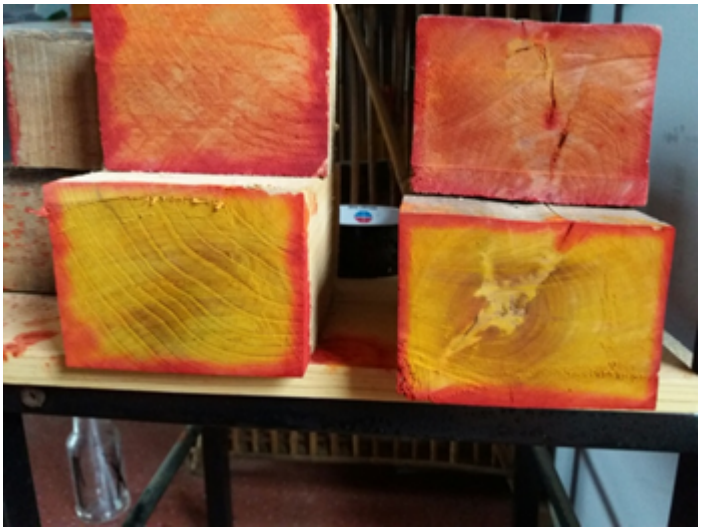

Figure 1: Timber treated with boron with the simple method complete – note the colour differences, indicating areas where the boron did not reach

3.3 Detailed method

This can be measured by spectroscopic or wet titration methods according to American Wood Protection Association standards. This gives an accurate idea of the % retention of the boron. Any of the three below can be used:

- A21. Standard Method of Analysis of Wood and Treating Solutions by Inductively Coupled Plasma Emission Spectroscopy.
- A40. Standard Methods for Determination of Boron Trioxide in Treating Solutions and Treated Wood by Potentiometric Titration with Sodium Hydroxide.
- A65. Standard Method to Determine the Amount of Boron in Treated Wood using Azomethine-H or Carminic Acid.

These wood analysis methods are also basically the same as those used in boron analysis of plant tissues in the agricultural sector. As a result, many university and private labs that are in that sector could also run these analyses.

Two laboratories which routinely undertake such testing are:

- Timber Products Analytical Lab. https://www.tpinspection.com/analytical-services/analytical-lab.
- Southern Pine Inspection Bureau. https://www.spib.org/wood-services/quality-assurance-laboratory .

Speaking to the first confirmed that this laboratory uses the A40 method and achieves accuracies of 1-2%. The cost of a single analysis is $50 and if they must cut and grind the sample from a solid piece of bamboo an extra $25 must be paid. The laboratories undertake similar analyses for boron-treated bamboo from Vietnam. The procedure for sample preparation can be supplied by the laboratory so it can be done in advance. It involves cutting a small sample and grinding until it can pass through a 20-mesh screen (20 openings per inch). Sample turnaround time is about 5 days and there may be economies of scale if many samples must be tested.

4 Minimum % retention of active chemical (boron)

The minimum % retention of the boron can only be measured using the detailed method. We have not been able to identify any reliable published information providing definite minimum % retention required of boron in bamboo to ensure durability. It is likely that different species and compounds of boron will require different % to remain effective. Notwithstanding this, the following is a likely rule, based on what is used for timber (Lloyd, 1997):

- At least 4-5kg/m^3 is likely to give enough protection against most termites and beetles (some termites may require >6kg/m^3).
- 2-3kg/m^3 is likely to give enough protection against beetles, but may be inadequate for termites.
- <2kg/m^3 is unlikely to provide sufficient protection against neither beetles nor termites.

Note that boron will be washed out if exposed to water, including driving rain, therefore effective treatment with boron requires the bamboo to be kept completely dry at all times. Overhanging roofs are typically not enough – the base of the wall needs to be protected with a waterproof material such as a plastic sheet or a render (paint is only partially effective and only temporarily as it breaks down in sun and cracks, leading to water ingress).

5 Disclaimer

This guidance is provided for information purposes only. Anyone using this guide must satisfy themselves regarding the application of statutory requirements, local building regulations, codes, insurance certification or other requirements or recommendations relevant to the location where and materials with which they plan to build. Examples of local conditions that will change the design include climate (flooding, temperature variation, insects), soil mechanics (foundations), seismic characteristics (earthquakes), chemicals and legislation regarding inclusive safe access (including emergency egress for fire).

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All personnel involved in treatment of bamboo, handling of materials and laboratory testing should use personal protective equipment (PPE) appropriate to the chemical and task. This may include gloves, dust masks and eye protection.

6 References

Arup (2018) Rohingya Refugee Camps and Sites, Cox's Bazar Region, Bangladesh: Technical Guidance Note 03: Durability and Treatment of Bamboo in Cox's Bazar. London: Arup

Liese W. and Kumar S. (2003) INBAR Technical Report 22: Bamboo Preservation Compendium, Beijing, China: INBAR

Lloyd, J. (1997) International Status of Borate Preservative Systems. In *The Second International Conference on Wood Protection with Diffusible Preservatives and Pesticides.* Wisconsin, USA: Forest Products Society