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Strategies to standardise bamboo for manufacturing process chains

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Abstract

The manufacturing challenges industry face need to be addressed in the multifaceted context of sustainability. In order to stay relevant and competitive the manufacturing industry is investigating several types of sustainable hybrid materials for structural components. Bamboo is a versatile plant with thousands of applications, but is produced in various shapes and sizes with different mechanical characteristics. Therefore, the objective of this study is to investigate strategies to standardise bamboo for manufacturing process chains. The treatments that bamboo must undergo in order to be used in high quality and resilient products were investigated. Sustainable and environmental friendly approaches to deal with pests and different drying methods of bamboo are discussed. Factors to be standardized are identified and strategies to standardize this in each phase before the manufacturing process chains are elaborated on. Benchmarking is done on the diameter and wall-thickness of the different tubes and an allowable variance is identified for each tube.

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Keywords: Standardisation of supply; Bamboo; Bamboo bicycle; Process chain development

1.Introduction

Bamboo is the most versatile and fastest growing plant on the earth. It has played an integral part in millions of lives for the past millenniums. In the last few decades it is exploited with renewed interest to serve as a substitute for timber [1]. This paper aims to serve as a stepping stone to further research on how to standardize this wonderful plant and increase the utilization of bamboo in the future. This paper is also a puzzle piece in a bamboo bicycle project [2].

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The fibres of bamboo grow unidirectional and are embedded in a lignin matrix. This makes bamboo a viable alternative to carbon fibre. The fibrous walls of bamboo are dividend in segments that contributes to the flexural strength and rigidity of bamboo, it also adds to the bamboo's résistance to impact. These segments help to dampen the vibrations caused by the road, while still providing a reasonable stiffness for a bicycle frame. The ultimate average tensile strength of bamboo is between 300-350 MPa. It has an average density of 0.4 (g/cm^3). Bamboo does not have any ray or knots like wood. This gives it the capacity to withstand more stress then wood, through the length of each stalk. Aluminium, a material commonly used to construct bicycles has an ultimate tensile strength of 310 MPa and an average density of 2.7 (g/cm^3). Thus concluding; bamboo has a higher strength-to-weight ratio than aluminium, which makes it a very good substitute for bicycle frames [3].

2. Problem statement

Bamboo like any other plant can differ from plant to plant or culm to culm with regards to diameter and wall thickness. Certain acceptable variances must be established for each of these varying factors. These allowable variances will be established for each of the bamboo components of the bicycle. Another issue that must be discussed is shrinkage and the prevention of splitting which is important to consider when using bamboo for manufacturing. Figure 1 shows certain areas of concern on the bicycle frame. Standardising strategies must be identified and linked to these factors with regards to the level of influence it has on the factors.

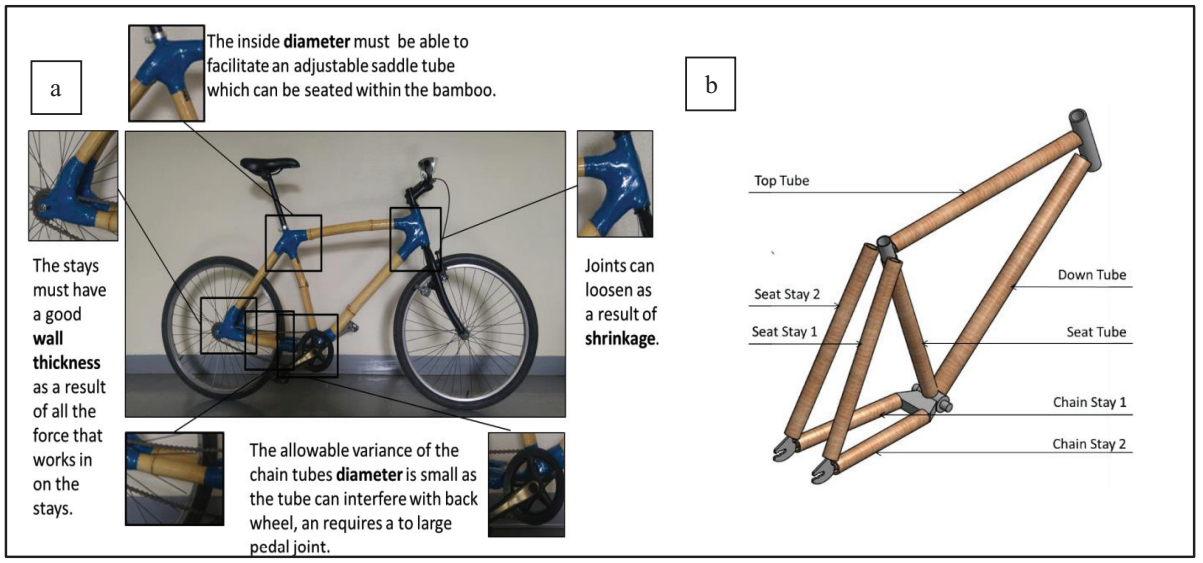

Figure 1. (a) Depicts the potential problems in the absence of standardisation; (b) the components of a bicycle frame.

3. Research objectives

- To benchmark the bamboo bicycle that was manufactured by Bamboo Bikes for Africa with regards to the shrinkage, diameter and the wall thickness with 3 other bamboo bicycles
- Developing a process chain for preparing bamboo for manufacturing of a bamboo bicycle
- Understanding the effect that each standardising strategy has on shrinkage, diameter and the wall thickness of the bamboo.