



New Findings on Bamboo-concrete Composite Slabs

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Summary

Bamboo is a natural material that is highly sustainable and has very favourable material properties, specifically high longitudinal strength and low density. This paper revisits a concept for the use of bamboo that specifically exploits its high tensile strength. Half-shells of bamboo rods are covered by concrete to form a composite beam or slab where the bamboo is used in tension and the concrete in compression. A numerical model assuming a rigid shear connection between concrete and bamboo is used for analysis. The applicability of the numerical model is shown by comparison with nonlinear laboratory tests performed on a similar specimen with a 4m span. In addition, new techniques are proposed for achieving proper bond between the bamboo and concrete in a more sustainable way. The paper discusses the main concepts of these novel elements providing an overview of the development and outlook.

Keywords: Bamboo; concrete; composite slabs; nonlinear analysis; experimental testing.

1. Introduction

Bamboo is a natural material classified in the grass family, similar to wheat, sugarcane, and rice. Many different species exist and it is a highly sustainable material not only because it is a plant, but also because it exhibits rapid growth. This growth rate can be as fast as 120 cm per day, but it is usually in the range of 10-40 cm per day, [1]. Depending on the bamboo, the diameter can vary between a few millimetres to 30cm, [2]. Bamboo grows mainly in the tropical regions of the world. Guadua bamboo was used for the testing discussed in this paper, which is one of 25 Columbian species of giant bamboo. Guadua can grow to a height of 30m with diameters between 10 and 15cm. The high sustainability of bamboo is coupled with very favourable material properties, specifically high longitudinal strength and low density. The tensile strength of bamboo can be of a similar magnitude to that of structural steel. The density of air-dried bamboo ranges from 600 to 800 kg/m³, [2].

This paper presents a new concept for the use of bamboo that specifically exploits its high tensile strength. Half-shells of bamboo rods are covered by concrete to form a composite beam or slab where the bamboo is used in tension and the concrete in compression. In the proposed concept the concrete also acts to add robustness to the sensitive bamboo and provides local load distribution between the bamboo rods. The bamboo can act as formwork during the casting, thus facilitating an easy construction. Acha and Ghavami [3] conducted tests on similar bamboo-concrete composite slabs, however in the tests performed here the bamboo is not coated and metallic shear connectors are used instead.

2. Numerical analyses

A nonlinear numerical model assuming a rigid shear connection between concrete and bamboo was used for analysis and compared to the lab tests. This model utilized the Lagrange principle of the