Developing Modern Bamboo Structures for Sustainable Construction

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Summary

The authors are conducting a comprehensive research program, with the goal to develop modern bamboo structures for buildings and bridges. This paper reports the design, construction, testing of modern bamboo bridges and buildings. The authors developed laminated bamboo girders, named as GluBam, and verified their satisfactory mechanical performance through full-scale testing. It was demonstrated that the laminated bamboo girders have satisfactory stiffness and load carrying capacity. The use of FRP can further enhance the stiffness and capacity of the bamboo girders. Based on the test results and analysis, a 10 m long single lane roadway bridge was designed and constructed, which was the first of its kind in the world. The field tests were carried out using an over loaded two-axel truck with a total weight of 8.6 ton which exceeded the given design truckload of 8.0 ton. The bridge performed satisfactorily with the mid-span deflection corresponding to the critical service loading condition being much smaller than the code required limit. The paper also reports the authors invention of modern bamboo buildings. In the aftermath of the Great Wenchuan Earthquake of May 12, 2008, the authors developed modern bamboo structure earthquake relief shelters and classrooms and deployed in the devastated area.

Keywords: bamboo; laminated; glubam; bridges; buildings; tests; earthquake relief shelters; sustainability; natural resource; green buildings.

1. Introduction

Bamboo, as a natural resource, has been utilized by mankind for thousands of years. However, modern structures using bamboo as basic material can well become a new breakthrough in the civil engineering field. There are several key characteristics in bamboo based structures. First, the source of raw bamboo materials is widely available in many parts of the world, particularly in Asia, most notably, China and India. Bamboo is essentially giant grass and grows much faster than trees. Bamboos typically can be harvested in less than four years, and they can re-grow. Second, bamboo has good mechanical properties and relatively easy to process for different purposes. Thirdly, but definitely not lastly, the manufacturing process of bamboo products can be essentially environmentally friendly, pollution-free, and suitable for sustainable development.

The fact that bamboo is not fully utilized in modern structures, due largely to the lack of validation based on the theory of mechanics, material science, structural design and testing. Use of original bamboo trunks as structural elements is traditional way of bamboo construction, mostly un-engineered. Bamboo reinforced concrete is a topic of bamboo usage in modern structures and has a reasonably long history of research and applications. However, such usage becomes somewhat obsolete due to the fact that bamboo can not offer the required strength and deformability as reinforcing steel bars for today's reinforced concrete structures. The laminated bamboo, or GluBam developed by the first author is an industrialized product that has the potential for building modern structures. Structures thus developed with bamboo as the main structural material can improve the

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