

Comparative study on moso bamboo shear strength in four tests

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Introduction

Bamboo is one such biological composite, which is the proper embedding of the stiff fibre caps of the vascular bundles into the soft parenchyma matrix. However, the vascular bundles are only arranged in longitude. And the vascular bundles density is gradient in radial direction, the outer the denser. The composite and gradient structure of bamboo result in the superior mechanical strength and toughness but shear strength. Splitting is the main and fatal fracture to bamboo. In order to explore the splitting strength and behaviors of bamboo, shear strength of moso bamboo (*Phyllostachys Pubescens*) were tested in four methods, including three in shear-parallel-to-grain and one shear-perpendicular-to-grain in bending. Comparative analysis on shear strength and behaviors were conducted

Materials and Methods

Four-year-old moso bamboo (*Phyllostachys pubescens* Mazel) culms were the materials of this study. According to ASTM D906-98 (R2017), GB/T30969-2014, GB/T, ISO 22157-2:2004 (E)- Part 2: Laboratory manual, The dimension of sample and test setups were presented in Fig.1. An Instron series 5582 (Instron, Boston, MA, USA) tensile tester equipped with a load cell with a capacity of 10 kN was used the tests. ESEM imaging were performed on an environmental scanning electron microscope (ESEM, XL30 FEG-SEM, FEI, Hillsboro, Oregon, USA). There were six specimens for each test.

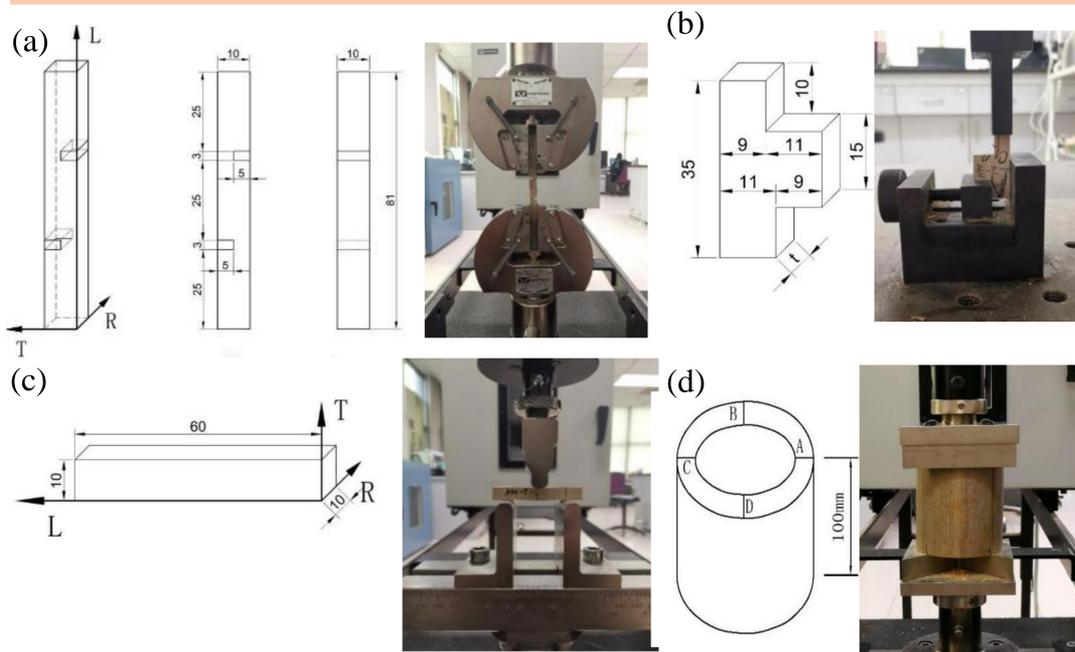


Fig.1 Dimension of specimen and Experimental setups of four test methods. (a) Tensile shear test, (b) Step shear test, (c) Short beam shear test, (d) Cross shear test .

Conclusions

The composite structure and longitudinal fiber arrangement determined the weaker interface between fibers and parenchyma tissues. Therefore, the shear strength of bamboo culm in longitude in radial surface were lower than tensile and bending strength. According to the different loading methods, the shear strength and fracture characteristics were different. shear strength of bamboo smaller specimen in shear-parallel-to-grain was highest, then shear strength in bending was second higher. The shear strength of shear-parallel-to-grain in tensile was lowest.

Results and Discussion

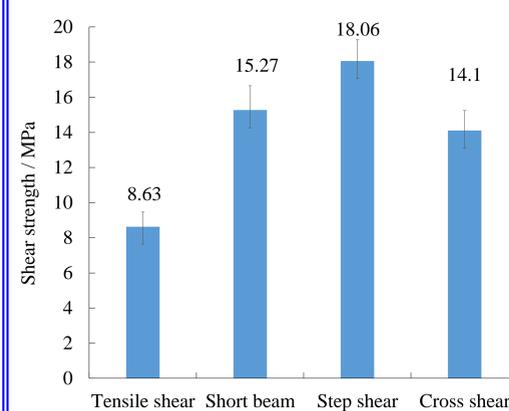


Fig.2 Shear strength of four test

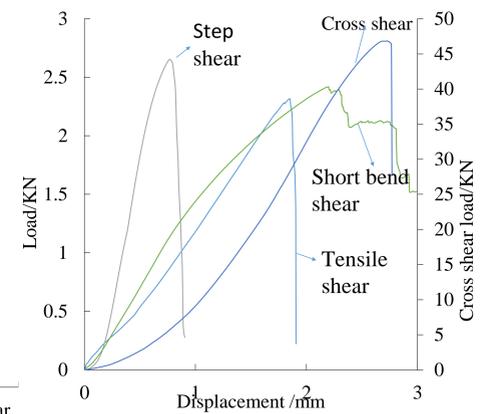


Fig.3 Typical load-displacement curves for four shear methods.

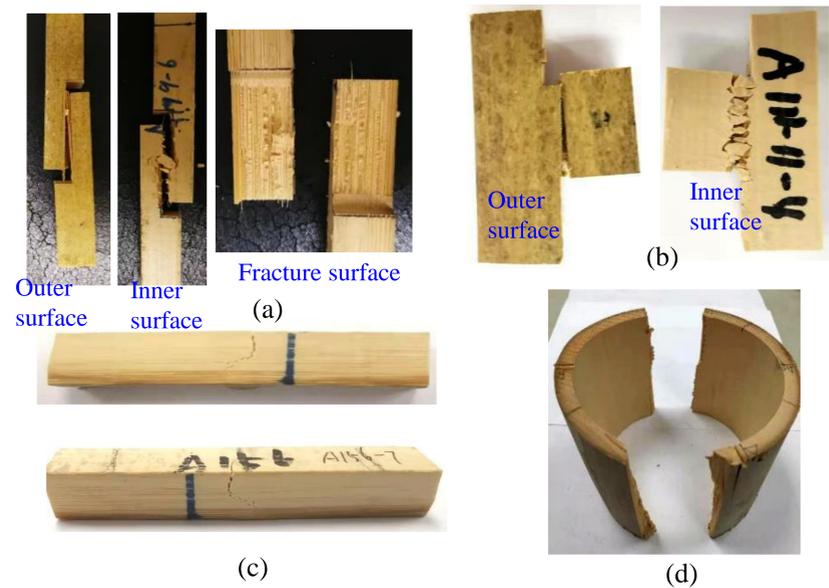


Fig.1 Fracture characteristics of four test methods. (a) Tensile shear test, (b) Step shear test, (c) Short beam shear test, (d) Cross shear test .

Comparing with the tensile and bending strength of bamboo, the shear strength was lower. Therefore, splitting was the popular fracture manner of bamboo. Moreover, the shear strength and fracture characteristics were different in different test method. Results indicated that shear strength of bamboo smaller specimen in shear-parallel-to-grain was highest, then shear strength in bending was second higher. The shear strength of shear-parallel-to-grain in tensile was lowest. There were sharp drops in load-displacement curves of shear-parallel-to-grain, which was different from the step by step failure mode in bending. And the interface shearing break was the main fracture characteristics in shear-parallel-to-grain. However, the bending fracture and interface debonding were the main fracture characteristics in shear-perpendicular-to-grain in bending. The tests methods determined to the shearing loading and shearing strength and behaviors. And the structure and longitudinal fiber arrangement determined to the weaker shear strength and clean fracture characteristics of bamboo.

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