

Physical and Mechanical Properties of Flatten Bamboo Panel (FBP) and Bonding Performance in Different Bonding Surface

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Introduction

As a biomass material, bamboo has drawn worldwide interest because it is an abundant and sustainable resource, has relatively short rotation, and excellent mechanical performance. Unfortunately, the irregular, tubular shape significantly restricts the comprehensive utilization of bamboo. Even until now, it remains a huge challenge to prepare large flat surface boards by directly sawing or cutting due to the hollow cylindrical shape of bamboo culms. Since the 1980s, various attempts have been made to directly flatten a section of bamboo culms into flat boards. New technology has been developed and bamboo stem was made with a linear cut to 2,3 or 4 pieces, softened with high-pressure steam, and flattened into a flattened bamboo panel (FBP) using a horizontal pressing apparatus. This study was to explore the physical and mechanical properties of FBP and bonding performance in different bonding surface.

Materials and Methods

FBP was chosen as the study group and bamboo was set as the control group.

Bonding surface: Outer layer/Outer layer(O/O), Outer layer/Inner layer(O/I) and Inner layer/Inner layer(I/I).

Test standards: ①15780-1995 Testing methods for physical and mechanical properties of bamboos; ② GB/T 17957-2013 Test methods of evaluating the properties of wood-based panels and surface decorated wood-based panels. The main test aspects was shown in Fig.1.

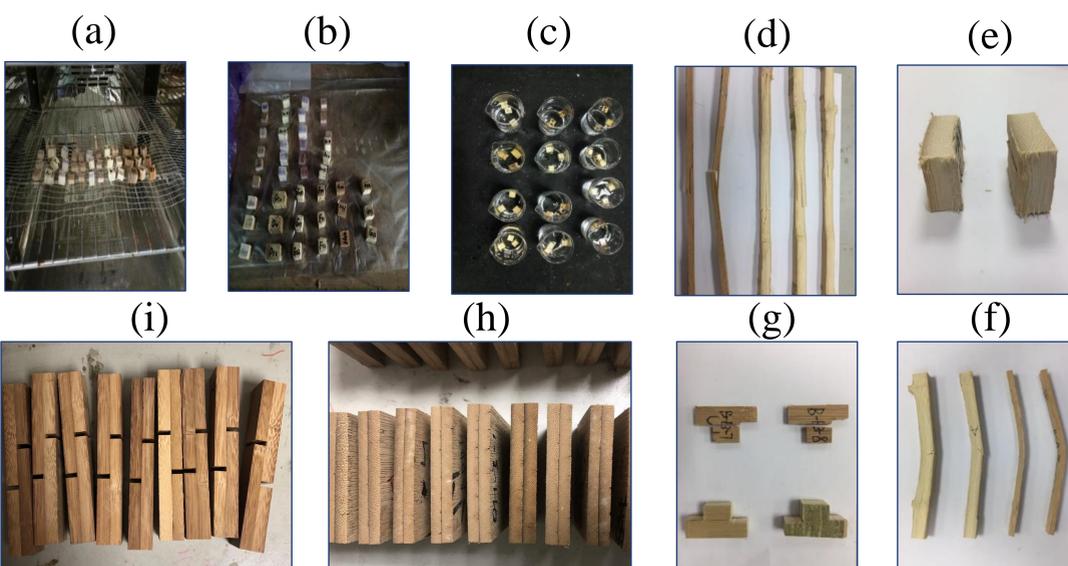
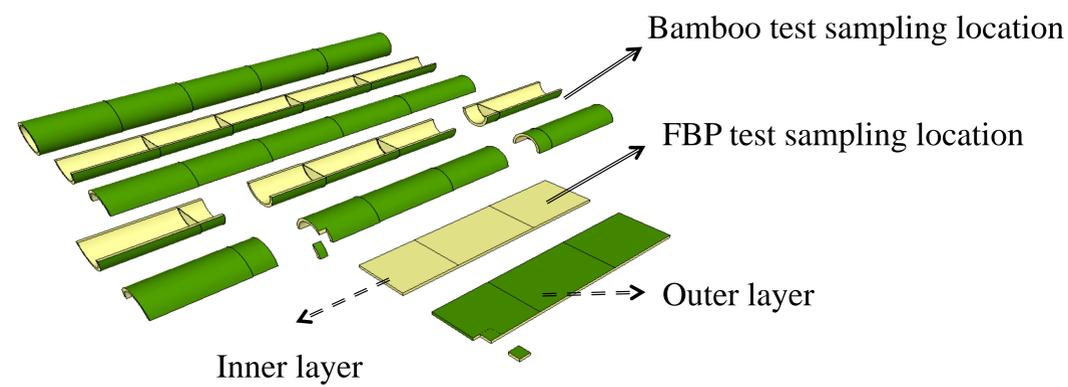


Fig.1 Diagram of FBP and sampling location. (a) Shrinkage (b) Density (c) Swelling (d)Tensile strength (e) Compression strength (f) Bending strength (g) Step shear strength (h) impregnated peel (i) two-incision tensile

Results and Discussion

Table 1 Physical properties of FBP and bamboo

Type	Density(g/cm ²)	Shrinkage rate (%)				Swelling rate (%)			
		Tangential		Radial	Longitudinal	tangential		radial	longitudinal
		Out layer	Inner layer			Outer layer	Inner layer		
FBP	0.74	9.79 (6.75)	4.86 (14.6)	9.4 (9.78)	0.24 (1.75)	9.79 (6.75)	4.86 (14.6)	9.4 (9.78)	0.24 (1.75)
Bamboo	0.71	6.89 (7.46)	4.2 (11.3)	6.75 (8.39)	0.27 (1.21)	6.89 (7.46)	4.2 (11.3)	6.75 (8.39)	0.27 (1.21)

Acknowledgements

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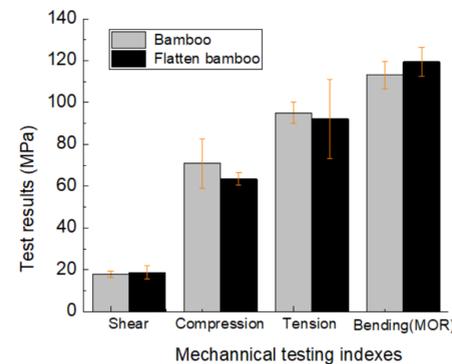


Fig.2 Mechanical properties of bamboo and FBP

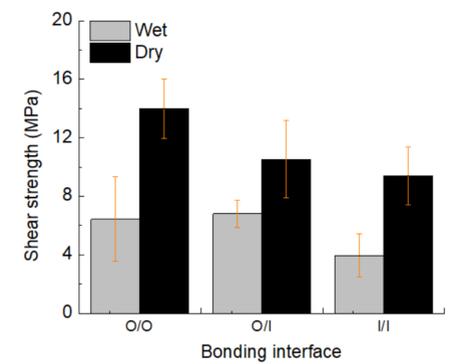


Fig.3 Shear strength in different bonding surface under wet and dry conditions

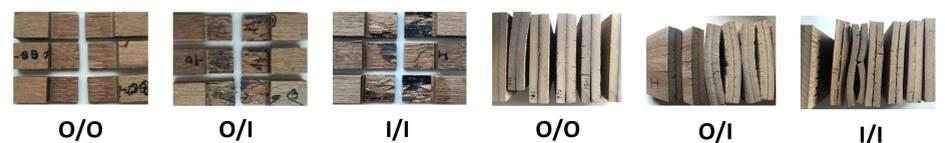


Fig.4 The main failure mode of two-incision tensile shear and impregnated peel test in three bonding surfaces.

Table 2 Impregnation peel length (mm)

Bonding Surfaces	Class I				Class II
	Max	Min	Average	Average	
O/O	75	0	36.16	0	
O/I	75	0	60.05	0	
I/I	0	0	0	0	

- Table 1 indicates that the density is slightly increased for FBP, the main reason is the flattening process of bamboo is extruded by flattening equipment to a certain extent. The values of shrinkage and swelling rate were: Tangential (outer layer) >radial>longitudinal, the shrinkage and swelling rate in tangential direction in outer layer were higher than those in inner layer. For FBP, the values of shrinkage and swelling rate is higher than those in bamboo in tangential and radial direction.
- Fig.2 shows that the shear strength and bending strength for FBP were slightly higher than those in bamboo, while the compression and tension strength were decreased to some extent.
- Fig.3 indicates that the shear strength in O/O interface was the biggest, followed by O/I, and the I/I interface was the lowest, the bonding strength meets the requirements of class I plywood;
- Table 2 suggests that the bond line delamination was not found in dipping peel test with class II, however, it occurred in dipping peel test with class I, the average lengths of dipping peeling are 36.16, 60.05 mm for O/O and I/I, respectively. Bond line delamination was not found in O/I but the test samples themselves have different degrees of deformation and crack, as shown in Fig.4.

Conclusions

- Compared with original bamboo, bamboo flattened panel still has good mechanical properties.
- Both the values of shrinkage and swelling rates and the bonding performance in different bonding surface indicates that the bamboo flattened panel prone to deformation and cracking, which means the FBP has poor dimensional stability.
- Test results and analysis of this study may serve as a useful reference for future development of new bamboo flattening apparatus, improvement of flattened bamboo panel dimensional stability modification and research on bonding parameters.