Hybrid OSB made from Moso bamboo (*Phyllostachys pubescens* Mazel) and Aspen (*Populus tremuloides* Michx.): bamboo surfaces, aspen core

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Introduction

Bamboo has significant potential as a construction material in many developing countries where large species, such as Moso (*Phyllostachys pubescens* Mazel) are easily grown[1,2]. It has excellent tensile strength and fracture toughness compared with wood but in spite of this relatively little progress has been made on developing and commercializing engineered composite building materials from it.

Interest in strand-based panels is increasing; China now has a large number wood OSB mills with one processing Moso bamboo. A challenge is bamboo culm stock is less readily available and also much denser than most wood species used in OSB manufacture. It is costly to procure and the process of conversion to strands is still cumbersome and labour-intensive. A logical next step in developing competitive building materials from bamboo is to combine it with low density, and more economically viable plantation wood, which is much easier to convert to strands, and compress into composite boards.

Other research into solid laminated structures has taken advantage of the high tensile strength the outer culm of bamboo by placing it in the shell of the composite[3], but this concept has never been applied to strand-based composites such as OSB.

A hybrid bamboo-wood OSB panel may be a viable option in countries like China which also has large resources of plantation poplars, firs and pines, which are common feedstocks for OSB.

The hypothesis is that oriented bamboo strands in the surface layers of OSB will improve the strength properties of the panel while the Aspen core will provide the required mat compaction characteristics essential in OSB manufacture.

Materials and Methods

Strands

Moso strands produced using a CAE 6/36 Laboratory Disk Flaker (Fig. 1a); length = 130 mm, thickness = 0.65 mm, width mostly 10 to 20 mm. Surface and core Aspen mill strands supplied by Weyerhauser, Edson, AB. Moso core furnish was compiled from the sieve fractions found to present in the Aspen core furnish (Fig. 1b).

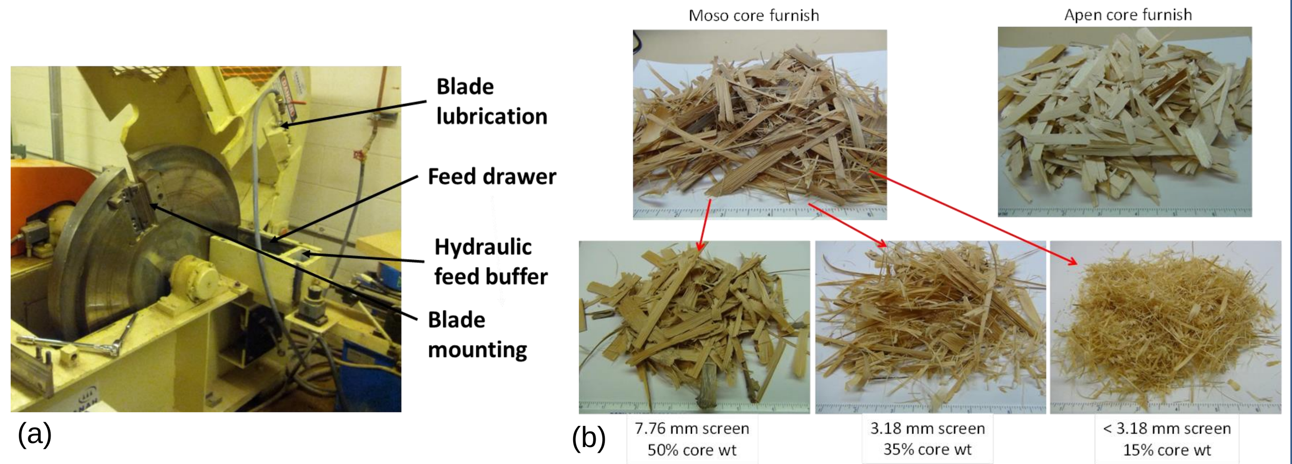

Fig 1. (a) CAE strander, (b) core furnishes showing Moso fines classification

OSB

Six replicates each of five types of 3-layer OSB were blended and pressed in the laboratory; their manufacturing specifications are given in Table 1.

Table1. Board types and manufacturing details.

Board Types-surface and core composition			
Board Type	Surfaces[a]	Core[b]	Replicates
1	Moso int'node	Moso fines	6
2	Moso node	Moso fines	6
3	Moso int'node	Aspen core	6
4	Moso node	Aspen core	6
5	Aspen face	Aspen core	6
Properties tests and specimen numbers			
Sample type	Per Board	Per Type	Total
Thickness	30	180	900
Density	30	180	900
Internal Bond	30	180	900
MOR ∥	2	12	60
MOE ∥	2	12	60
MOR ⊥	2	12	60
MOR ⊥	2	12	60
LNR ∥	2-3	15	30
LNR ⊥	2-3	15	30
TS	1	6	30
WA	1	6	30

[a]25% each by weight, oriented; [b]50% by weight, random.

Results and Discussion

Tested properties according to ASTM D1037[4], and mean values for each board type are given in Table 2; means with the same letter not significantly different at $p \leq 0.05$.

Table 2. Mean board properties.

Test	Pure aspen	Moso-aspen-moso		Pure Moso	
		Internodes	Nodes	Internodes	Nodes
Thickness, mm	11.45a	11.39a	11.38a	11.7b	11.6c
Density, kg/m³	737.1a	747.8a	735.3a	713.4b	706.0b
Surface dens, kg/m³	986.9a	913.8a	887.4a,b	856.5b	810.3c
Core density, kg/m³	656.5a,b	684.8a	655.1a,b	640.7a,b	619.7b
Internal Bond, MPa	0.65a	0.72b	0.73b	0.76b	0.78b
MOR ∥, MPa	48.6a	70.5c	61.3b,c	69.07b,c	57.15a,b
MOE ∥, GPa	7.53a,b	7.75a,c	6.96a,b	8.09c	6.67a
MOR ⊥, MPa	20.2a	21.0a	17.3a	17.39a	17.15a
MOE ⊥, GPa	1.40a	1.96b	1.72a,b	1.58a,b	1.40a
LNR ∥, N	2238.1a	2345.1a	2364.1a	2338.5a	2869.0a
LNR ⊥, N	2658.2a	2460.4a	2868.7a	3058.9a	2849.0a
2h TS, %	10.93a	7.35b	5.29b,c	3.72d	1.85c,d
24h TS, %	21.21a	11.55b	10.92b	5.34c	6.79c
2h WA, %	33.85a	30.26a	23.18a,b	13.52b	23.70a,b
24h WA, %	58.83a	48.09a,b	41.77b	28.47c	38.37b,c

- All boards meet CSA O437.0[5] requirements for IB, flexure and lateral nail withdrawal properties, except for ⊥MOE in pure bamboo boards.
- Pure bamboo boards higher in final board thickness, IB, and lower in mean and core density.
- Bamboo strands do not compress and densify (Fig. 2) during hot pressing due to its hardness and high compressive strength (>20 MPa[6]). Over 50% higher ∥ MOR of hybrid and pure bamboo boards due to high tensile strength of bamboo.
- No increase in ∥ MOE due to low specific stiffness of Moso bamboo.
- Nodes in bamboo surface strands significant reduce board consolidation and flexural properties.
- Core composition (Aspen or bamboo) has little effect on flexural properties.

Results and Discussion

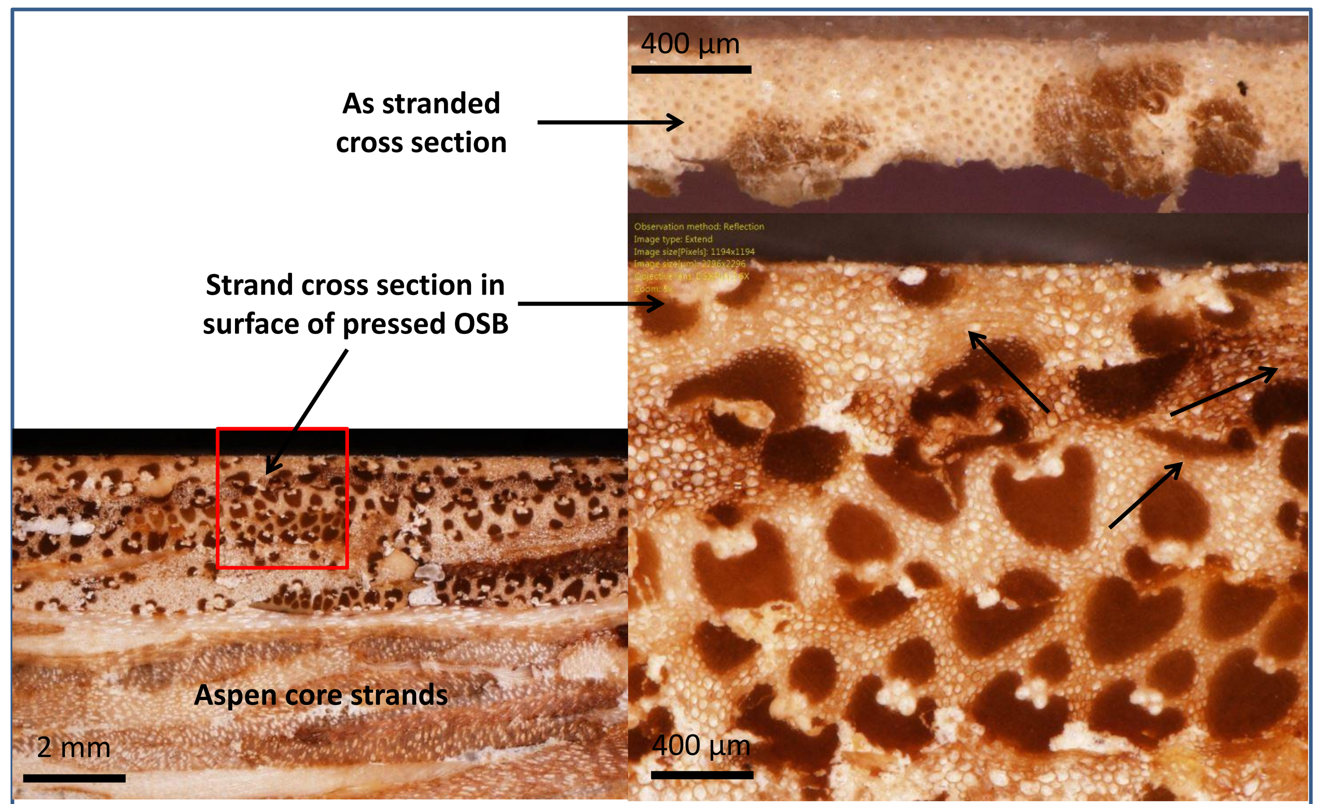

Fig 2. Transverse section of bamboo strands before and after board pressing

- Bamboo surfaces significantly improve the water resistance of OSB; without wax addition water absorption and thickness swelling are reduced to below the 15% TS required by CSA O437.0. Likely due to lack of tissue compaction during hot pressing; the greater the wood densification the greater the swelling [7].
- Properties are similar to Moso bamboo OSB made by previous researchers of similar density and manufactured using similar resin and dosage.

The specific strength and stiffness of building materials (i.e. strength to weight ratio) is a key requirement for products handled manually on building sites. Bamboo OSB are over 40% higher in density than standard plywood, but similar or lower in strength properties. Further work needs to focus on retaining the benefits of bamboo on strength and water resistance properties but reducing product density, as well as addressing the adverse effects of nodes on board consolidation and quality.

Objectives

Manufacture and assess the properties of OSB made under the following conditions:

(a) Face and core strands are pure Aspen mill face and core furnish

(b) Face strands are Moso bamboo and core furnish is Aspen mill strands (core).

(c) Face strands are Moso bamboo and core furnish is Moso bamboo strands and fines

(d) Face strands for (b) and (c) are either 100% node-free (internode) or 100% noded.

Conclusions

1. Replacing Aspen face strands with Moso internode strands increased MOR by >50%; no change in MOE.
2. Results similar to boards made by other workers using conditions (density, resin, dosage, etc)
3. Significant reduction in strength with the use of noded strands due to lower strand quality.
4. No significant difference in LNR between board types; all meet CSAO437.0.
5. Bamboo strands in surface layers significantly reduces TS of boards made without wax to below 15% required by CSAO437.

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