



INTERNATIONAL CENTRE FOR
BAMBOO AND RATTAN

国际竹藤网络中心

Experimental Study on Flexural and Compressive Properties of Bamboo-wood corrugated Sandwich Panel

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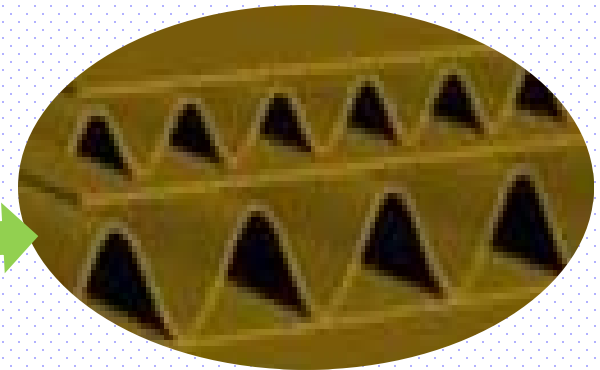
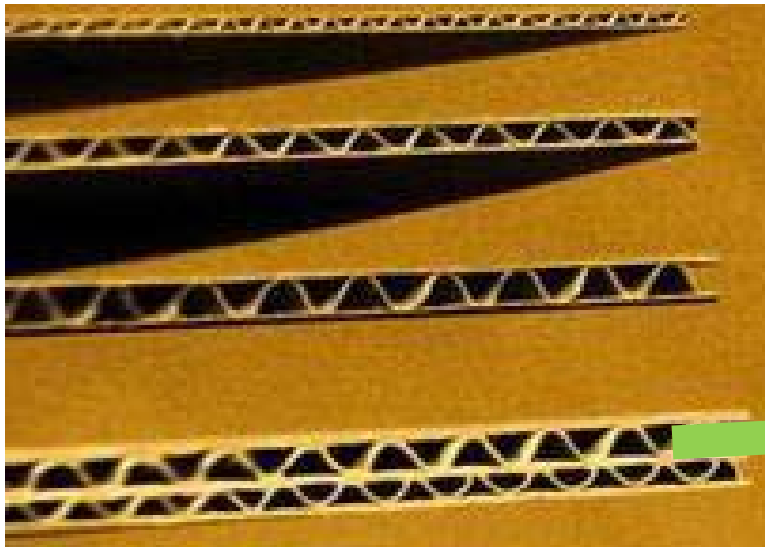
Layout

- **Background**
- **Experimental Program**
- **Experimental Results**
- **Conclusions**

Background

- **Corrugated structure**

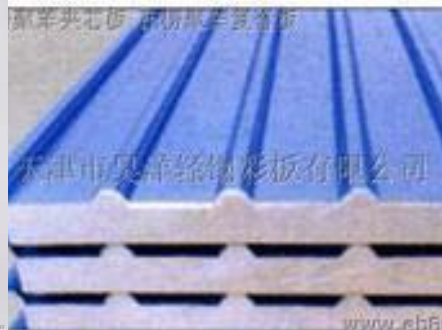
- is the optimal load form.
- used in the cartons widely.



Background

■ Numbers of studies carried out

- A better shear strength
 - three to seven times of honeycomb structure, in Y and Z direction
- The current commercial products is mainly for Packaging
 - carton
 - enclosure material of refrigerator wagon
 - Mobile house, etc.



Background

- **applications are limited**

- No corrugated furniture product in china
- only honeycomb papery furniture

- **no uniform test available for the physical and mechanical properties**



Experimental Program

- **Manufacture of Bamboo-wood corrugated Sandwich Panel(BCSP)**

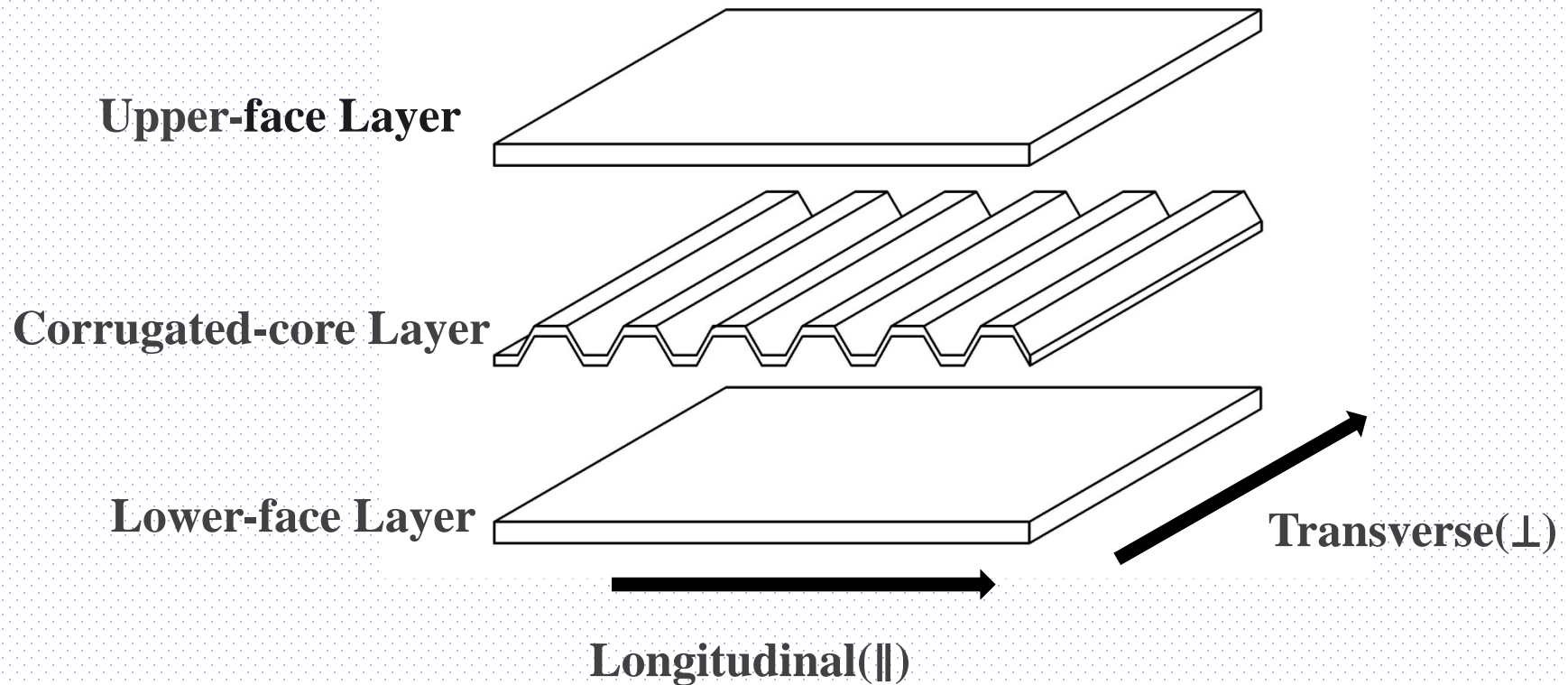


Fig .1. Diagram of BCSP

Experimental Program

■ Manufacture of sandwich panels

face layer material	core layer material
PW	bamboo particle
MDF	wood flake
BPSL	wood fiber

Note: ①-5mmPlywood (PW); ②-5mm medium-density fiberboard (MDF); ③-5mm bamboo parallel strand lumber (BPSL); I -8mm corrugated core of wood fiber; II -8mm corrugated core of wood flake; III-8mm corrugated core of bamboo particle.

I



II



III



Experimental Program

For serial number from 1 to 3, the face material was ① with other parameters constant.

For serial number from 4 to 6, the face material was ② with other parameters constant.

For serial number from 7 to 9, the face material was ③ with other parameters constant.

Table 1. Specimen Information

No.	Face	Core
1	①	I
2	①	II
3	①	III
4	②	I
5	②	II
6	②	III
7	③	I
8	③	II
9	③	III

Experimental Program

1

- The face and core layer material of BCSP were choose.

2

- Pressing factors of core layer manufacture were studied.

3

- BCSP tested in three-point bending and compressive strength.

Tab.3. The orthogonal experiment

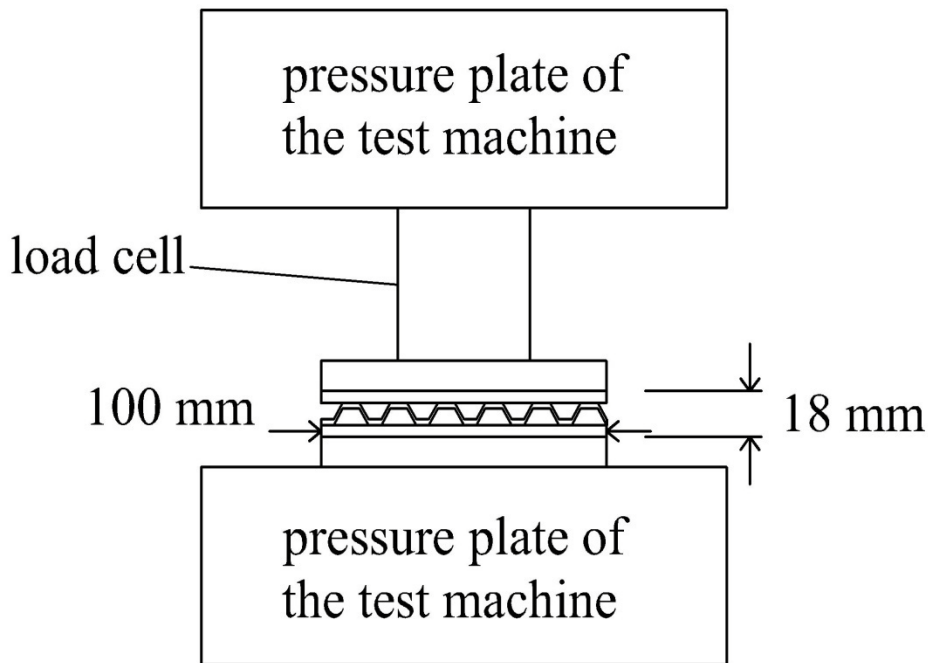
level	factor		
	Temperature (T)/°C	Pressure (P) /Mpa	Time (t)/min
1	150	2.5	5
2	160	3.0	7
3	170	3.5	9

Table 4. Specimen Information

No.	T(°C)	P (MPa)	T (MPa)
1	155	2.5	5
2	155	3.0	7
3	155	3.5	9
4	160	3.0	5
5	160	3.5	7
6	160	2.5	9
7	165	3.5	5
8	165	2.5	7
9	165	3.0	9

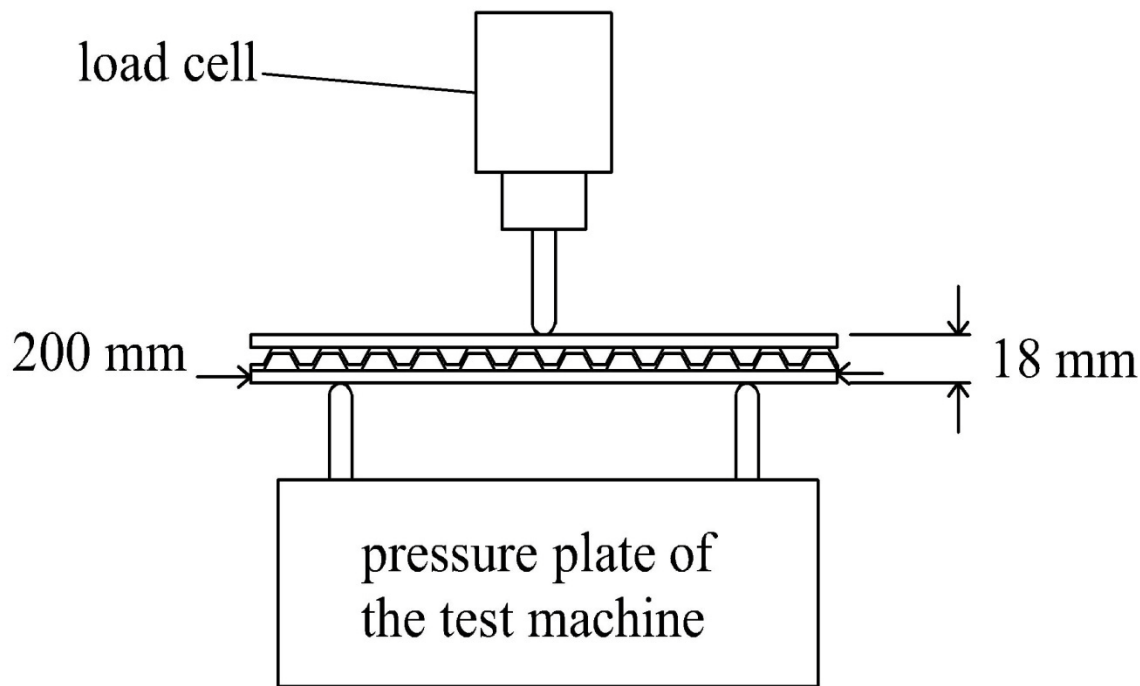
Experimental Program

Test series	Specimen shape	Specimen size/mm
flexural	rectangle	50(width) × 200 (length) × 18(height)
compressive	rectangle	100 (width) × 100 (length) × 18(height)



Experimental Program

Test series	Specimen shape	Specimen size/mm
flexural	rectangle	50(width) × 200 (length) × 18(height)
compressive	rectangle	100 (width) × 100 (length) × 18(height)



Results

Comparison of Flexural and Compressive strength

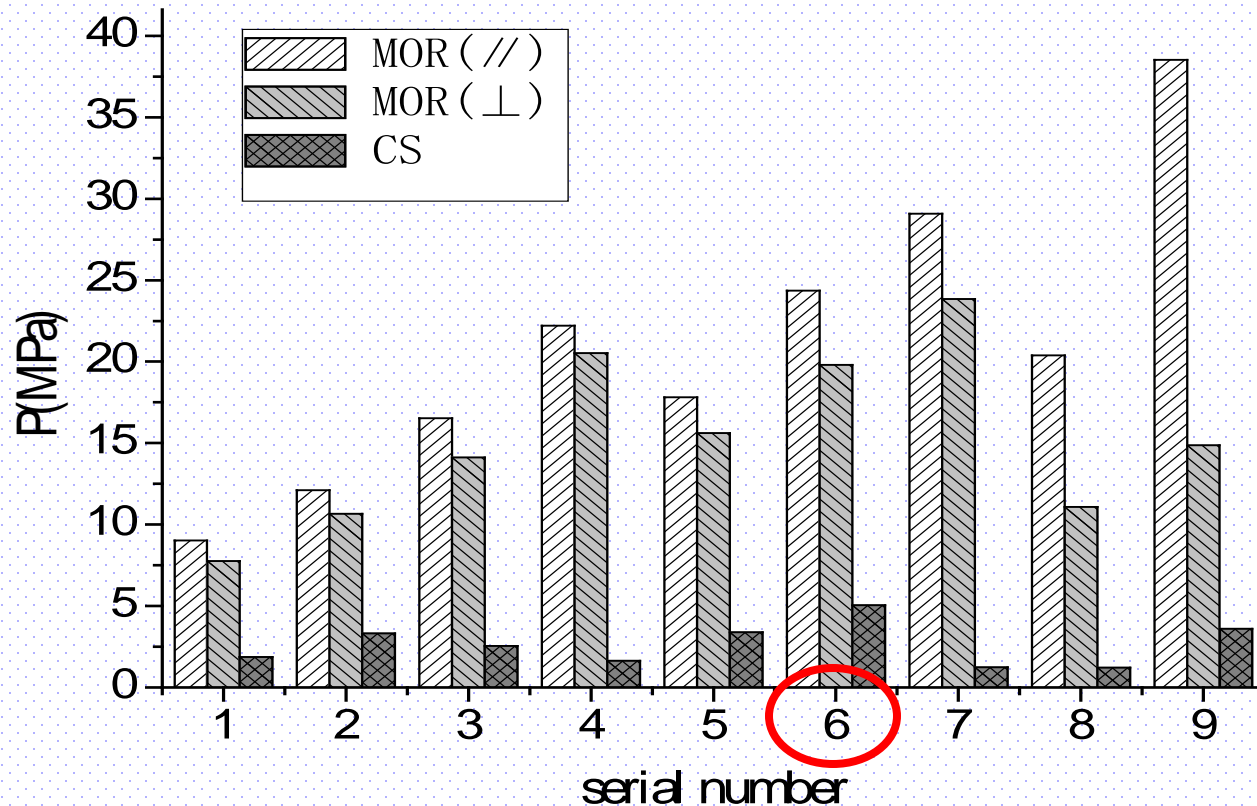
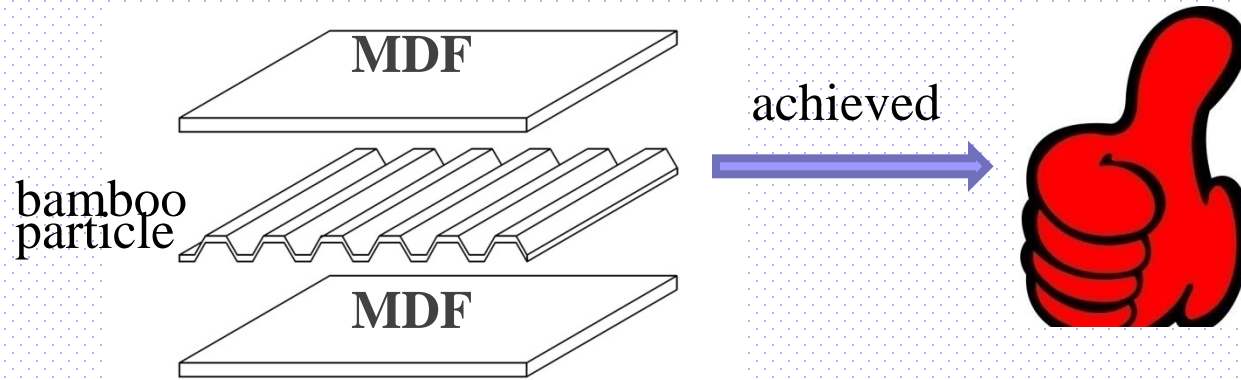


Fig. 2. Comparison of strength between various face and core structure

Results



- panel made from MDF face-layers and the bamboo particle core-layer was chosen in orthogonal experiment.
- the pressure, temperature and time of the manufactured core layer were studied.

Results

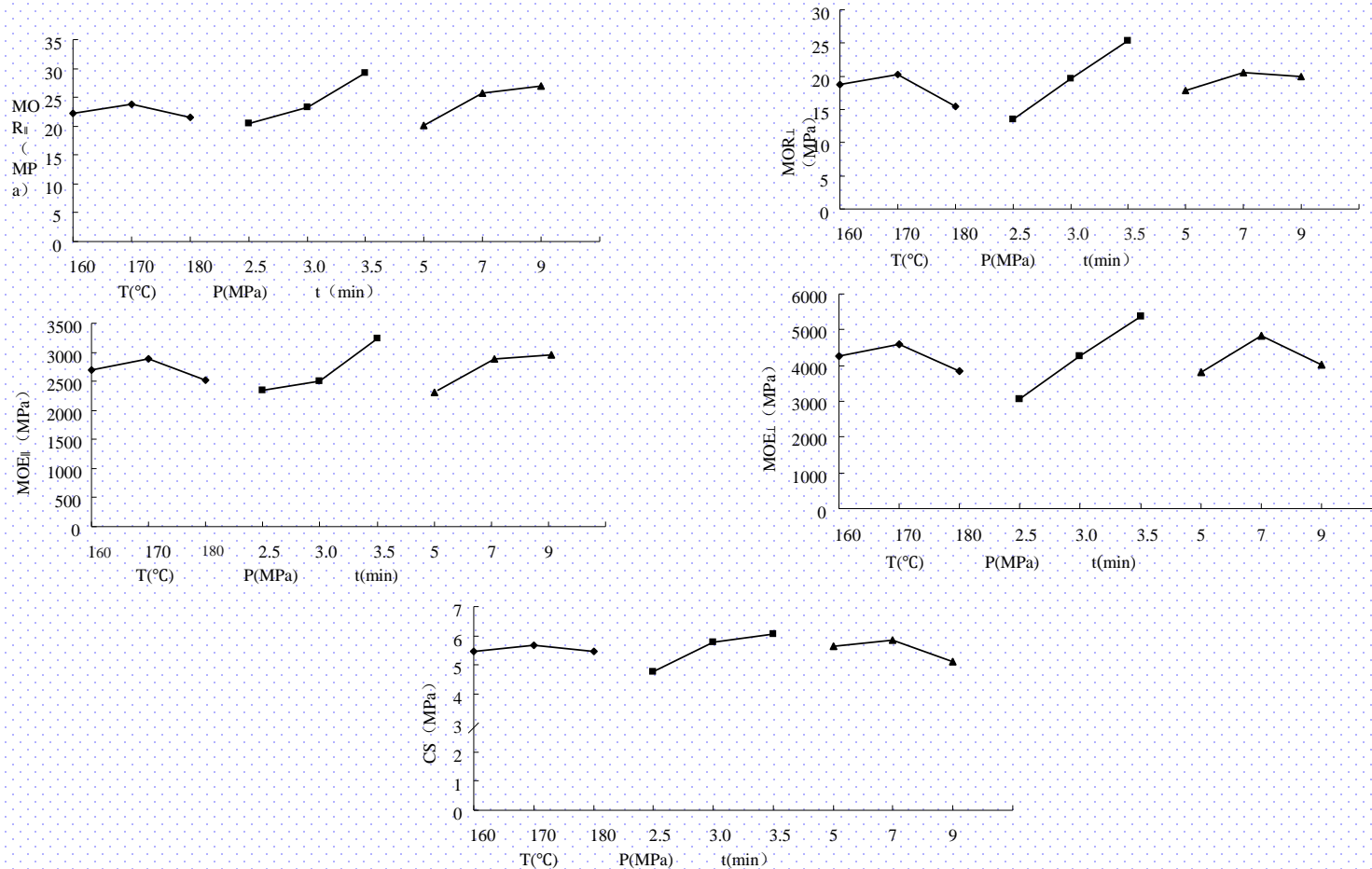


Figure .3. Technology factors affecting the mechanical properties of BCSP

Results

■mechanical property affected by the temperature of the manufactured core layer

Results



The bending and CS values of BCSP increased and then decreased with the temperature increase (from 150°C to 170°C).

Temperature from 150 °C to 160 °C

Analysis



adhesive viscosity decreased, and bamboo material heated, liquidity enhanced, more contact between the material and adhesive.

Temperature from 160 °C to 170 °C

material degradation under high temperature, and even coking phenomenon lead to the brittle surface increase. As a result, less value was being obtained.

Conclusion



Better performance of panel was obtained in 160 °C.

Results

■mechanical property affected by the pressure of the manufactured core layer

Results

↔ The bending and CS values of BCSP increased with the pressure increase(from 2.5MPa to 3.5MPa).

Pressure below 3.0MPa

Analysis

↔ the more closely contact between internal material and adhesive had an advantageous to the bonding strength.

Pressure over 3.0MPa

3.0 MPa pressure may be can satisfy the needs of gluing between the strands, the curing degree becomes a major factor influence mechanical properties.

Conclusion

↔ Better performance of panel was obtained in 3.0 Mpa.

Results

■mechanical property affected by the time of the manufactured core layer

Results

↔ The bending and CS strength of BCSP improves with increasing time (5min to 7min), and MOR_{\perp} , MOE_{\perp} and CS decrease in the range of 7min to 9min.

time from 5min to 7min

Analysis

↔ the extension of time, can promote curing of the glue to achieve a better mechanical properties within a certain range.

time from 7min to 9min

degradation of bond line was occurred.

Conclusion

↔ Better performance of panel was obtained in 7min.

Results

Table 5 Comparison of mechanical properties and cost of BCSPs with wood honeycomb panel

Properties	Bamboo-wood corrugated Sandwich Panel	Wood honeycomb panel
Flexural strength(MPa)	25.6-30.7	14.2-21.5
Compressive strength(MPa)	5.0-6.8	0.5-2.3
Density(kg/m ³)	490-560	149-406
Cost of product(USD/fc)	5.23-6.79	7.04-13.3

•Note: Properties of wood cellular panel are from available literature (Cheng, 1988; Si, 2012).

Conclusion

- (1) The manufacture of BCSP from corrugated strands of moso bamboo (*Pylostachys pubescens* Mazel) appears to be technically feasible.
- (2) The Optimum technologic parameters of core layer manufacture are following: 160°C of press temperature, 3.0MPa press pressure, and 7min press time.
- (3) BCSP showed superior strength properties, and suitable to used as commercial nonstructural products.

Thanks for your attention !

