New Engineered Materials from Bamboo Resources

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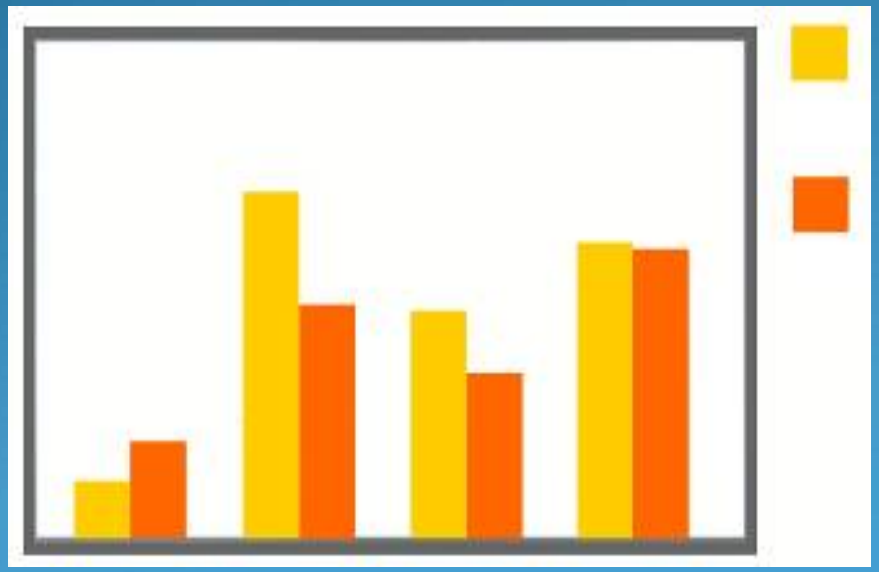
Introduction

- ✓Material is the base of human physical civilization.
- ✓New materials are backbones of the economic development in the 21st century.
- ✓Wood is one of the four most important materials -- steel, concrete, plastic and timber.

- Deforestation due to unsustainable logging of timber is a serious environmental threat facing the world today.
- Population growth and increasing demand for timber to fulfill construction requirements are the main causes of the problem.
- To meet the demands of growing population for timber for housing and to mitigate the current social and environmental problems, an alternative sustainable solution is urgently needed.
- Bamboo is one of the good solutions.

Bamboo- an environmental friendly material

- fast growing with short production cycle
- multiplication easy and growing on poor soil
- energy efficient material, its processing needs 2/3 energy of that for wood, 1/9 for steel, 1/4 for aluminum and 1 /22 for concrete.
- good strength, flexibility and versatility



Strength and stiffness comparison

- Bamboo has long been used as an important material for various applications in many parts of the world.
- Bamboo houses are low cost, quick to construct, durable, and environmental friendly.
- It is estimated that more than one billion people in the world live in bamboo houses.

Bamboo in China

- Chinese people love bamboo and China is the country with the longest history in research, cultivation and utilization of bamboo
- with 500 bamboo species, ranking the top place in the world in terms of number of species, planted areas , standing volume, production and export value of bamboo, China is the home of bamboo in the world

Chinese Bamboo Culture

bamboo has been used for about years	
construction	*7000*
weaving products such as baskets	*5000*
Furniture: bed, table, chair	*3000*
bamboo shoots for food	*2500*
Transportation: bridge, rafter, boat	*2000*
Paper making	*1800*

Bamboo Housing

Nowadays, some minorities in the Southwest China, like the Dai people in Yunnan, still live in bamboo houses.

The famous Scholar Su Dongpo(1037-1101) once said :

“we eat bamboo shoots, live in bamboo house, transport goods with bamboo rafters, use bamboo as fuel for cooking, wear bamboo cloth and bamboo shoes, we cannot survive without bamboo even for a single day!

Solid bamboo has difficulties in industrial applications as

- its tapered culms with nodes
- it doesn't have standard sizes
- its properties vary among species, between culms of same species, and between pieces of the same culm
- low nature durability, preservative treatment more difficult than wood

New Bamboo Based Engineered Materials
Engineered Material –Panel products

Made through a series mechanical/ chemical processing, bamboo based panels featured in large standard sizes with good strength and flexibility, can be widely used for decorative, structural and environmental protection applications

Advantages of Bamboo Engineered Materials

- standard sizes
- good / stable properties
- Engineered products with anti-insects/decay properties, can meet requirements on strength /stiffness by adjusting structure/sizes
- From renewable resources

Recent Development of New Bamboo Engineered Materials

A lot of efforts have been made in recent years to develop New Bamboo Engineered Materials

National key S & T Project (2001-2005)

"Research, Development & Demonstration on Technologies For making New Bamboo Engineering Materials"

Project leader
Prof. Jiang Zehui

Implementing agencies

- *ICBR*
- *CAF*
- *Nanjing Forestry University*

Output of the project

New engineered bamboo materials developed in three categories

- structural materials
- decorative materials
- charcoal materials

- 6 approved Chinese patents
- 3 national and industrial standards prepared
- Pilot production lines established at Zhejiang Fustar Company, Guo Lin Bamboo and Rattan S & T Co., Ltd.
- The achievements of the project won the First Grade Prize of 2006 National Science & Technology Progress Awards

1. New Bamboo Structural Materials

1) **Bamboo panels for structural purposes**

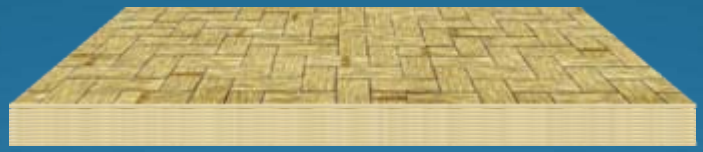
Bamboo laminated lumber, bamboo plywood and particleboard were developed from ***Phyllostachys pubescens*** **(or Mao Jue) and** *D. Yunnanicus*

- The mechanical properties of structural grade bamboo laminated lumber were higher than that of JIS Standard " Laminated veneer lumber for structural uses" .
- The performance properties of bamboo plywood and particleboard for wall and roof panels were higher than that of US/ European OSB standards.

2) Large span bamboo roof trusses developed at Pingbian Primary School Building

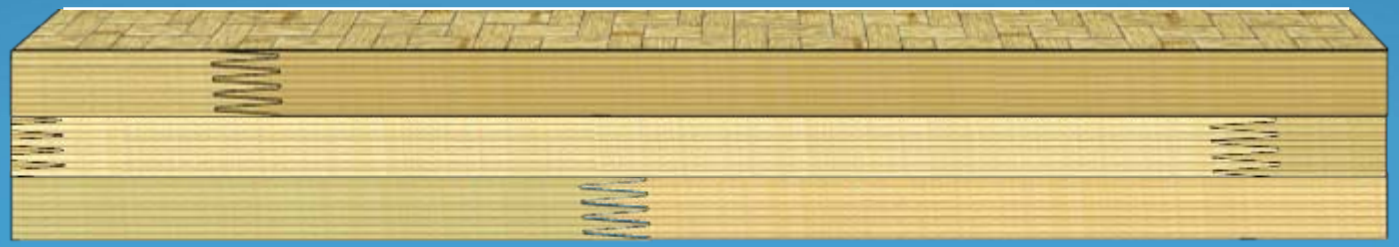
Bamboo plywood panels & bamboo laminated beams were used for roof trusses, sheathing boards and wall panels at the ***Primary School Building at Pingbian, Yunan*** **constructed** in 2004

Process for making bamboo laminated beams



Bamboo panel making

Bamboo panel Sawing



Finger Jointing and laminating

3) Bamboo-wood composite for container flooring

- **Composition, structure and properties of bamboo-wood composite were studied.**

- **The performance of the bamboo- wood composite met the requirements of relevant Chinese National Standard for container flooring.**

4) Bamboo- wood composite

- Composition, structure and properties of bamboo- wood composite from Mao bamboo and poplar wood for structural and decoration applications were studied to optimize use of the raw materials and the performance of the composite.

- High frequency pressing technology was applied and the hot pressing efficiency was significantly improved.

5) Bamboo- wood comply

After dipping in aqueous low molecular PF solution and double vacuum drying in low temperature, bamboo curtains were laminated in the same direction surfaced with poplar wood veneer and hot pressed into bamboo- wood comply, which is good for structural applications.

6) Environmental friendly preservatives for bamboo

- New environmental friendly preservatives ACQ and CuAz for bamboo were developed
- The CuAz preservative met AWPA standard and officially approved as a new preservative product in China.

7) Bamboo panels for prefabricated model housing

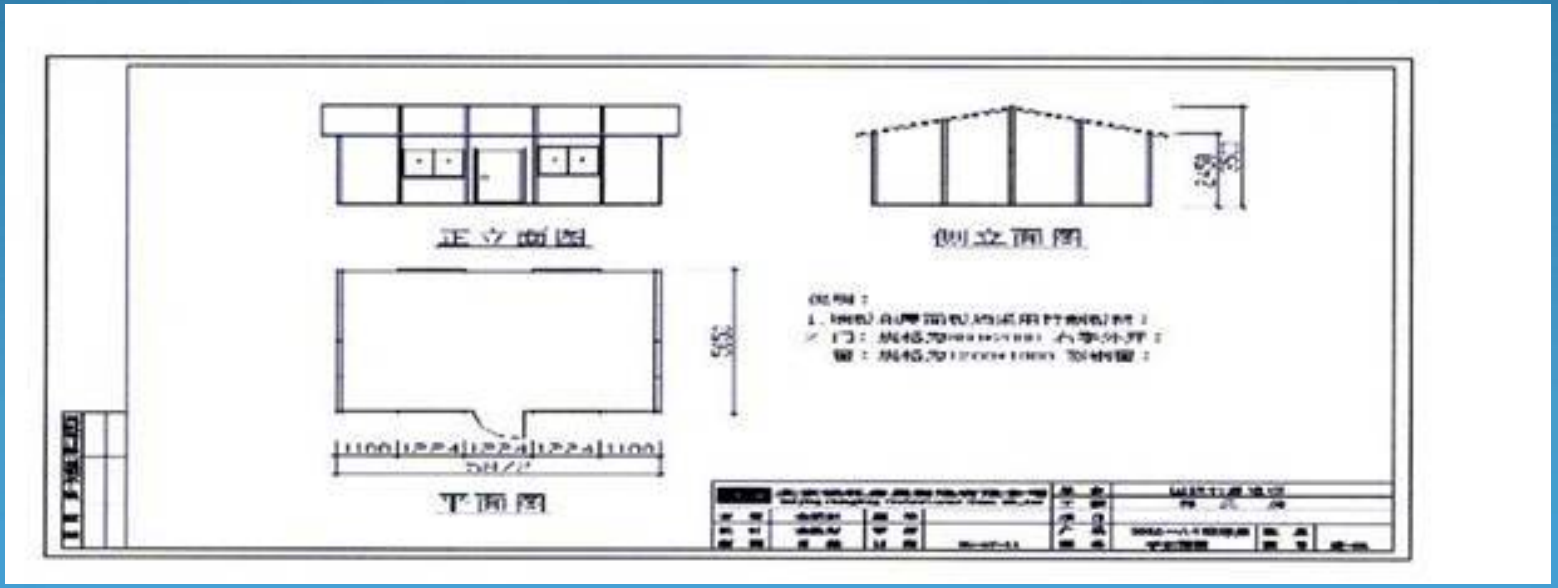
In cooperation with INBAR, CAF, Fustar and Beijing Chengdong Co, technology for making prefabricated bamboo panel housing was developed and explored the potential of using bamboo panels as a valuable construction material for both developing and developed construction markets and a bamboo panels module house was demonstrated primarily for emergency relief.

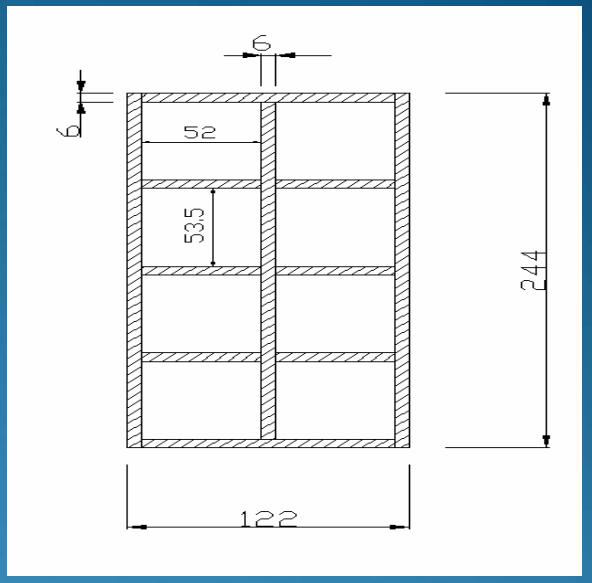
•main structure -light steel frame

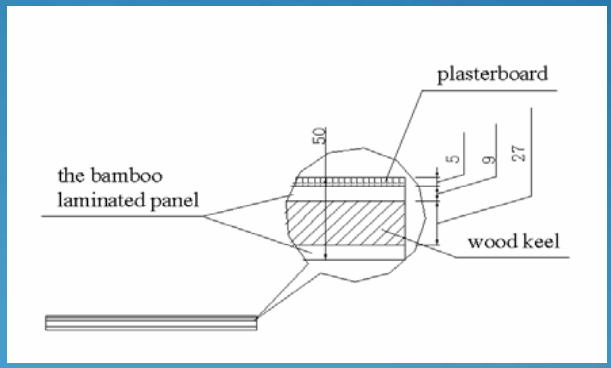
• roofing and wall panels -bamboo panels.

•All the components are standardized & prefabricated at factory

• houses featured in fast erection, easy for storage and transportation, able to be supplied in large quantity in a short time.







Prototype Bamboo panel prefabricated house

- According to relevant Chinese National standards, sound insulation, thermal transmission and fire-resistance properties of the panel components were tested at the National Center for Quality Supervision and Test of Building Engineering.

- The testing results showed that the sound insulation of the bamboo panel component reached Class III, and the thermal insulation reached Class IV, and both met the requirements of performance for building wall materials. The fire resistance performance of the bamboo panel component was higher than Class IV for non loading wall, partitions for escape passage and rooms.

- Bamboo panel wall & roof components can be used for pack-flat prefabricated module houses for the emergency /disaster relief and temporary use .They can be feasible in technical/economical/environmental aspects.
- Fast erection, easy for assembly/storage /transportation
- It is estimated that in future production, the unite price of bamboo panel components could be reduce to about 70 yuan/m^2

- INBAR, ICBR, CAF, Fustar and Beijing Chengdong are implementing a Blue Moon Fund project “Development and Promotion of Pre-fabricated Bamboo Module Housing to Provide both Income and Housing to Poor People”
- The project will develop various prototype modular bamboo house designs in accordance with standards, costs, and uses in a range of climatic regions and will aim at different groups, i.e. primarily designs for disaster victims (emergency shelters), poor rural families and slum dwellers, but also for schools, small offices and houses for richer families.
- In China 5 units with different designs will be produced and tested this year.

2. New bamboo decoration materials

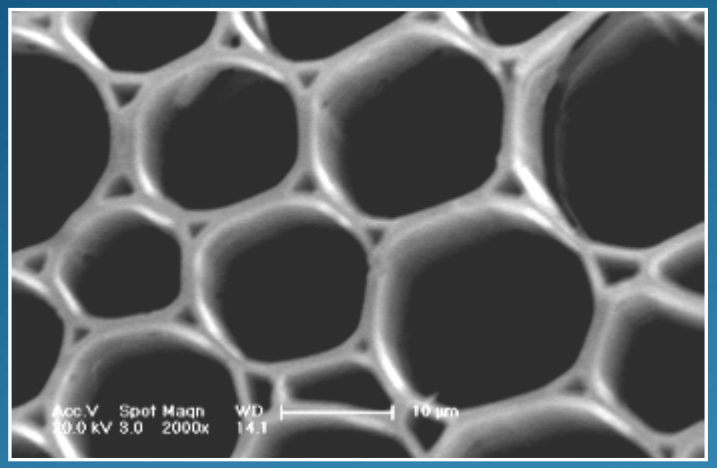
1) Large format rollable nonwoven cloth backed bamboo decorative veneer (thickness 0.3-0.8mm) developed, improved bamboo utilization efficiency

Bamboo veneer peeling

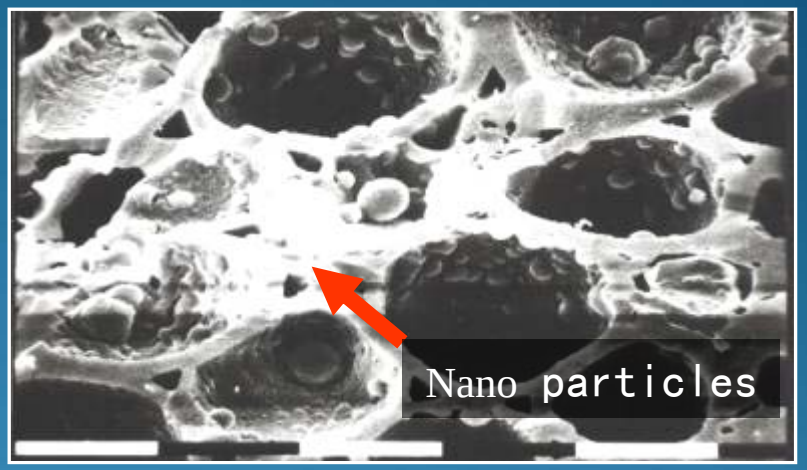
2) Formaldehyde-free laminated bamboo

It is the first time to use isocyanate resin for the production of formaldehyde-free high-intensity laminated bamboo in China. Adopted the "spray sizing" patented technology, the amount for sizing is only 1/5 ~ 1/7 of the traditional adhesive, and the cost is similar to UF. The water resistance performance was greatly improved, the products can be used for furniture and decoration applications.

3. New bamboo charcoal materials



Normal bamboo



bamboo charcoal modified with nano-TiO2

• the average diameter of the pores of bamboo charcoal is 200nm, much larger than that of both bamboo and wood active carbon, which are less than 20Å (2nm)

• bamboo charcoal modified with nano-TiO2 has very good adsorption and photo catalysis effects , is an excellent new sorbent and bactericide. The average bacteriostatic ratio is about 98％， elimination ratio of toxic gas reaches 85%

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Conclusion

✓Bamboo is a fast growing, easy sustainably managed renewable resource.

✓Bamboo based engineered materials can be a good substitute for wood in many applications.

Conclusion

It is of great significance for developing bamboo- based engineered materials so as to promote bio-economy, efficient use of biological resources and the harmony between man and the nature.

Make a better world with bamboo !