Utilization of Agricultural Waste for Composite Panels

Chung Y. Hse
Principal Wood Scientist
USDA Forest Service

Todd F. Shupe
Associate Professor
Louisiana State University

6th Pacific Rim Bio-Based Composites Symposium
Portland, OR
November 10-13, 2002

Background

World demand for wood fiber is expected to increase as the global population continues to increase. There is potential for agricultural residue fiber to assist in satisfying the need for wood fiber. The benefits of utilizing agricultural residues for wood composite panels include developing a value-added product from a fiber source that is currently not well utilized as well as decreasing the demand for wood fiber.

Situation in Louisiana

- Sugar cane is the second most valuable agricultural plant commodity behind forestry (LSU AgCenter 2000).
- Began at the production of ridged insulation board in Louisiana in the early 1920s.
- Acadia Board Co. (New Iberia, LA) now is producing bagasse/ISO panels

Bagasse Panels

- ***Current*** - smooth-two sided fiberboard, particleboard, medium density fiberboard, and dry process hardboard.
- ***Future*** - a wide variety of these products can be manufactured to a high-quality level when utilizing bagasse as the fibrous raw material.
- ***Future*** - looks very bright for rapid growth in the use of bagasse as a raw material for composites, especially in developing countries, where the supply of wood is limited, and sugar cane is a productive crop.

Bagasse Panel Drawbacks

- Currently, mainly non-structural, interior grade with limited moisture resistance.
- Bagasse panel research should focus on the development of a structural exterior-grade board in order for bagasse to play a larger role in housing and infrastructure in developing countries.

Rice Panel Drawbacks

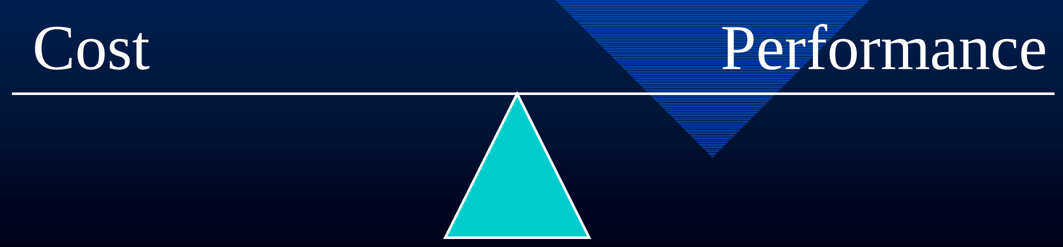
- Particleboards from rice husks have not found commercial acceptance because of substantially higher quantities of adhesive required to yield board with acceptable properties.

Rice Panel Potential

- Since rice husks are quite fibrous by nature and require little energy input to prepare, it has been used for the manufacture of particleboard.

Main Objective

- Determine the mechanical and physical properties of panel products manufactured with either bagasse or rice husks as the furnish and with a resin system consisting of either urea formaldehyde (UF) or UF in conjunction with polyisocynate (ISO).



Specific Objectives

- The objective of the bagasse study was to determine an optimal resin application method based on thickness swell (TS) and IB.
- The objective of the rice husk study was to apply the optimal resin application method to a new furnish type and explore other mechanical properties to better assess the potential of the resin method.

Materials and Methods - Bagasse

- The bagasse was obtained from a local processing plant near Baton Rouge, LA. The furnish for the bagasse panels consisted of fibers primarily from the rind area. The pith was manually removed from the ground fiber. No attempt was made to remove the epidermis or to optimize the geometric size to maximize panel properties. The particles were conditioned to a moisture content of 3-4 percent prior to panel assembly.

Materials and Methods - Bagasse

- Five resin levels (4, 5, 6, 8, and 9 percent), two resin types (UF and ISO), and three different application methods were used for the bagasse panels. Not all resin levels were used with all of the application methods. The three application methods were as follows: (1) spraying ISO first, (2) spraying UF first, and (3) spraying each resin at the same time.

Materials and Methods - Rice

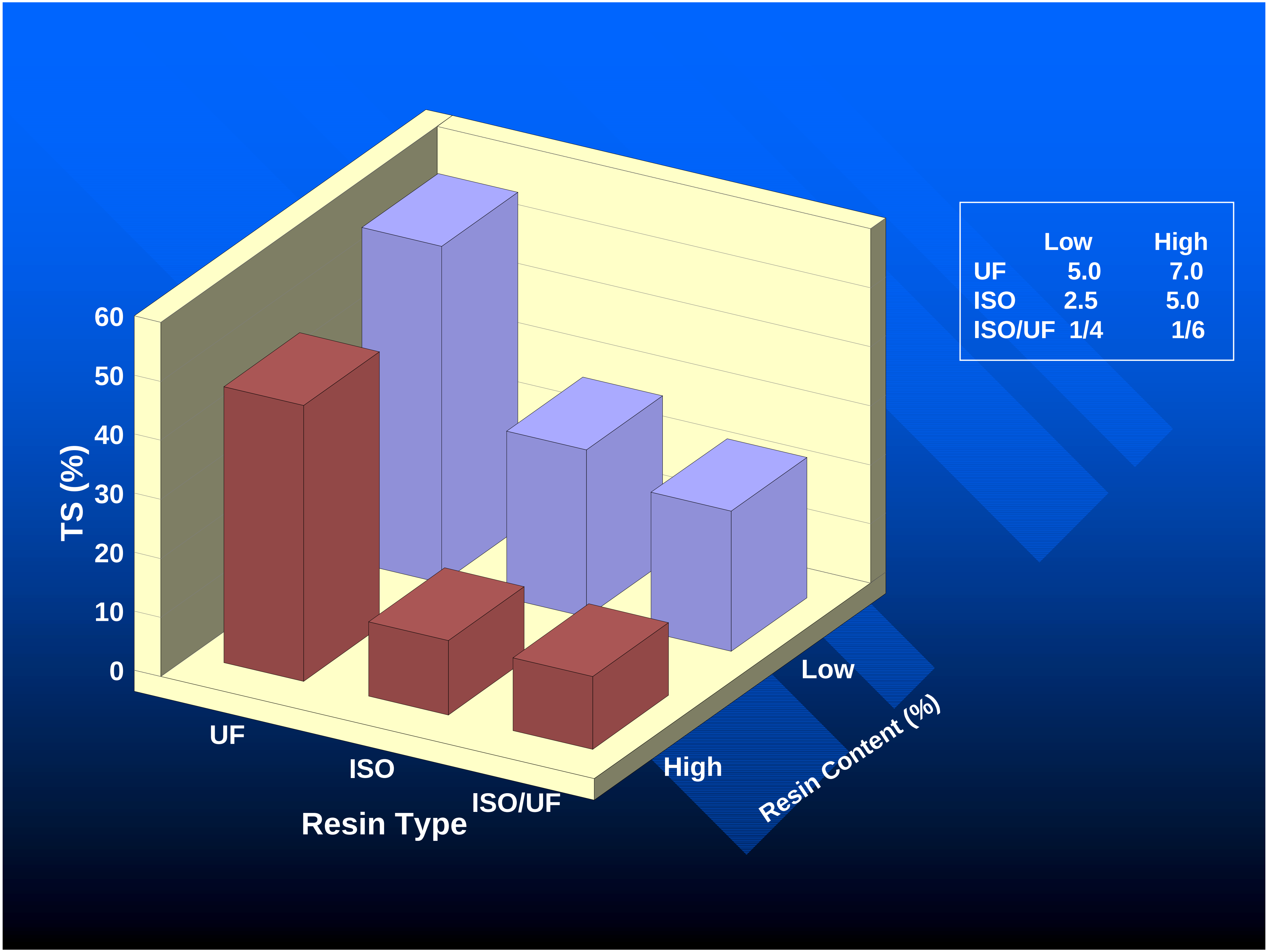
- All boards were prepared in the laboratory with equal weight (50:50) mixture of rice husks and wood particles. The rice husks were obtained from a local rice mill. They were passed through a lawn shredder to break the “boat-shaped” husk particles, sieved to remove the fines, and then conditioned to an average moisture content of 4 percent. The dry southern pine (*Pinus* sp.) wood particles were obtained from a local particleboard plant and used without any further treatment.

Materials and Methods - Rice

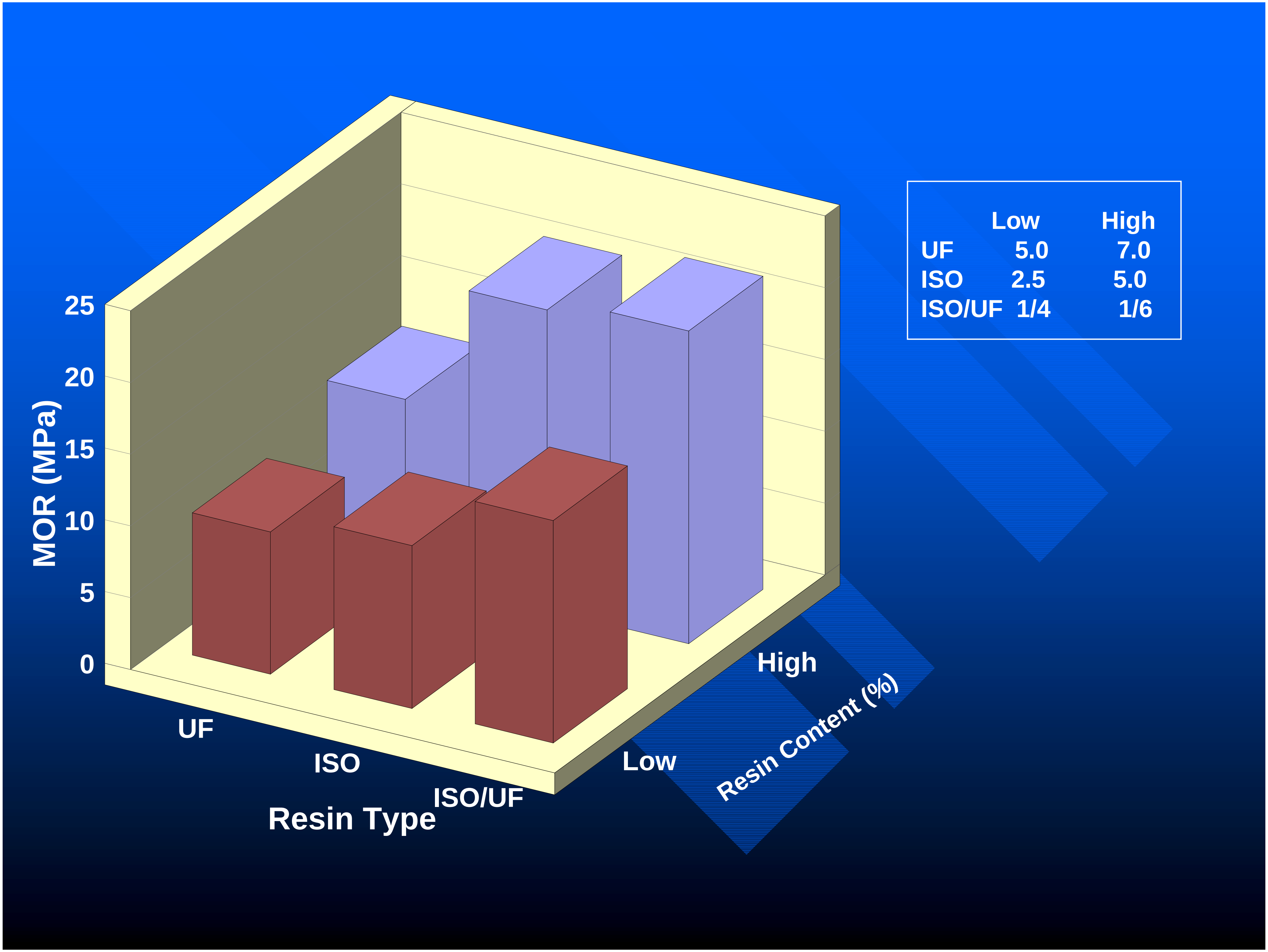
- Panels were made with one of three different resin combination methods. The resin was either UF, ISO, or a ISO/UF mixture. The ISO/UF mixture panels, as well as the UF panels, were sprayed at a resin content of 5% and also at 7%. The panels sprayed with ISO as the only resin received either 2.5% or 5 % resin content.

Board Manufacture

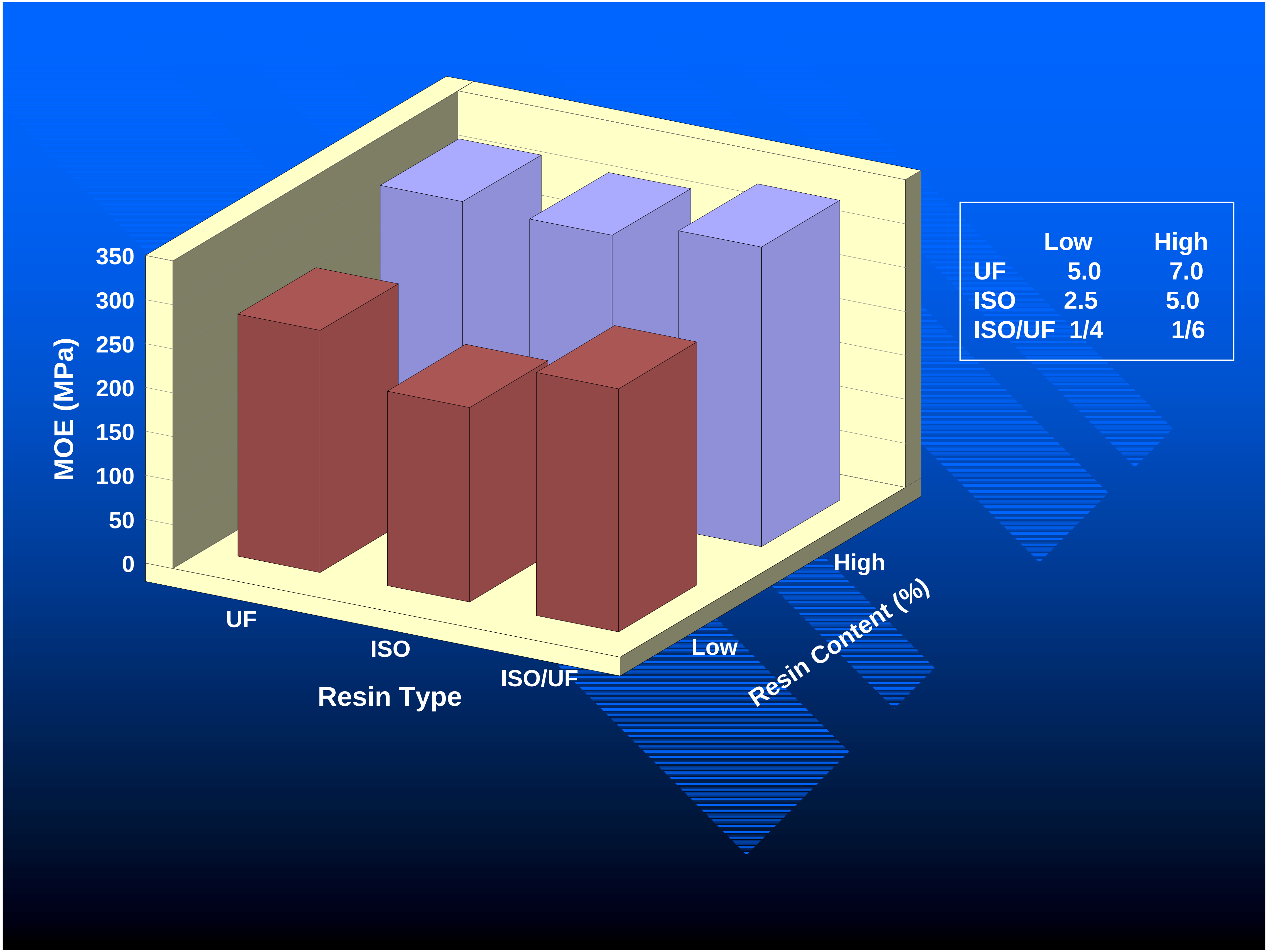
- After blending, each furnish was carefully felted into a 35.56 x 35.56 cm box. Neither furnish type was oriented during the forming process. The mat was transferred to a 50.8 x 50.8-cm single opening hot press with the platen temperature at 170º C. Sufficient pressure (approximately 3,792 KPa) was applied so that the platens closed to 1.27 cm thickness stop in approximately 45 seconds. Press time was 4 minutes after closure.



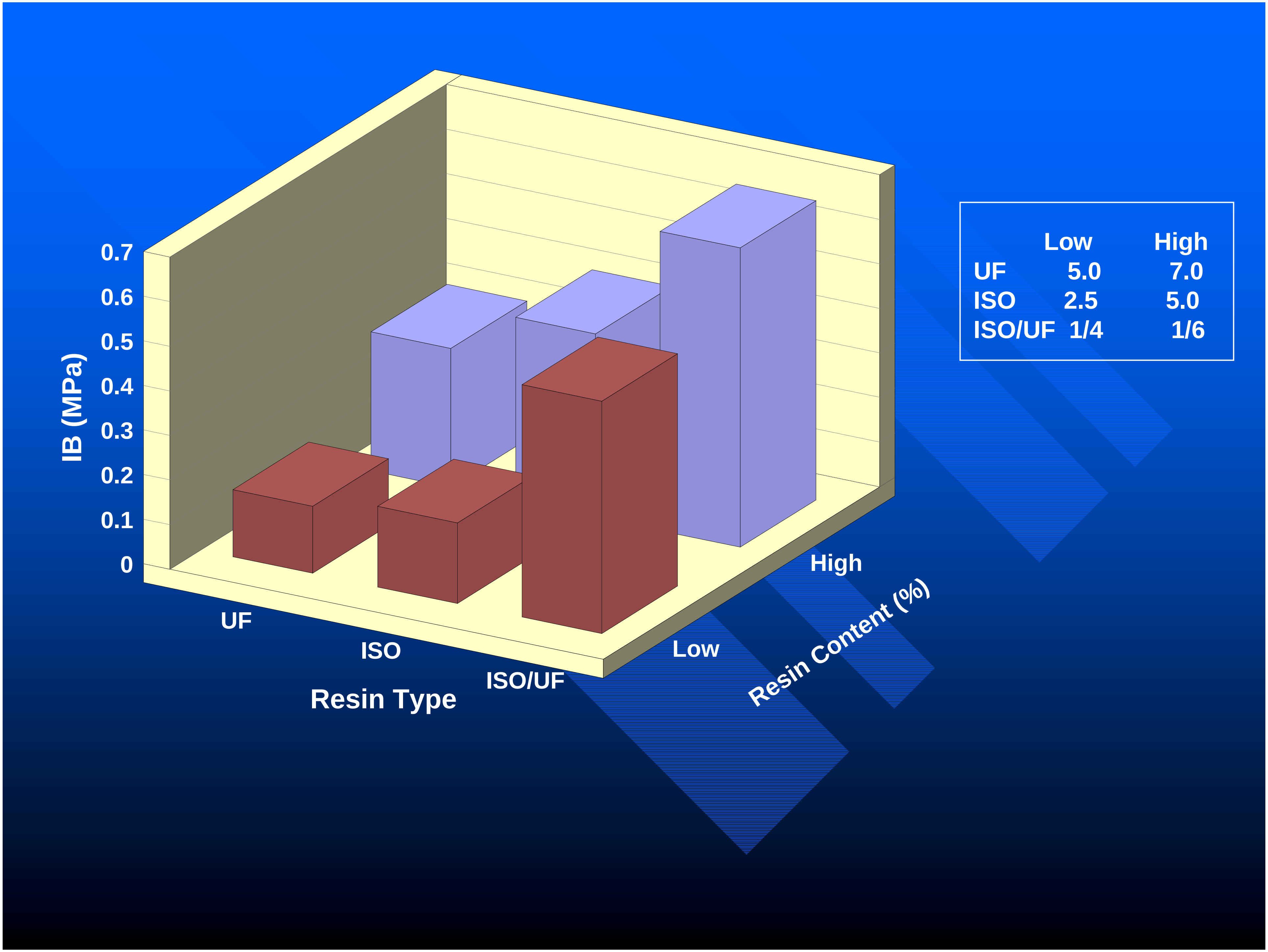
60
50
40
30
20
10
0
TS (%)
UF
ISO
ISO/UF
Resin Type
High
Low
Resin Content (%)
Low High
UF 5.0 7.0
ISO 2.5 5.0
ISO/UF 1/4 1/6



MOR (MPa)
0
5
10
15
20
25
UF
ISO
ISO/UF
Resin Type
Low
High
Resin Content (%)
Low High
UF 5.0 7.0
ISO 2.5 5.0
ISO/UF 1/4 1/6



MOE (MPa)
350
300
250
200
150
100
50
0
UF
ISO
ISO/UF
Resin Type
Low
High
Resin Content (%)
Low High
UF 5.0 7.0
ISO 2.5 5.0
ISO/UF 1/4 1/6



IB (MPa)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
UF
ISO
ISO/UF
Resin Type
Low
High
Resin Content (%)
Low High
UF 5.0 7.0
ISO 2.5 5.0
ISO/UF 1/4 1/6

Group	Resin Content			Density	IB
	ISO		UF	[kg/m^3]	[KPa]
A	1	→	4	806	601
B	1	←	4	799	538
C	1	→	7	801	741
D	2	←	7	812	664
E	2	→	4	796	738
F	2	←	4	787	598
G	2	→	7	834	947
H	2	←	7	810	738
I	4			788	919

Group	Resin Content		Density	TS	TS
	ISO	UF	$[kg/m^3]$	[%]	[%]
A	1 →	4	806	49	18
B	1 ←	4	799	55	20
C	1 →	7	801	49	15
D	2 ←	7	812	64	16
E	2 →	4	796	40	17
F	2 ←	4	787	42	24
G	2 →	7	834	41	15
H	2 ←	7	810	45	15
I	4		788	31	16

Conclusions

- Resin content and resin type had substantial effects on panel performance.
- Resin application method was found to be important in determining panel properties.
- Panel properties are excellent when ISO is sprayed first and followed by UF.

Conclusions

- Panels sprayed with 1% ISO followed by 6% UF showed very promising results for MOR, MOE, IB, and TS.
- There are substantial economic implications from the technical findings of this study. Since the cost of UF (U.S.$ 0.37/kg) is substantially lower than that of ISO (U.S.$ 1.89/kg), economic gains of ISO/UF resin could be great by using UF as the major component in a hybrid resins system.

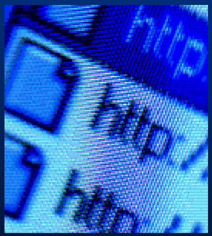
Conclusions

- The superiority of the resin systems contain ISO is apparent for all resin levels and most mechanical and physical properties.
- Conventional UF resins did not perform well with rice husk composites and further indicates the benefits of the ISO/UF system.
- It is anticipated that satisfactory IB strength can be economically achieved by improving the ISO efficiency and increasing the UF content

Contact Us

Utilization of Southern Resources,
U.S. Forest Service,
2500 Shreveport Highway,
Pineville, LA 71360-2009

phone: (318) 473-7271
fax: (318) 473-7246



http: www.srs.fs.fed.us/4701
e-mail: chse@fs.fed.us

Questions?