Mechanical Holding Power of Melt-Blend Boards Made From Recycled Plastic and Kenaf

Poo Chow, Tait Bowers, Dilpreet S. Bajwa
Department of Natural Resources and Environmental Sciences
University of Illinois, Urbana, Illinois
John A. Youngquist, Jim H. Muehl, Andrezej M. Krzysik
U.S.D.A. Forest Products Laboratory
Madison Wisconsin
Charles G. Cook
Mid Valley Chemicals, Inc.
Santa Rosa, Texas

ABSTRACT

This paper presents the progress of an on-going research project to demonstrate the viability of using agricultural fibers and recycled plastics in producing thermoplastic composites. Kenaf *(Hibiscus cannabinus* L.) has been identified as a viable non-wood fiber source for industrial fiber use. The kenaf stalks were collected from the experimental plots at the University of Illinois. The material was milled and screened to –35 mesh, which is equivalent to common grades of commercial wood flour fillers. Then polypropylene plastic was used. The materials were compounded using a standard 32 mm twin screw extruder. The compounded materials were then pelletized and dried at 105° C for 24 hours before panel making. Melt-blended kenaf-plastic composite panels were made using compounded pellets. These composite panels can be used to develop products for the building component industries. At present there is no performance data on strength properties of this composite available. Information on the performance of mechanical fasteners is needed for comparative purposes. Two different fastener resistance tests were conducted on the kenaf-plastic composite panel specimens. These tests are meant to simulate the conditions encountered when wind or earthquake forces pull sheathing or siding from a wall. These test results show that some kenaf-plastic composite panels are suitable for consumer and building panel uses.

INTRODUCTION

Composite boards using other fibers other than wood fiber are in an increasing demand in today's industrial marketplace. Utilizing other plant fibers such as kenaf is in the developmental stages. It is common that different percentages of fiber are mixed with plastics and molded into panel products. The ASTM standards are used to evaluate the holding power of these boards with the use of mechanical fasteners. These results can be used to compare to boards made with wood fiber.

OBJECTIVES

Our objectives in these experiments are to first, find the viability of using kenaf and corn stalk fibers, and recycled plastics in making thermoplastic composite panels for structural use. Second, find the holding power performance of two mechanical fasteners.

MATERIALS

The boards used in this test were made from the USDA Forest Products laboratory in Madison, Wisconsin, A majority contained corn stalk fiber with a low percentage of very high to high-density polyethylene. These boards were tested had a thickness of l/2 inch(A-D), and l/4 inch(G-H). The polyethylene was used as the adhesive for the board. Thirty-seven other boards were tested (L, M, N, and O), but they consisted of a higher percentage of plastic than kenaf or corn fiber.

The panels L, M, N, and O all contained LDPE, which is recycled Low-Density Polyethylene. These were pelletized. The LDPE selected was from post-consumer waste such as grocery bags. They were tested under the same testing procedures, but there may be some bias because of the high consistency of plastic. The other three types of plastics used in the production of the corn stalk boards A-D, G, and H were VHDPE, which is virgin high-density polyethylene, HDPE, recycled high-density polyethylene, and PP, polypropylene. This is otherwise known as Fortilene HE3 3907, an injection molded grade plastic with a melt point index of 44g/10 min. The fasteners that were used in the test were 6-penny nails, and No. 10AB sheet metal screws. These were both used according to ASTM standards.

PROCESSING

The materials were compounded at the U.S. Forest Products Laboratory using a Davis Standard (Pawcatuck,. CT) 32mm twin screw extruder at 40% by weight filler. The compounded materials were then pelletized and dried at 105^{o} C for 24 hours before being injection molded. The materials were molded at 40%, 80%, and 90% by three respective weight fillers into standard ASTM test specimens in a 333-ton Cincinnati Milacron (Batavia, Ohio).

There were some problems with the injection molder. All of the blends at 40% fillers content were compounded with such a low bulk density that they created a bridge at the fed throat and had to be pushed into the feed throat by hand. This was an inconvenience, but did not affect the final product. Compounding these dense pellets could eliminate the problem in the future. The system of Polyethylene filled at a content of 40% kenaf occasionally clogged the nozzle of the injection molder. However, a sufficient number of samples were molded before the nozzle clogged. The melt-blended kenaf- or cornstalk-plastic composite panels were made by using the compounded pellets in a hydraulic hot press.

SPECIMEN TESTING AND ANALYSIS

The Kenaf and LDPE panels were subjected to five different ASTM 1037 tests. These were lateral nail resistance, nail withdraw, nail-head pull through, screw edge, and face tests. The specimens were all cut to the specified dimensions needed for each test. The dimensions were 3 in. x 6 in. for all tests. All specimens were tested at 65% Relative Humidity and 68° F condition. The dimensional stability remained in the humidity level according to its schedule. The specimens were tested on a Tinus-Olsen machine at 1200 pound setting level. All other levels were met to ASTM standards.

These tests were run to find the maximum load that could be held until the fastener could be removed or pulled through the test specimen. The actual data results are seen in Table 1 and Table 2. Table 1 consists of two types of kenaf board and two types of corn stalk board. The difference between the two types for each type of fiber is the specific gravity, which was either .7 or 8. It can be seen that there is not too much difference between the corn stalk fiber and the kenaf. There was only a difference in results was from the specific gravity in the board.

CONCLUSIONS

Both kenaf and cornstalk can be used as filler in plastics for producing thermoplastic composite panels. A technique was developed to produce agricultural fiber-plastic composite panels by employing a melt-blend method through the processes of material compounding, pelletization, melt-forming, and hot-pressing. Test results show that the kenaf and cornstalk fiber-plastic composite panel demonstrated good strength. The specific gravity in the LDPE panels did affect the nail holding capacity. Most of the composite panels possessed nail holding power properties equal to or better than the minimum required values for hardboard siding, waferboard, and plywood.

The two main problems with this material is that, first, it is very flexible and may lose rigidity over time and may lose holding power at high temperatures, and second, it is not as uniform in density as MDF or other types of hardboard. Its real advantage is the fact that it can be used as an exterior product, because from previous testing, it has been shown to have little if no affect to moisture.

Testing of these materials are opening many new aspects of the fiber science. Being able to use fiber from a crop that was before thrown away, will help in the natural recycling of materials. If we are to utilize more agricultural fibers and recycled plastics in the future to replace some of the virgin plastics, we may have to discover new methods of making uniform board density, and new methods of testing these new type of composite panels.

Table 1. Results of Mechanical Fastner Tests on Plastic Composite Panels

Board Type		Lateral Resistance	Nail Withdrawl	Head Pull Thru	Screw Edge	Screw Face
M	Avg.	209.28	48.64	156.49	104.64	156.50
(40% Kenaf	STD	40.711	11.05	13.07	22.95	9.92
60% LDPE)	C.V.	19%	23%	8%	22%	6%
.7 SG						
L	Avg.	230.52	59.94	183.16	113.51	170.56
(40% Kenaf	STD	35.56	3.84	11.90	28.00	11.28
60% LDPE)	C.V.*	15%	6%	6%	25%	7%
.8 SG						
N	Avg.	211.50	36.35	148.23	68.69	172.85
(40%Corn Stalk	STD	57.02	7.35	27.69	13.07	17.65
60% LDPE)	C.V.	27%	20%	19%	19%	10%
.7 SG						
O	Avg.	231.83	56.14	168.58	101.38	162.35
(40%Corn Stalk	STD	24.19	8.97	22.28	13.75	11.25
60% LDPE)	C.V.	10%	16%	13%	14%	7%
.8 SG						

* C.V.= Coefficient of Variation= (std.dev/mean)*100

Table 2. Results of Mechanical Fastner Tests on Plastic Composite Panels

Board Type		Nail Withdrawl	Head Pull Thru	Screw Edge	Screw Face
A	Avg.	17.44	139.32	N/A	56.38
(90% corn stalk	STD	6.01	7.82	N/A	20.85
10% VHD)	C.V.	34%	6%	N/A	37%
B	Avg.	18.79	179.11	56.24	94.20
(80% corn stalk	STD	12.39	44.92	30.61	41.53
20% VHD)	C.V.	66%	25%	54%	44%
C	Avg.	18.14	174.87	N/A	86.34
(90% corn stalk	STD	5.19	34.50	N/A	35.39
10%HD)	C.V.	29%	20%	N/A	41%
D	Avg.	37.46	136.41	52.26	67.08
(80% corn stalk	STD	11.19	36.53	19.39	13.97
20% HD)	C.V.*	30%	27%	37%	21%
G	Avg.	35.86	244.44	118.10	324.40
(90% corn stalk	STD	7.60	41.57	48.14	115.74
10% PP)	C.V.	21%	17%	41%	36%
H	Avg.	37.58	259.06	163.53	273.44
(80% corn stalk	STD	17.87	31.21	39.11	107.27
20% PP)	C.V.	48%	12%	24%	39%

* C.V.= Coefficient of Variation= (std.dev/mean)*100

Lateral Nail Resistence

	Edge	Minimum (lbs.)
Hardboard Siding	3/8"	150 (8-penny)
APA	1"	120 (6-penny)
FHA (Ext. Particleboard)	1/4"	90 (6-penny)
	1'2"	200 (6-penny)

Nailhead Pull-through Standards

	(1/2" Thick) (6-penny)	Minimum (lbs.)
Hardboard Siding		150
FHA (Ext. Particleboard)		250

Direct Nail Withdrawl Standards

	(6-penny)	Minimum (lbs.)
Fiber Insulation Board		40
APA (Plywood)		20
Waferboard (Canada)		20
FHA (Ext. Particleboard)		30

Face Screw

	(10 AB)	Minimum (lbs.)
Standard particleboard		200

Edge- Screw

	(10 AB)	Minimum (lbs.)
Standard particleboard		180

PROGRAM AND ABSTRACTS

1999 Second Annual American Kenaf Society Conference

Fiber
For Our
Future

Menger Hotel
San Antonio, TX
Feb. 25 - 26, 1999