Report No. 07-020-03 R02

NATURAL FIBRE MAT FOR REINFORCING THERMOSET COMPOSITE PARTS

FIBRE EVALUATION AND SELECTION REPORT

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Project Sponsors:

Flax Canada 2015

Department of Agriculture and Agri-Food Canada

Rev 1.0
16 November, 2007

EXECUTIVE SUMMARY

Flax and hemp fibres were tested to evaluate the suitability of these materials for use in a nonwoven mat to replace E-glass chopped strand mat in the manufacture of thermoset composite structures. The test program included fineness, length, curvature and cleanliness, as well as strength and stiffness under tensile loading. In addition to these performance factors, the availability of material to meet the price and quantity requirements of the composites industry was also considered. In total, five samples of flax and two samples of hemp were evaluated with one sample of each crop type selected as having the greatest potential for use as a commercial composite reinforcement.

Hemp sample 1 and flax sample 5 were found to have the best overall performance in their crop category. The properties of these fibres are illustrated in Table 1. To provide a relative comparison, the table also lists the overall best and worst results as measured for any one of the seven fibre samples.

Table 1: Properties of Selected Fibres

Test	Measure	Selected Hemp	Selected Flax	Best Result	Worst Result
Fineness	Average Diameter	48.1 µm	44.9 µm	43.4 µm	49.9 µm
Length	Average Fibre Length	6.46cm	10.98cm	6.46cm	14.26cm
	Length Standard Deviation	2.78cm	4.50	2.68cm	5.12cm
Curvature	# Crimps / 25 mm[1]	2.9	6.4	2.9	6.4
	# Kinks / 25 mm[2]	0.2	0.7	0.2	0.8
Cleanliness	% Pure Bast Fibre[3]	97.0%	58.6%	97.0%	13.4%
Strength	Tensile Breaking Strength	35.7 cN/tex	54.9 cN/tex	55.6 cN/tex	29.5 cN/tex
Stiffness	Tensile Modulus	686 cN/tex	1026 cN/tex	1129 cN/tex	513 cN/tex

[1]a crimp is defined as any bend in the fibre that causes a change in direction
[2]a kink is defined as any crimp that forms an enclosed angle of 90º or less
[3]as determined by weight fraction of fully decorticated bast fibre, not including core (shive/hurd), seed heads, or whole/partially separated stalk

Comparing the mechanical properties with E-glass fibres, the highest tensile strength of 55.6cN/tex for the natural fibres was almost 58% weaker than the estimated strength of e-glass. The highest normalized stiffness of 1129cN/tex for the natural fibres was at least 63% less stiff than estimated E-glass property. This indicates that the composite performance of the natural fibres will be reduced in comparison to their E-glass counterparts.

The selected flax and hemp fibres will be used in a subsequent phase of the 07-020-03 project to conduct mat fabrication trials using a variety of manufacturing methods. The hemp sample is suitable to be processed as received, but it is recommended that the flax fibre be cut to a length of 5-10 cm to facilitate optimum performance of the mat forming technologies. Cleanliness was an important factor in choosing the fibre as contaminants can reduce the performance of a composite. It is expected that the matting process will remove additional contaminants, a factor important in improving the quality of the flax fibre sample. Although other fibres were found to be less suitable as direct substitutes for glass reinforcements, some of these materials may be desirable in blended mats or complementary products where the goal is to improve specific properties such as resin permeability or cost.