BC Birch Veneer Based Valued-added Products

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EXECUTIVE SUMMARY

This study investigated the feasibility of BC Paper birch veneer used as an overlay on the MPB infected SPF substrate, in order to use the underutilized birch in BC and to enhance the appearance of MPB infected wood. The bonding of the veneer were evaluated under standard condition, high humidity condition, and sever wet/dry condition. The standard condition was 20 °C and 65% relative humidity. The high humidity condition was 20 °C and 80% relative humidity. The sever wet/dry condition was simulated by a soaking-fast drying process. The veneers were tested in two thicknesses: 0.8 mm (1/32") and 1.6 mm (1/16").

The tension perpendicular to surface test indicated the bonding between the veneer and lumber was sufficient since the predominant failure mode was wood failure. The specimens conditioned at higher relative humidity did not had significant difference with the specimens at standard conditions, in terms of failure strength or failure mode. This suggested the bonding had good resistance to exposure of high level of relative humidity. The bonding also maintained its integrity with both low and high density substrates.

The delamination test evaluated the bonding under severe exterior exposure by a soaking-fast drying process. The thick veneer specimens had a much lower delamination rate, 39% on average compared to 61% of the thinner veneer group. The thicker veneers also behaved more uniformly on both surfaces on each specimen, while the thinner veneer on one surface often delaminated more significantly than the other.

Based on this study, the bonding for both thin and thick veneers was found to be sufficient for general indoor use, under standard condition or even exposed to high relative humidity. The bonding worked well with both low and high density substrates. For severe conditions with wet/dry cycles, thicker veneers were more suitable than thinner veneers.

With the information obtained from this project, the birch veneer has the potential to be used as overlay on other lumber, engineered wood products, or composite substrates, and on structural or non-structural components. This study also could aid in the development of birch veneer plywood with BC resources.

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1 INTRODUCTION

In British Columbia Paper birch (*Betula papyrifer*) is an abundant but underutilized species. The area where birch volume was greater than or equal to 65 cubic meters per hectare was estimated to be 996,000 hectares (FII 2006). The birch-leading stands were about 210,000 hectares, and the largest birch supply was found in the northeast part of the province, especially in the Fort Nelson Timber Supply Area with 7 869 000 m^3 available (Peterson et al. 1997). Birch is not considered as a valuable species for a long time and its use as timber products has been limited to a small scale and in small mills. Birch has also been used as art/craft or in the food/health sector. The development of birch-based timber products will provide great economic opportunity to utilize this resource in BC. Commercial precedents have been found in Europe such as birch plywood. In this project, the birch veneer was used as an overlay on the mountain pine beetle (MPB) infected Spruce-Pine-Fir (SPF) lumber, to enhance the appearance of its surface. The bonding property under different configurations and conditions was investigated.

2 MATERIAL AND METHODS

Three BC paper birch logs (2.75 m long, 0.35-0.41 m in diameter) were purchased from a local supplier and processed into three cants (0.25 m by 0.25 m) at the UBC Timber Engineering and Applied Mechanics Laboratory. They were then sent to BC Veneer Products Ltd. (Surrey, BC) for veneer slicing. The veneers were sliced into two thicknesses: 0.8 mm (1/32") and 1.6 mm (1/16"). The average yield of sliced veneer was 625 m^2/m^3 log for a veneer thickness of 0.8 mm and 313 m^2/m^3 log for a veneer thickness of 1.6 mm. The total loss after sliced veneer production was about 50% of the total log input.

MPB infected SPF lumber was obtained from an industrial partner. The lumber had various degree of stains caused by the infection. Three pieces of 2×4 lumber (38 mm × 89 mm) were planed, edge squared, and edge glued together to form a panel (250 mm wide) fit the width of one sheet of veneer. The veneers were then bonded onto the top and bottom surfaces of the panel with PVA wood glue. The panels were placed in Italpresse SCF6 Press at a pressure of 0.15 MPa for four hours at room temperature. They were then taken out and left to cure for 24 hours before further processing/conditioning. Four panels were made for each veneer thickness. The specimen preparation process is shown in Figure 1.

The panels before and after veneer application are compared in Figure 2. The original substrate surface with defects and stains was replaced by a natural streak formed by the brown heartwood on the background of nearly white sapwood. The veneers could be arranged to create unique and attractive patterns on a large sized panel, as shown in Figure 3. The veneers may also be produced exclusively from sapwood or heartwood to have a uniform color display. This type of product could be used for nonstructural appearance-grade purposes, including walls, panels, and furniture components.

Figure 1 The process of specimen preparation

Figure 2 Appearance of the panel before and after veneer applied

Figure 3 Veneers arranged into patterns

The strength and durability of the bonding between the veneer and the substrate are crucial factors in the application. The tests conducted in this project considered different substrate properties and the various environment conditions, in order to provide a database for the future product development and manufacturing.

The bonding property between the veneer and lumber was first investigated by tension perpendicular to surface test, adopting the internal bonding method specified in ASTM D1037-12. Two panels of each veneer thickness were cut into 51 mm × 76 mm blocks. Every two blocks were bonded together crosswise to form one specimen, as shown in Figure 2. There were 29 replicates for each configuration. One set of specimens was conditioned at 20 °C and 65% relative humidity. Another set was conditioned at 20 °C and 80% relative humidity. This design was to simulate both the standard and high relative humidity conditions in use. The specimens were conditioned to equilibrium before testing. The test setup for tension perpendicular to surface test is shown in Figure 4.

The delamination test evaluated the veneer bonding property under severe exterior exposure. For each veneer thickness, nine specimens were cut into 76 mm × 76 mm. They were completely submerged into 20±2 °C water for 24 hours. After that, the specimens were taken out and dried in the oven at 70 °C for two hours. The length of delamination at every glue line was measured after this process, with eight gluelines on each specimen.

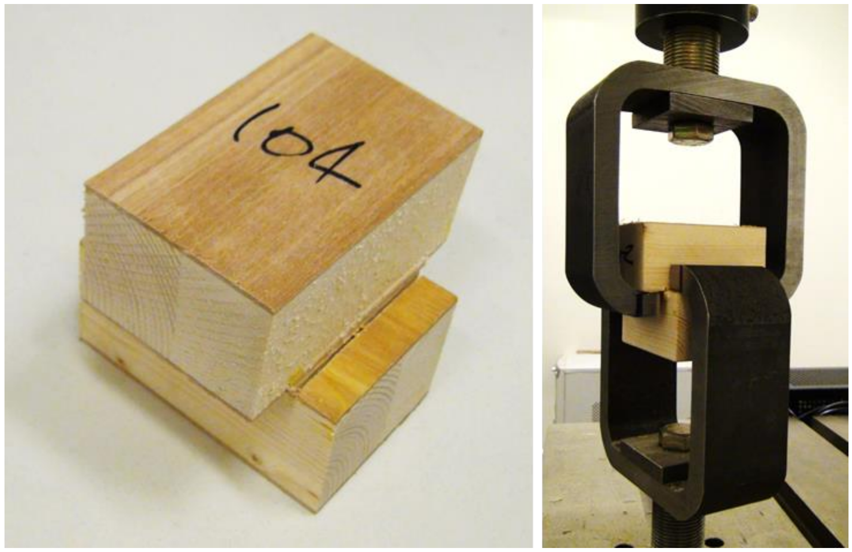

Figure 4 Test specimen and setup for tension perpendicular to surface test

3 RESULTS

The summary of the tension perpendicular to surface test results is shown in Table 1. The amount of wood failure and glue failure on the failed interface was estimated as a percentage of the whole surface. The average wood failure was above 85% in all four groups. The majority of the specimens had wood failure only. An example of wood failure is shown in Figures 5. Higher relative humidity did not affect the failure mode significantly. The specimens conditioned at higher relative humidity maintained the same level of wood failure as their counterparts.

In terms of bonding strength, the average of the thinner veneer group was much higher than the average of the thicker veneer group in both conditions. Since the failure was predominantly wood failure, this difference was caused by the lumber substrates rather than the veneers. Further examination of the specimens indicated that the lumber in thinner veneer groups had an average density about 12% higher than the thicker veneer groups. Since the bonding strength was determined by the tensile strength perpendicular to grain when wood failure occurred, a higher wood density led to a higher bonding strength.

Table 1 Tension perpendicular to surface test results

Condition		20 °C and 65% RH		20 °C and 80% RH	
Veneer thickness (mm)		0.8	1.6	0.8	1.6
Bonding strength (MPa)	Average	2.00	1.46	2.07	1.44
	Stdev	0.24	0.31	0.24	0.28
	CV	12%	21%	12%	19%
	Maximum	2.57	2.13	2.52	2.04
	Minimum	1.55	0.35	1.50	0.90

Average wood failure	94%	86%	91%	89%
# of specimens with wood failure ≥ 80%	27	25	26	24
# of specimens with wood failure =100%	21	22	25	22

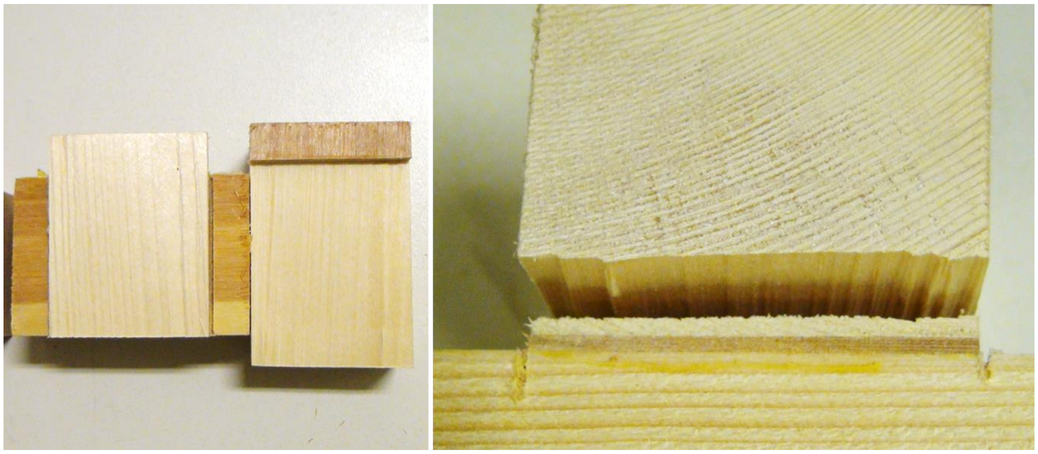

Figure 5 Wood failure of the tension perpendicular to surface test

The delamination test results are shown in Table 2 and Figure 6. The thicker veneer group had a lower delamination rate, 39% on average compared to 61% of the thinner veneer specimens.

The tested specimens are shown in Figures 7 and the examples of glue delamination are shown in Figure 8. The thinner veneer on one side of specimen was almost peeled off after the soaking and drying process. The two surfaces of the thicker veneer specimens behaved more uniformly, as shown in Figure 9.

Table 2 Delamination test results

	Thinner veneer	Thicker veneer
Average	61%	39%
Stdev	15%	17%
CV	24%	44%
Maximum	80%	58%
Minimum	33%	4%

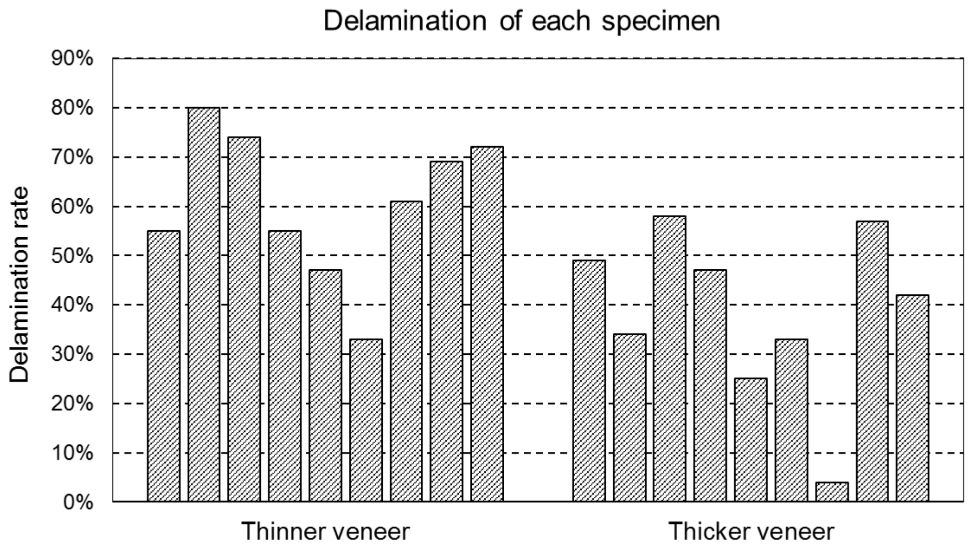

Figure 6 Delamination rate for each specimen

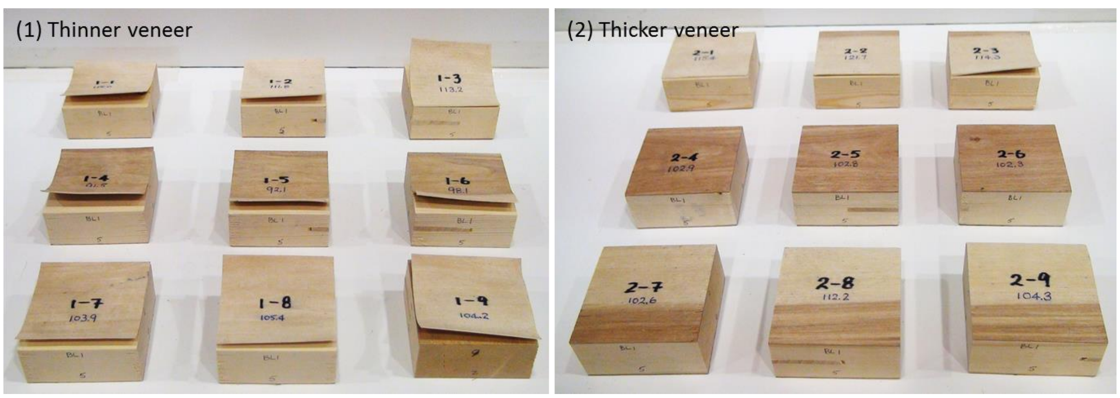

Figure 7 Delamination after accelerated cyclic exposure

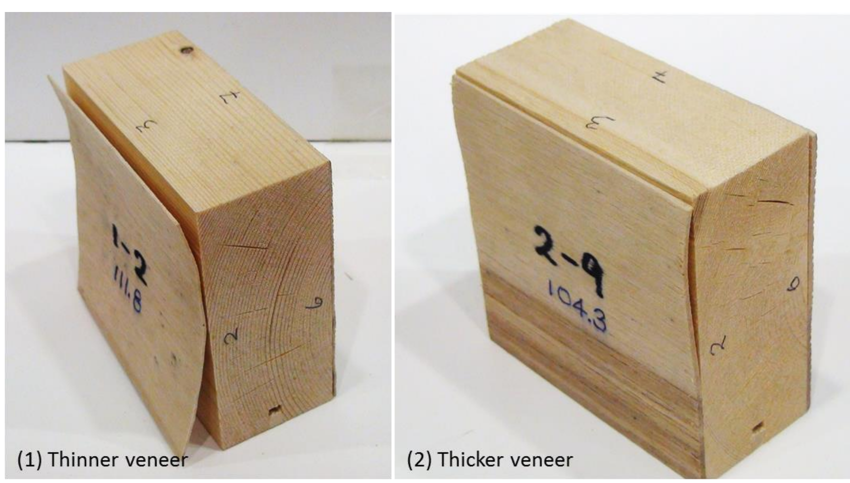

Figure 8 The delamination of glue lines

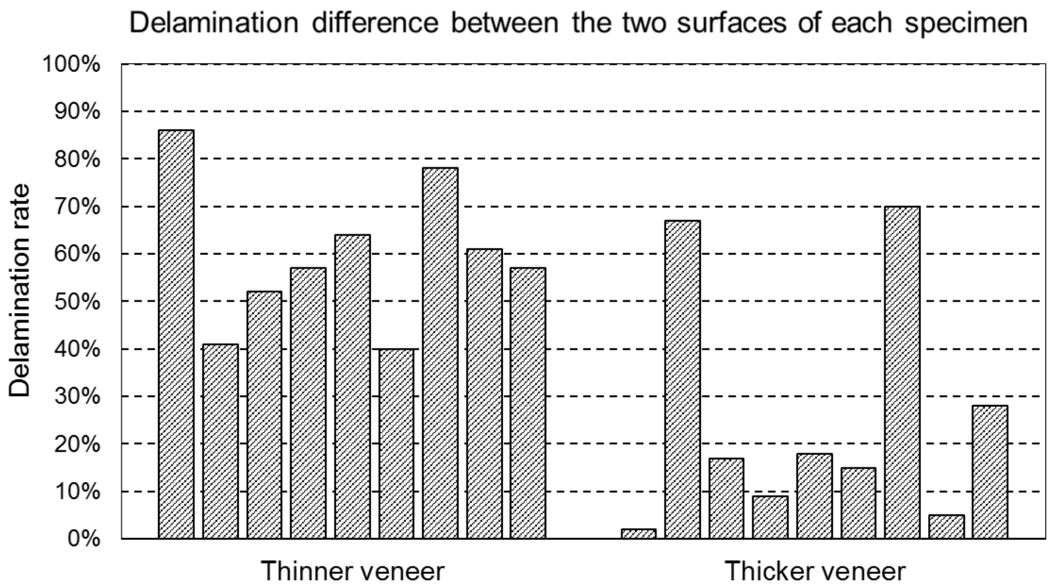

Figure 9 Delamination difference between the two surfaces of each specimen

4 CONCLUSIONS AND RECOMMENDATIONS

The BC Paper birch veneer was used as an overlay on the MPB infected SPF substrates. The tension perpendicular to surface test indicated the bonding between the veneer and lumber was sufficient since the predominant failure mode was wood failure. The specimens conditioned at higher relative humidity did not had significant difference compared with the specimens at standard conditions, in terms of failure strength or failure mode. This suggested the bonding had good resistance to exposure of high level of relative humidity. The bonding also maintained its integrity with both low and high density substrates.

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With the information obtained from this project, the birch veneer has the potential to be used as overlay on other lumber, engineered wood products, or composite substrates, and on structural or non-structural components. This study also could aid in the development of birch veneer plywood with BC local resource.

5 REFERENCES

ASTM D1037-12, Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials, ASTM International, West Conshohocken, PA, 2012, www.astm.org

FII (2006) Market and Product Development for Birch Timber and Non-Timber Products: Current Status and Potential in British Columbia. Forest Innovation Investment Ltd., Vancouver, BC

Peterson E.B., Peterson N.M., Simard S.W., and Wang J.R. (1997) Paper Birch Managers' Handbook for British Columbia. Co-published by B.C. Ministry of Forests. Issued by the British Columbia Hardwood and Vegetation Management Technical Advisory Committee.

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