EFFECTS OF CYCLIC BOIL-DRY TREATMENT ON PROPERTIES OF BINTANGOR (*Callophyllum sp*) LAMINATED VENEER LUMBER

By

CHUO TOUNG WRN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Master of Science.

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Abstract of thesis submitted to the Senate of Universiti Putra Malaysia in fulfillment of the requirements for the degree of Master of Science.

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Chairman: **Associate Professor Mohd. Zin Jusoh**

Faculty: **Faculty of Forestry**

This study evaluates the physical and mechanical properties of bintangor (*Callophyllum sp*) laminated veneer lumber (LVL) under cyclic boil-dry (CBD) treatment. The properties studied were thickness swelling (TS), linear expansion (LE), water absorption (WA), delamination, bending shear and static bending (moduli of elasticity and rupture). LVLs of 1220 x 2440 mm in size were manufactured on a commercial LVL production line. The thicknesses of the veneers were set at 3.1 and 4.1 mm, producing 17- and 13-ply LVL panels respectively. A total of two hundred and sixty four large specimens were prepared for static bending (50 x 90 x 1000 mm) and bending shear (40 x 50 x 300 mm). To determine the effect of sample size, seventy two small static bending specimens (12.5 x 50 x 305 mm) were cut from the 13-ply LVL. The small and large static bending specimens were tested according to American Society for Testing and Materials D 143 and AS/NZ 4063:1992 Timber – Stress-graded – in-grade strength and stiffness evaluation respectively. Bending shear was determined according to AS/NZ 4357. In all cases, the CBD treatment procedure was conducted by taking consideration the size factor so that each specimen would experience similar degree of heating regime. The analysis of variance (ANOVA) shows that the TS, delamination, stiffness (MOE) and strength (MOR) were significantly influenced by the specimen size, veneer thickness and number of CBD cycle while bending shear were significantly influenced by the number of CBD cycle and veneer thickness. The most severely degraded were specimens that have been treated for 10 cycles. LVL produced from thinner veneers (3.1 mm) as in 17-ply LVL, was apparently more stable where acceptably low TS, WA, LE and percent delamination were recorded resulting in low reductions in stiffness, strength and shear after CBD treatment. There was a negative relationship between delamination and bending shear after CBD treatment where 17-ply LVL showed a curvilinear trend whilst 13-ply LVL showed a linear relationship. The study also found inspite having the same

degree of heating regime, larger specimens experienced much more severe strength degradation which mainly caused by shear failure at the center (middle layers) of the LVL panel. The shorter span used for the large specimens (1: 10) was observed to be responsible for the shearing effect that subsequently reduced the MOE and MOR values in this study. The outdoor aging revealed that MOE of smaller specimens was badly degraded (40%) compared to the large specimens (22%) after six months of outdoor aging. Large and small specimens produced from 13-ply LVL (thicker veneers) experienced more strength reduction under 6 months outdoor aging (28%) compared to 10 cycles of CBD treatment (24%). MOE and MOR after any one of 2, 5 or 10 cycles of CBD treatment showed good correlation with MOE and MOR after 3 and 6 months of outdoor aging.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk Ijazah Master Sains

KESAN-KESAN RAWATAN BERULANG DIDIH-KERING KE ATAS SIFAT-SIFAT PAPAN VENIR BERLAMINA BINTANGOR (*Callophyllum sp*)

Oleh

CHUO TOUNG WRN

Julai 2004

Pengerusi: **Profesor Madya Mohd. Zin Jusoh**

Fakulti: **Fakulti Perhutanan**

Kajian ini menilai sifat fizikal dan mekanikal papan venir berlamina (LVL) bintangor (*Callophyllum sp*) selepas rawatan berulang didih-kering (CBD). Maklumat tentang prestasi LVL selepas CBD adalah terhad walaupun sifat-sifat itu amat diperlukan dalam rekabentuk ahli-ahli struktural. Dalam kajian ini, penebalan kembang (TS), kembang lurus (LE), pengambilan air (WA), delaminasi, prestasi ricih lentur dan lentur statik (kekenyalan dan kekuatan patah) untuk LVL yang diperbuat daripada bintangor telah dinilai. LVL sampel dalam kajian ini dihasilkan dalam garis produksi LVL komersial. Seratus dan dua puluh spesimen lentur statik besar berukuran 50 x 90 x 1000 mm dan spesimen ricih statik berukuran 40 x 50 x 300 mm, kedua-duanya mempunyai dua jenis ketebalan venir iaitu 3.1 mm (17-lapis) dan 4.1mm (13-lapis) telah disediakan. Enam puluh spesimen lentur statik kecil yang berukuran 12.5 mm x 50 mm x 305 mm juga disediakan daripada 13-lapis LVL. Spesimen lentur statik kecil dan besar diuji mengikut *American Society for Testing and Materials D 143: Standard Methods of Testing Small Clear Specimens of Timber* dan *AS/NZ 4063:1992 Timber – Stress-graded – in-grade strength and stiffness.* Ricih lentur pula diuji mengikut AS/NZ *4357: Structural Laminated Veneer Lumber.* Variasi analisis (ANOVA) menunujukkan bahawa TS, delaminasi, kekuatan kekenyalan (MOE) dan kekuatan patah (MOR) LVL dipengaruhi secara signifikant oleh saiz spesimen, ketebalan venir dan bilangan pusingan CBD manakala ricih lentur hanya dipengaruhi secara signifikant oleh ketebalan venir dan bilangan pusingan CBD. Sifat-sifat seperti TS, LE dan delaminsi dalam spesimen kecil lebih serius dipengaruhi oleh rawatan CBD dan rawatan luar-pintu. Namum demikian, spesimen itu mengalami susutan kekenyalan (MOE) dan kekuatan (MOR) yang lebih rendah. LVL diperbuat daripada venir nipis (3.1 mm) dalam 17-lapis adalah lebih stabil dalam TS, WA, LE dan delaminasi yang dicatatkan. Sifat-sifat ini menyebabkan susutan yang lebih rendah dalam kekenyalan, kekuatan patah and ricih selepas rawatan CBD dan luar-pintu bagi

17-lapis LVL. Delaminasi dan ricih lentur menunjukkan hubungan negatif di mana 17-lapis LVL menunjukkan trend linear-bengkok dan 13-lapis LVL pula menunjukkan trend lurus. Spesimen besar mengalami susutan kekuatan yang lebih serius di mana ia disebabkan oleh kegagalan ricih di tengah-tengah papan LVL. Span yang pendek (1:10) yang digunakan dalam spesimen besar didapati menyebabkan kesan ricih yang membawa kepada susutan dalam MOE dan MOR dalam kajian ini. Rawatan luar pintu menunjukkan MOE bagi spesimen kecil menyusut dengan lebih serius (40%) berbanding dengan spesimen besar (22%). Spesimen kecil and spesimen besar yang diperbuat daripada 13-lapis (venir tebal) mengalami susutan kekenyalan dan kekuatan yang lebih tinggi selepas 6 bulan rawatan luar-pintu (28%) berbanding dengan 10 pusingan rawatan CBD (24%). MOE dan MOR selepas mana-mana satu dari 2, 5 atau 10 pusingan rawatan CBD menunjukkan kolelasi yang baik dengan MOE and MOR selepas 3 dan 6 bulan rawatan luar-pintu.

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I certify that an Examination Committee met on 16 of July 2004 conduct the final examination of CHUO TOUNG WRN on his name of degree of Master of Science thesis entitled "EFFECT OF CYCLIC BOIL-DRY (CBD) TREATMENT ON THE DIMENSIONAL STABILITY AND MECHANICAL PROPERTIES OF BINTANGOR (*Callophyllum sp*) LAMINATED VENEER LUMBER." In accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

CHUO TOUNG WRN

Date :

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