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Effect of resin application sequence, content, and powder/liquid combination ratio on OSB performance

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Abstract: Powder and liquid phenol-formaldehyde (PF) combination binder system has been commonly used in North America for oriented strand board (OSB) manufacturing. This binder system has shown its suitability for improving resin efficiency and bond quality as compared with either powder PF (PPF) or liquid PF (LPF) resin. This study was conducted to investigate the effect of resin application sequence (LPF-PPF-LPF, LPF-PPF, PPF-LPF), resin content (3.0%, 5.5%, 8.0%), and PPF/LPF combination ratio (50:50, 65:35, 80:20) on strand board performance. Board properties evaluated include internal bond (IB), thickness swelling (TS), water absorption (WA), dry and wet modulus of rupture (MOR), dry modulus of elasticity (MOE), edgewise shear, and compression shear strength. In addition, a non-destructive test method (TROBEND) developed at Forintek was also used to measure the modulus of elasticity (MOE) and shear modulus of elasticity (G).

Response Surface Methodology (RSM) was used in the experiment design. Significant response surface models were established for individual panel properties, including the linear model for IB, dry MOR, dry MOE, and compression shear, as well as the quadric model for TS, WA, and wet MOR, and 2FI (two factor interaction) for edgewise shear. ANOVA for response surface model indicated that the resin content was a significant model term for IB, TS, dry MOR and MOE, wet MOR, and compression shear properties. An increase in resin content improved these board properties. Powder/liquid ratio was a significant model term for TS, WA, and wet MOR. Resin application sequence was not a significant model term for any panel property, but its interaction with resin content was a significant model term for edgewise shear property.

In most cases, the interactions between experimental variables were not significant model terms for predicting panel properties, but they still

significant model terms for predicting panel properties, but they still revealed some trends. Regarding Sequence 3 (PPF-LPF), 50:50 PPF/LPF ratio (lower level) resulted in higher IB, dry MOR, and compression shear, while 80:20 PPF/LPF (higher level) yielded lower WA and higher dry MOE. For Sequence 2 (LPF-PPF), 65:35 PPF/LPF ratio (middle level) favoured TS, while 50:50 PPF/LPF ratio (lower level) favoured wet MOR. Sequence 1 (LPF-PPF-LPF) combined with 50:50 PPF/LPF ratio (lower level) also gave lower WA values. In general, an increase in resin content improved the board properties with the above combinations. In addition, Sequence 3 (PPF-LPF), with 3.0% resin (lower level), yielded higher edgewise shear strength regardless of resin application sequence.

An attempt was made to correlate the panel mechanical properties measured using both destructive and non-destructive test methods. The strongest correlation was observed between IB and compression shear (R2=0.70), followed by TORBEND G with modulus of elasticity (TORBEND MOE) (R2=0.40), and TORBEND G with compression shear (R2=0.28) and with IB (R2=0.26). However, no correlation seemed to exist between MOE (static bending) and TROBEND MOE.

An image analysis indicated that an increase in resin content significantly increased resin coverage on strand surface. At each resin content (3.0%, 5.5%, and 8.0%), a decrease in PPF/LPF ratio in Sequence 1 (LPF-PPF-LPF) or an increase PPF/LPF ratio in sequence 3 (PPF-LPF) seemed to result in higher resin coverage. Resin coverage seemed to correlate to TS (R2=0.45), IB (R2=0.42), compression shear (R2=0.39), TORBEND G (R2=0.39), dry MOR (R2=0.25), wet MOR (R2=0.25), and dry MOE (R2=0.18). However, resin coverage did not seem to correlate to WA, TORBEND MOE, or edgewise shear properties.

Resin application

OSB

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