Delamination Due to Outdoor Exposure of Southern Yellow Pine Plywood

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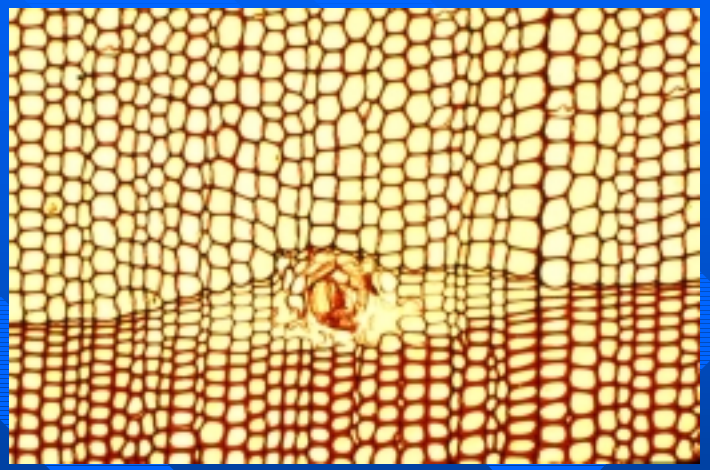
- Insert pictures from Piao of veneer
- Insert pictures from Chung of exposure fence

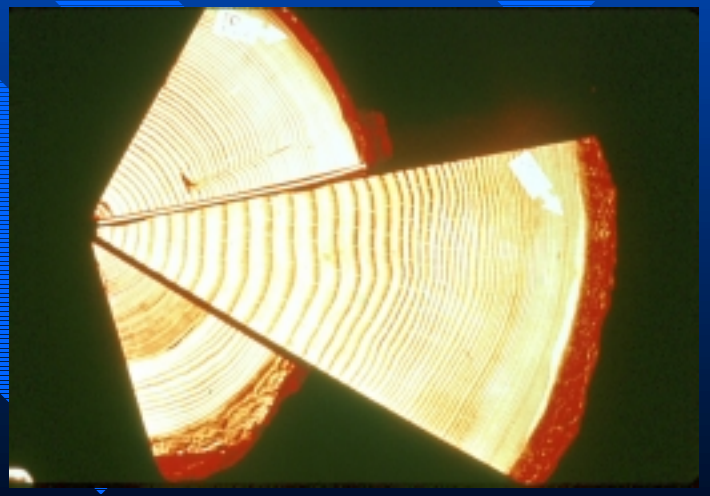
Wood Durability

- In the U.S., interest in wood durability has been vigorously renewed as a result of the substantial damage done to wooden structures by the Formosan subterranean termite (FST) (*Coptotermes formosanus* Shiraki)

Traditional Wood Durability

- The emergence of the FST has also renewed interest in traditional wood durability.
- Insects & fungi
- Atmospheric factors





Southern Pine Plywood Markets

- SYP plywood has gradually been loosing market share to OSB
- SYP plywood represents 60% of the total plywood production for North America

Louisiana Forest Industry

- The forest products industry is the second largest industry in Louisiana adding over $5 billion per year directly to the economy and providing jobs for over 25,000 of Louisiana's citizens.

Resins

- Fairly standard, approximately 26 % resin solids southern pine plywood glue mixes with filler and extender were prepared.
- Of the five resins, four resins were prepared in the laboratory and one commercial resin was used as a control.
- The compositions of the four resins prepared in the laboratory, including the various alkylated phenol copolymers and the all phenol control, are listed in Table 1.
- In each resin prepared in the laboratory, 20 percent (mole basis) of the standard phenol was replaced with one of the alkylated phenol. The method for resin preparation and glue mixing were described by Rice and Chen (1974).

Experimental resins used in the fabrication of southern pine plywood

Resin Number	Resin type
1	3,4-xylenol copolymer with phenol
2	3,5-xylenol copolymer with phenol
3	2,3-xylenol copolymer with phenol
4	2,5-xylenol copolymer with phenol
5	Standard PF resin

Experimental Veneer

- Commercially peeled southern pine (*Pinus* sp.) veneer of 1/8-in. (3.2 mm) thickness was obtained from a Louisiana mill and redried to a mean moisture content (MC) of 1.5%.

Panel Assembly

- The panels were pre-assembled without glue and conditioned to 3 percent moisture content.
- The latewood and earlywood zones on the inner faces of the veneers were mapped on tracing paper with the pilot holes as references.
- Following conditioning, the veneer pairs were randomly sorted into 180 groups with two pairs in a group (panel replication) for tests of variables.

Veneer Pieces

- Veneer pieces were cut to 12 in. x 12 in. (30.5 x 30.5 cm) for fabrication into 2-ply plywood.
- These pieces were randomly matched in two-ply, cross-laminated panels arranged with tight side to tight side, in order to minimized the effects of lathe checks.
- Special attention was given so that each 0.5 in. (1.27 cm) square piece of a selected sample was comprised of either a EW to EW or LW to LW bond.

EW/LW Determination

Panel Pressing

- The panels were hot pressed in a laboratory press for 5 minutes with a platen temperature of 300oF (148.9oC) and a panel pressure of 200 psi (35.7 kg/cm2). Partial hot stacking was accomplished by storing the panels in an insulated box for an overnight postcure period.

Experimental Variables

- Glue was spread at 3 rates: 65, 80, and 95 pounds per 1,000 ft.2 (317, 391, 464 kg/m2) of double glueline.
- After spreading, the panels were stored in an oven at 100 F according to 4 assembly times: 10, 20, 40, and 80 minutes.
- After panel fabrication, ½ inch square (3.2 cm^2) were sawn to yield latewood-to-latewood (LW) and earlywood-to-earlywood (EW) specimens.

Experimental Overview

- A total of 3,600 specimens (5 resins x 3 resin replications x 3 spreads x 4 assembly times x 2 panel replication x 2 wood surfaces x 5 specimen replications) were prepared and tested for delamination in exterior exposure.

Objectives

- The objective of this research was to determine the effect of resin, glue spread, and assembly time on delamination of southern pine plywood EW to EW as well as LW to LW bonded samples

Exposure Fence

Delamination Test

- An exposure fence was fabricated with plywood fixed on a south-facing, 45-degree, exterior exposure deck. A total of 720 rectangular holes were cut in the plywood. The specimens, 5 in a group, were then placed in the rectangular holes and kept in place by placing wire net on both faces of the plywood.

Delamination Measurement

- The delaminations were measured by inserting a round-end blade 1/16-in. (1.6 mm) wide and 0.004 in.(0.1 mm) thick into the deteriorating glue line at sufficient points to allow mapping o the delamination on 1/10-in. (2.54 mm) grid paper. Delamination was expressed as a percentage of total glue line area.

Results and Discussion

Resins

- The statistical analysis revealed no significant differences for the percentage of delamination for the five resins for the EW samples.
- Since a EW to EW bond is easier to establish than a LW to LW bond, the EW to EW delamination values are quite small and range from 7.1 – 9.7%. The LW to LW samples yielded much higher delaminatin values, which ranged from 45.3-56.2%.

Glue Spread

- As expected, delamination decreased as glue spread amount increased.
- For the EW samples, the lowest glue spread category (65 lbs/1,000 ft.^{2} (317 kg/m^2)) showed significantly higher delamination (12.8%) than the other groups.
- The results for the LW samples were similar to the EW samples in that the delamination amount was inversely related to the glue spread amount.

Assembly Time

- In general, assembly time was directly related to the percentage of delamination. For EW samples the trend was 40>10>20>80 and the values were 6.5, 6.6, 6.7, and 13.7%.
- The assembly time was truly directly related to the percentage of delamination of LW samples. Each grouping was also statistically unique.
- The 80 minute assembly time is clearly too long and delamination occurs as a result of glue line dry out.

Conclusions

- None of the laboratory prepared alkylated phenol isomer mixture resins performed as well as the commercial resin for both LW and EW samples. However, the superiority of the commercial resin was very minimal for both wood types, particularly EW samples.
- As expected, delamination decreased as glue spread amount increased. For the EW samples, the lowest glue spread category (65 lbs/1,000 ft. ^{2} (317 kg/m^2)) showed significantly higher delamination (12.8%) than the other groups.
- The results for assembly time indicate that plywood delamination was directly related to the percentage of delamination. Therefore, shorter assembly times provided more favorable delamination results.
- The results of this study were encouraging and indicate that plywood resins made with xylenol copolymerized with phenol have good potential. Future research regarding the economic viability is recommended to compliment this study on technical feasibility.

Acknowledgements

- Rice, J.T. and C.M. Chen. 1974. Study of dryout resistance of phenolic copolymer resins for pine plywood glues – Part 1. Forest Prod. J. 24(3):20-26.

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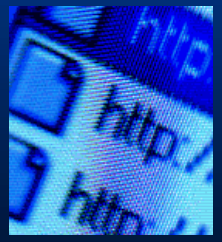

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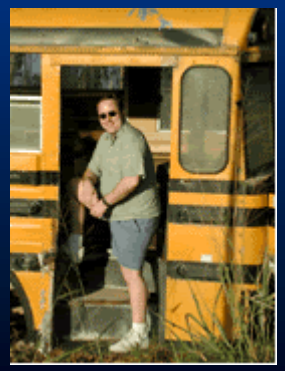

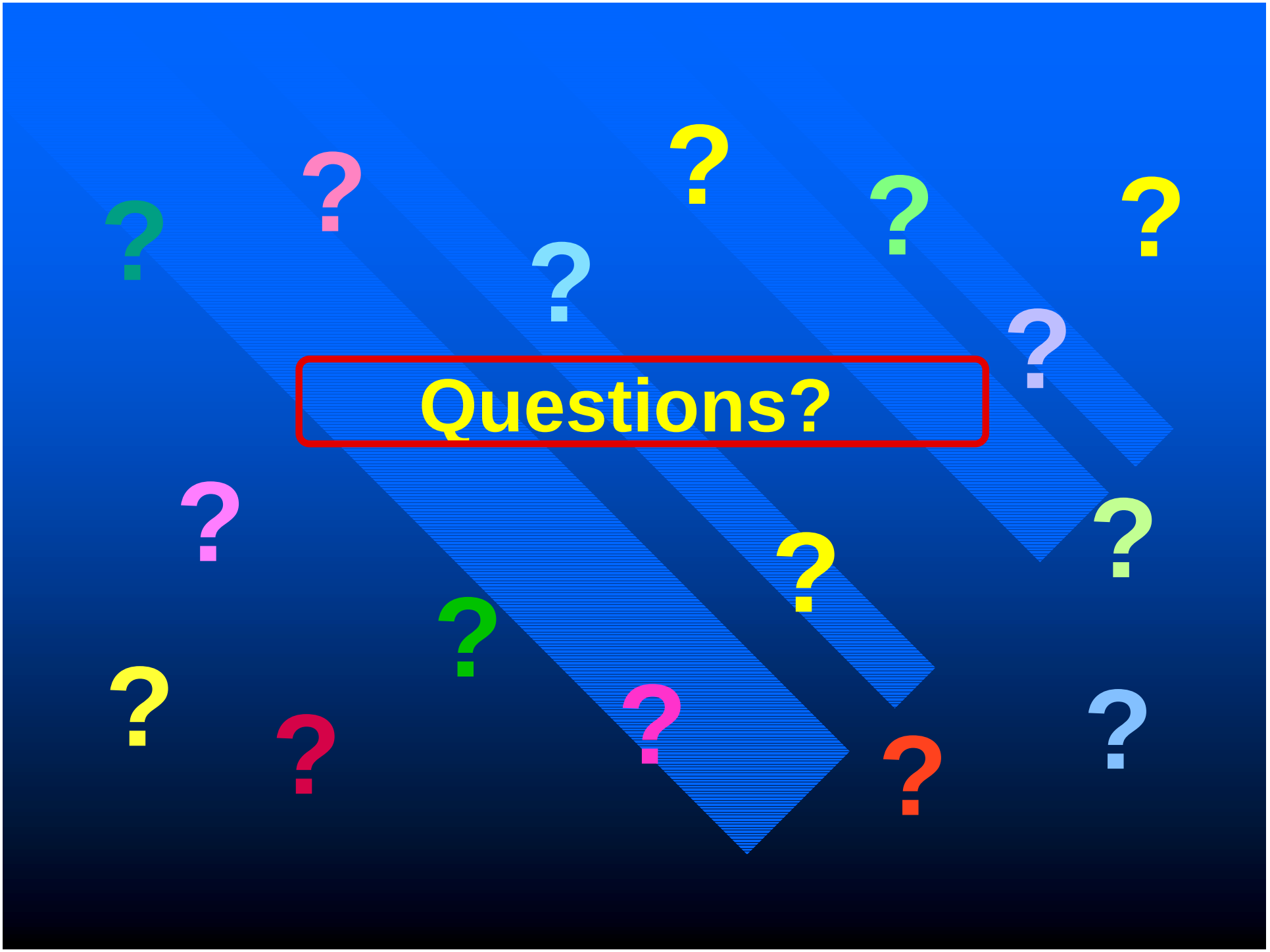
Questions?