

# Research & Development Summary



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## Review of Standard Test Procedures for Assessing the Delamination Resistance of Solid Wood Bond Lines

**B**ond line delamination testing is a common procedure specified in adhesive standards to assess the durability of the adhesive. In glued wood product standards, it is used to assess not only the bond line durability, but also the quality of the manufacturing process. The delamination test procedures amongst North American and overseas standards vary not only in approach, but also in time duration, from a few hours to a few days. Inconsistent test procedures can lead to an uneven playing field in global markets. For example, some U.S. agencies have a simpler test procedure than that used in Canada. Given that testing for bond line durability is a mandatory step in glued wood product standards, this is a disadvantage to Canadian producers who have to meet more stringent requirements.

A review of delamination/durability tests was conducted, and tests were selected for comparative study. The tests were not found to be equivalent. For example, the National Lumber Grades Authority (NLGA) delamination test showed a greater tendency for rejecting a process compared to the durability-bending test.

The judgement on the quality of the manufacturing process is based on tests on a small number of samples. These procedures are subject to errors which may lead to the conclusion that the manufacturing process is unacceptable when in fact it is; and concluding that the process is acceptable when in fact it is not. The results and knowledge of the behaviour of delamination testing were used to improve the NLGA fingerjoint standards by minimizing these errors. The changes dealt mainly with sampling and analysis of delamination results during qualification, quality control, and reinspection. The changes were accepted by the NLGA standard committee, and were implemented in fingerjoint mills in Canada.



*In a fingerjoint bond line delamination test, the test specimens are subjected to several cycles of water impregnation and drying. Significant separation of the bond lines on the end grain surfaces of the specimen are noted as delamination.*

## Introduction

Inconsistent test procedures can lead to an uneven playing field in global markets. Certain jurisdictions have adopted procedures that tend to be simpler to carry out and appear to be less sensitive to bond line separation in amounts that are generally not found to impact the structural performance. Given that testing for bond line durability is a mandatory step in glued wood product standards, this is a disadvantage to Canadian producers who have to meet more stringent requirements upon manufacture. There is, therefore, a desire to adopt these alternate procedures. With a delay in test results that can vary from several hours to several days, shipping the product on time becomes problematic.

The project was aimed at developing a better understanding of the effectiveness of common tests for evaluating the durability of bond lines in laminated and fingerjoined lumber during product qualification and quality control.

## Methodology

Before endorsing adoption of an alternate procedure, Forintek proposed making a comprehensive review of delamination testing so that, if necessary, the entire approach to delamination testing could be updated. A review of 20 North American and international glued wood product standards, incorporating delamination and durability test procedures was carried out.

Based on the review, a comparison of five standard delamination test procedures was performed in face-bonded lumber. The factors examined were adhesive type and catalyst level. In fingerjoined lumber, three cases of non-conforming fingerjoints were considered: low catalyst level, loose-fitting joint, and adhesive pre-cure. The main objective of the fingerjoint study was to compare the NLGA delamination test with the durability-bending (DB) test in terms of product acceptance or rejection.

## Results and Discussion

The review indicated that the current test procedures in North America and overseas vary in time duration from a few hours to a few days.

The five standard delamination test procedures studied were not found not to be equivalent. They responded differently in the evaluation of conforming and non-conforming adhesives. Details of the results can be found in the report.

In the fingerjoint study, when samples with low catalyst level, loose-fitting joints, and pre-cured adhesive bond line were tested using the NLGA delamination test, a number of the fingerjoint samples showed delamination failures and required retests. On the other hand, when a matched group of samples were tested in accordance with the DB test, the samples passed the requirements for at least No. 1 / No. 2 2x4 spruce-pine-fir fingerjoined lumber. Details of the results can be found in the report.

The above three cases indicated that the delamination test and the DB test were not equivalent. It was found that drying conditions have an impact on the test results by increasing the occurrence of “false positives” and “false negatives”.

## Benefits and Implementation Costs

Products benefiting from the results of this project include glued-laminated timber and fingerjoined lumber. There is potential for producers of these products to shift to a shorter delamination test procedure in quality control resulting in lower production cost, and increased frequency of product shipment resulting in greater cash flow.

The results of the study were implemented mainly as revisions to the NLGA fingerjoint delamination test procedure. The study indicated that delamination in bonded products exhibits some variability among samples, which could be considered to have a normal distribution. The revision of the test procedure was based on this concept, and was concentrated mainly on reducing the sample size and sampling frequency, relaxing the number of cyclic delamination conditioning when possible, and relaxing the delamination requirements during qualification, quality control and re-inspection.

In addition, a recommendation was made to differentiate between actual delamination and glue skip (lack of adhesive). Glue skip, while still treated as an issue that should be corrected, is no longer counted as bond line delamination.

Mill staff have benefited from these changes in terms of background knowledge and reduced quality control work. Although reports on this study are available, there are subtle differences between that which was recommended and that which was actually approved by the NLGA. Therefore, mill staff should always consult their agency and the applicable standard first, or contact Forintek for more information.

## Conclusion

The five standard delamination test procedures studied are not equivalent. They respond differently in the evaluation of conforming and non-conforming adhesives.

The moisture content (MC) level to which the joint is dried affects the amount of delamination observed, with the delamination increasing with decreasing MC. This shows that standards specifying different drying MC levels are not equivalent, and that for purposes of process monitoring, it is recommended that plants adopt a target MC level to which all samples should be dried. Finally, the delamination test and the durability-bending test are not equivalent and may not detect the same bond durability issues.



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