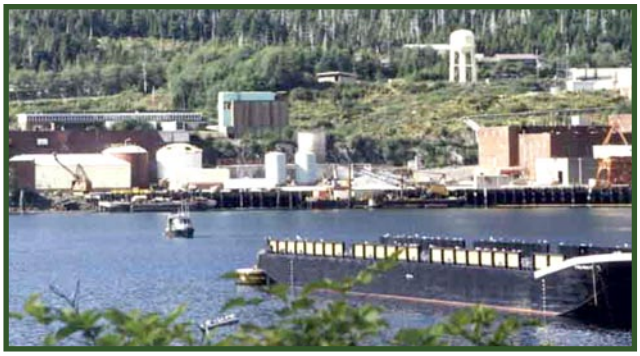
RESEARCH in Progress

Forest Products Laboratory

Durability of Structural Lumber Products at High Ambient Temperatures

Durability of wood is usually thought of as resistance of wood to decay organisms. From a wider perspective, durability may also include resistance to other environmental factors, such as chemical or thermal degradation. Dry wood, at moderate temperatures, is remarkably durable. Tests of wood from very old buildings suggest that significant strength losses occur only after several centuries under normal aging conditions.



Thermal degradation is of concern in industrial buildings.

In North America, ambient air temperatures within habitable regions may reach extremes of –60°F to +115°F. Industrial structures may be exposed to temperatures that exceed these extremes. At elevated temperatures, the moisture content of wood can be quite low. In industrial plants that use a wet process involving steam, moisture contents in structural wooden members can range from 12% to 20% and temperatures from 80°F to 150°F or higher. Wooden members could be exposed to elevated temperatures for decades. Little data exist to tell an owner or engineer how wooden members will perform in these extreme environments. Anecdotal information and discussions with consulting engineers suggest that current guidelines are inadequate.

Background

Current design philosophy in the United States assumes that exposure of untreated wood to temperatures up to 150°F causes no permanent loss in properties unless the exposure is prolonged. Only limited guidance is available on the length of time that lumber can be exposed to high temperatures before permanent loss in strength might occur. Virtually all the available data are based on exposures of small, clear wood specimens, generally less than 1 by 1 inch in cross section. No information is available on the durability of structural composite products when exposed to air at high ambient temperatures.

Objectives

The objectives of this study are to

- establish the effects of thermal degradation on the bending strength and stiffness of solid-sawn lumber and structural composite lumber products for a range of temperatures and humidities that might be typically encountered in industrial applications and
- develop analytical models for predicting durability and service life.

Approach

All lumber used in this study is commercially produced and graded 2 by 4's. Solid-sawn lumber is Machine Stress Rated. Composite lumber will be laminated veneer lumber (LVL) and laminated strand lumber (LSL). The table shows the combination of products and maximum anticipated exposure times. Changes in chemical composition of the specimens are being determined at each exposure condition to track the

Experimental Design of Temperature-Durability Study on 2 by 4's

		Exposure time (years)			
Product	Species group	150°F 12% MC	150°F 4% MC	180°F 12% MC	180°F 4% MC
Solid-sawn	Spruce–Pine–Fir	6	3	1	2
	Douglas-fir	4	3	2	2
	Southern Pine	3	4	2	2
LVL	Douglas-fir	6	4	1	2
	Southern Pine	6	4	1	—
	Yellow-poplar	6	4	1	2
LSL	Aspen	2	3	1	1
	Yellow-poplar	3	3	1	1

fundamental causes of thermal degradation. This study complements recent FPL studies on thermal degradation of chemically treated wood, reversible effects of temperature on lumber properties, and the effect of extremely low moisture contents on lumber properties.

Expected Outcomes

This research will provide analytical models for engineers and code officials to predict thermal degradation for ranges of temperatures and moisture contents not tested in the study. The data will also help establish where thermal degradation is not likely to be a problem. Research reports will be submitted to appropriate standard organizations for reference in such documents as the American Forest and Paper Association's National Design Specification and relevant standards of the American Society for Testing and Materials.

Timeline

Initial results at 150°F/12% MC and 180°F/4% MC are published (Green and others 2003). Results at 180°F/12% MC should be available in 2005. Exposures at 150°F/4% MC are expected to be complete in 2006, with final results and analytical models to be published following testing.

Reference

Green, D.W.; Evans, J.W.; Craig, B.A. 2003. Durability of structural lumber products at high temperatures I: 66°C at 75% RH and 82°C at 30% RH. Wood and Fiber Science 35(4):499–523.

Cooperators

This study is primarily funded from Federal sources. The Weyerhaueser Corporation supplied some of the solid-sawn lumber; all composite lumber products were supplied by Trus Joist, a Weyerhaueser business.

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