Stress Grading of Recycled Lumber and Timber

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Abstract

This paper presents an overview of selected research at the Forest Products Laboratory (FPL) to characterize the grade distribution and engineering properties of lumber and timber recycled from deconstructed buildings on US. Army installations. The effects of splits on timber beam and column strength and the effects of damage on lumber grade yield are reported here.

Introduction

For decades, the preferred method of disposal for buildings has been to demolish them mechanically and place the debris in a landfill, saving little material for reuse, Over the last decade, the demand for old timbers has grown significantly, making it worthwhile to salvage this material from buildings slated for disposal. This is particularly the case for large old-growth softwood timbers, which can be resawn into structural members or millwork. While larger timbers command a high price and are regularly recycled, dimensional lumber is not often reused. However, recent studies suggest the feasibility of deconstructing buildings and salvaging and reusing the dimensional lumber stock (NAHB 1997, FORA 1997). Ongoing research at FPL is characterizing the grade distributions and engineering properties of lumber and timber recycled from deconstructed buildings (Falk et al. 1998a,b,c; Green et al. 1998). To date, more than 1,700 pieces of lumber and timber have been collected from the U.S. Army's Twin Cities Army Ammunition Plant (TCAAP) in Minnesota and Fort Ord in California. At TCAAP alone, this cooperative program has resulted in recycling of more than 4,700 m^3 (2 million board feet) of lumber and timber (Falk et. al 1995, Lantz and Falk 1996). This paper highlights the results of testing timbers in bending and columns in compression and grading dimension lumber.

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Materials and Methods

Material from both military bases ranges from nominal 2 by 4 in. (standard 38 by 89 mm) to nominal 10 by 18 in. (standard 241 by 445 mm). A sample of lumber and timber was collected from a 59,000-m^2 (548,000-ft^2) dismantled building at TAACP in 1995. The FPL research staff and U.S. Army facility engineers and demolition contractors selected approximately 82.6 m^3 (35,000 board feet) of lumber and timber for testing (Falk et al. 1998b,c; Green et al. 1998).

The 1994 closure of the Fort Ord U.S. Army Military Reservation in Marina, California left more than 1,200 buildings that either did not meet current building code requirements or contained remnant hazardous materials requiring abatement. The Fort Ord Reuse Authority (FORA) developed a deconstruction project focused on distinct building types and monitored the cost, timing, and work involved in building disassembly and material collection and reuse (FORA 1997). The FPL developed a cooperative research agreement with FORA and the West Coast Lumber Inspection Bureau (WCLIB) to develop information on the grades of lumber reclaimed from the deconstructed buildings.

The lumber and timber collected from both military bases was primarily Douglas Fir and was visually assessed for structural grade by a WCLIB grading supervisor according to standard no. 17 in *Grading Rules for West Coast Lumber* (WCLIB 1996). Particular attention was paid to damage, defined as holes resulting from nails or bolts, splits caused by factors other than drying, saw cuts, notches, decay, and mechanical damage (such as gouges, broken ends, and missing sections resulting from splits). If a bolt and/or nail hole or holes were present in the piece, the grader estimated an equivalent knot size for determining the grade.

Results

Ninety nominal 6- by 8-in. (standard 140- by 191-mm) timbers were collected from TCAAP and shipped to FPL for testing (Green et al. 1998). Thirty timbers with heart checks (boxheart splits), characteristic of old timbers installed in dry locations, and 60 “unchecked” timbers were selected for testing. Most beams were Select Structural Beams and Stringers grade by current grading rules. Bending tests were performed according to ASTM D198 methods (ASTM 1996). Analyses of bending strength data indicated that the mean modulus of rupture of beams with heart checks was about 15% lower than that of beams without heart checks.

Nominal 8- by 8-in. (standard 191- by 191-mm) Douglas Fir columns were collected at TCAAP and sent to FPL for grading and testing (Falk et al. 1998b). Columns were tested in direct compression with no intermediate lateral support (ASTM 1996). The ends were laterally supported to prevent slippage, although no attempt was made to stabilize them. An inspection of the building indicated that the timber had been installed green and many members had developed significant drying checks and/or splits. In spite of being in service for 55 years and containing many in-service defects, 75% of columns were graded as No. 2 or higher and 40% as

Select Structural. In-service defects, such as checks, splits, and mechanical damage, resulted in downgrading of approximately one-third of the columns. To study the effect of defects on column strength, "checked" and "unchecked" members were selected on site. Checks had little effect on column compressive strength (Fig. 1). All columns were found to be higher in strength than expected by current design procedures (Fig. 2).

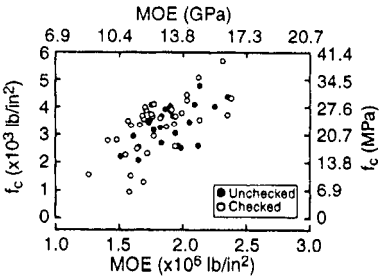

Figure 1. Effect of checks on strength of 8 by 8 columns.

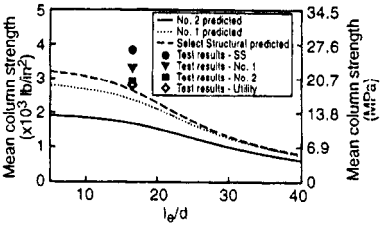

Figure 2. Comparison of actual and predicted strength of columns,

More than 900 pieces of 2 by 4, 2 by 6, 2 by 8, and 2 by 10 lumber (standard 38 by 89, 38 by 140, 38 by 191, and 38 by 235 mm lumber) were: collected from four deconstructed buildings at Fort Ord (Falk et al. 1998a). Most pieces graded as Structural Joists and Planks qualified for No. 2 grade (47%); most 2 by 4 pieces were graded as Standard (68%). As expected, Douglas Fir was the predominate species group (92%), although Hem-Fir (6%) and sugar pine (2%) were also present. From the standpoint of structural use, the most distinguishing feature of the recycled lumber compared to freshly sawn lumber was the presence of damage, which may have been a result of the original construction process (for example, nail holes, bolt holes, saw cuts, notches), building use (drying defects, decay, termite damage), and/or the deconstruction process (edge damage, end splitting, gouges). Damage reduced the average grade of the lumber (Fig. 3).

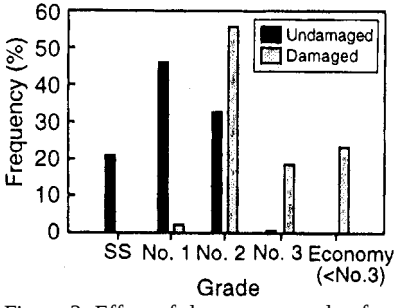

Figure 3. Effect of damage on grade of 2 by 8 lumber. n = 504.

Conclusions

Results to date indicate that heart checks lower the modulus of rupture in recycled timber beams but have little effect on the strength of recycled timber columns. The quality of dimensional lumber from the reconstructed buildings is on average one grade lower than that of freshly sawn lumber as a result of damage incurred during deconstruction. Because the value of lumber is tied directly to its quality, evaluation of the grades of lumber from these buildings will help determine reuse options and market value.

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