

THE PROPERTIES OF LUMBER AND TIMBER RECYCLED FROM DECONSTRUCTED BUILDINGS

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SUMMARY

This paper overviews recent efforts by the Forest Products Laboratory of the USDA Forest service, in cooperation with the U.S. Army and the West Coast Lumber Inspection Bureau (WCLIB), to develop information on the grade yield and engineering properties of lumber and timber recycled from deconstructed buildings. More than 1,700 pieces of lumber and timber have been collected to date, ranging in size from 38 by 90 mm (2 by 4 in.) to 220 by 445 mm (10 by 18 in.). This material has been gathered from two military bases. This paper presents the effects of splits on timber beam and column strength and the effects of damage on lumber grade yield.

INTRODUCTION

Building demolition is often a wasteful process, with potentially valuable wood materials ending up as broken-up waste destined for the landfill. In the United States, the practice of building deconstruction (or reverse construction) is being evaluated as an environmentally attractive alternative to demolition. An important aspect of deconstruction is reusing the salvaged materials. Because the reclaimed lumber is often damaged in both the construction and deconstruction processes, it needs to be evaluated in terms of options for reuse.

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 dimensional lumber stock [1-3]. Ongoing research at the Forest Products Laboratory (FPL) is characterizing the grade distributions and engineering properties of lumber and timber recycled from deconstructed buildings [4-7]. 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. This paper highlights results of tests on timbers in bending and columns in compression, and the grading of dimension lumber

TCAAP PROJECT

working cooperatively with the FPL, the U.S. Army Successfully recycled more than 4,700 m³ (2 million board feet) of lumber and timber from two large military industrial buildings at the TCAAP [8,9]. In 1995, research staff at the FPL worked cooperatively with U.S. Army facilities engineers and demolition contractors at the TCAAP to select a sample of lumber and timber

members from Building 503 for testing. This 59,000-m² (548,000-ft²) heavy timber building contained approximately 4,400 m³ (1,875,000 board feet) of softwood timber, primarily Douglas Fir. Approximately 82.6 m³ (35,000 board feet) of lumber and timber were collected, ranging in size from 140 by 190 mm (6 by 8 in.) to 240 by 445 mm (10 by 18 in.). Details have been reported [5-7].

FORT ORD PROJECT

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 that 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 job creation involved in building disassembly, material collection, and material reuse [3]. 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 deconstructed buildings.

GRADING METHODOLOGY

The lumber and timber collected from the two 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* [10]. The WCLIB is one of six rules-writing agencies recognized by the American Lumber Standard Committee. Particular attention was paid to damage, defined as holes resulting from nails or bolts, splits resulting from factors other than drying, saw cuts, notches, decay, and mechanical damage (such as gouges, broken ends, 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

Beam Strength

Ninety 140- by 190-mm (6- by 8-in.) timbers were collected from the TCAAP and shipped to the FPL for testing [7]. 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 procedures [11]. Analyses of the 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.

Column Strength

Nominal 190- by 190-mm (8- by 8-in.) Douglas Fir columns were collected at TCAAP and sent to FPL for testing [5]. Columns were tested in direct compression with no intermediate lateral support [11]. The ends were laterally supported to prevent slippage, although no attempt was made to secure the ends. 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 the fact that the wood had been in service for 55 years and contained many in-service defects, 75% of the 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. The selection criteria were rather qualitative; Figure 1 indicates a typical “checked” member. Checks had little effect on column compressive strength (Fig. 2). All columns were found to be higher in strength than expected by current design procedures (Fig. 3).

Lumber Grading

More than 900 pieces of nominal 2 by 4, 2 by 6, 2 by 8, and 2 by 10 lumber (standard 38 by 90, 38 by 140, 38 by 190, and 38 by 235 mm lumber) were collected from four deconstructed buildings at Fort Ord [4]. Most pieces graded as Structural Joists and Planks qualified for the No. 2 grade (47%); most of the 2 by 4 pieces were graded as Standard (68%). As expected, Douglas Fir was the predominant species (92%), although Hem-



Figure 1—Typical “checked” column.

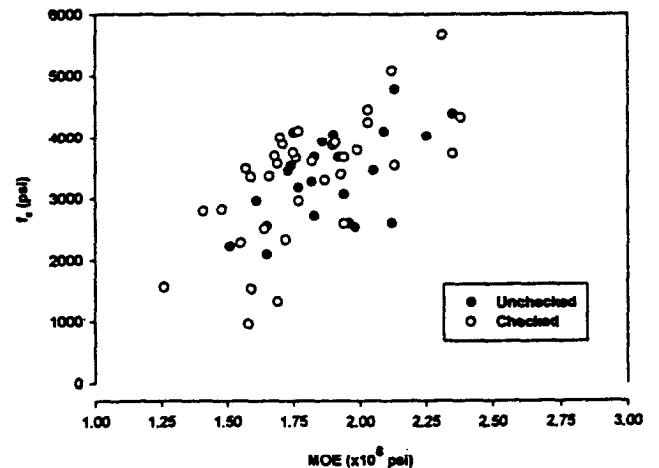


Figure 2—Effect of checks on 8 by 8 column strength. $1,000 \text{ lb/m}^2 = 6.9 \text{ MPa}$.

Figure 3—Comparison of tested 8 by 8 column strength to design equation. $1,000 \text{ lb/in}^2 = 6.9 \text{ MPa}$

Fir (6%) and sugar pine (2%) were also present. From the standpoint of structural use, the most distinguishing feature of recycled lumber compared to freshly sawn lumber is the presence of damage, which may be a result of the original construction process (for example, nail holes, bolt holes, saw cuts, notches), building use (drying defects, decay and termite damage), and/or the deconstruction process (edge damage, end splitting, gouges). Damage reduced the average grade of the lumber (Fig. 4).

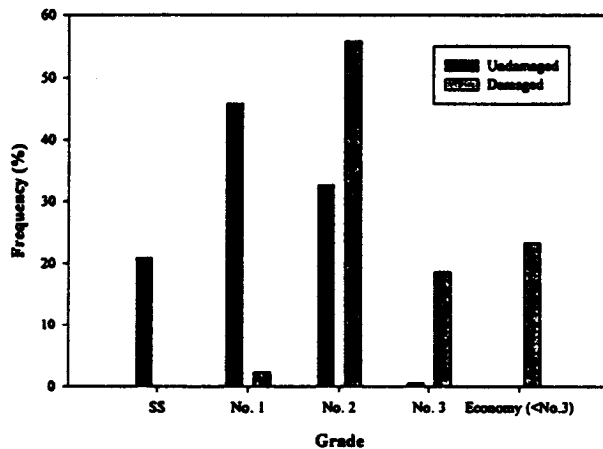


Figure 4—Grade reduction of 2 by 8 lumber resulting from damage. $n = 504$.

CONCLUSIONS

Results to date indicate that heart checks lower the modulus of rupture of recycled timber beams but have little effect on the strength of recycled timber columns. As a result of damage, the quality of dimensional lumber from non-industrial military buildings is on average one grade lower than that of freshly sawn lumber. 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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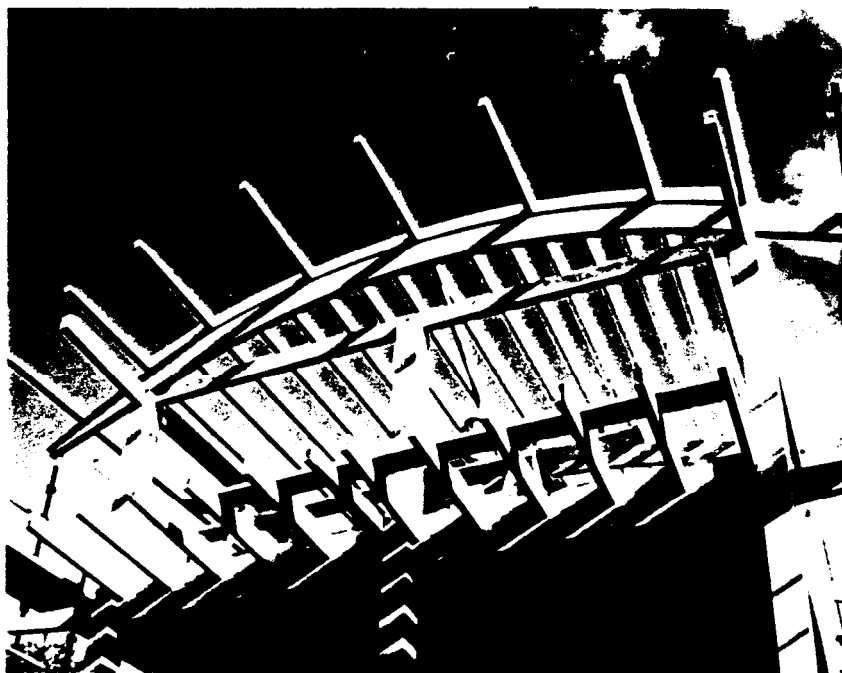


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