The Problem: Can American elm be dried without excessive warping?

The Answer: By John M. McMillen, Technologist

American elm is known to warp considerably during seasoning. The basic cause is longitudinal shrinkage that is due principally to spiral grain and tension wood. In addition, wood from small logs will cup, and there is a considerable tendency for distortion around knots. A series of pilot study kiln runs was made at the Forest Products Laboratory with 4/4 American elm to determine the effects of drying procedures on warping.

Commerically, elm is divided into the rock elm and the soft elm groups. American elm (Ulmus americana L.), regardless of its actual hardness, falls in the soft elm group along with slippery elm (U. rubra Muhl.). The American elm is sometimes subdivided commercially into a soft gray type and a hard or second-growth type. Specific gravity tests on elm selected to represent the two types disclosed that the gray elm was average or lower in specific gravity, while the hard type was average or higher in specific gravity. There is no recognized botanical division between these two types of American elm, but the gray-type elm is readily recognized by its narrow growth rings. The hard-type elm has wide rings—about 5 to 9 per inch of radius—and considerable more luster than the gray type.

Quality of Elm

The material investigated came from forest sites or large woodlots. American elm trees grown in such sites have a straight central stem 2 to 4 logs high. They can be expected to produce a reasonably high proportion of fairly straight-grain lumber. Open-grown or street-tree elm was not studied.

Results of Pilot Studies

The results of the various kiln runs are shown in table 1. Surface and end checking was no problem with any of the schedules. An arbitrary method was used for judging warping results. This consisted of tallying the 4-foot lengths that would not plane out to a full 13/16-inch dimension for their full width and length. This evaluation indicated the suitability of the stock for paneling as well as for larger furniture cuttings. The percentage figures shown do not indicate complete losses, however, for many shorter cuttings would be suitable for fine furniture use.

1 The data were obtained by M. Y. Pillow, Technologist.

† Maintained at Madison, Wisconsin in cooperation with the University of Wisconsin

(Report) No. 1769-26

Agriculture - Madison

July 1960
The moderate-temperature kiln schedule formerly recommended for drying 4/4 American elm caused too much warping with both the gray- and the hard-type elm. The low-temperature schedule resulted in considerably less warping with both types of elm. Drying time was extended somewhat, but not excessively, with the low-temperature schedule. Elm appears to dry rapidly under low-temperature drying conditions.

Even with the low-temperature schedule, however, the hard-type elm kiln dried from the green condition warped too much for general commercial use. A preliminary air-drying period before kiln drying appears to be desirable with this class of stock.

The inclusion of logs from large limbs and upper portions of trees in a kiln charge greatly increased the warping when the moderate-temperature schedule was used, but preliminary air drying followed by low-temperature kiln drying greatly reduced warping in this class of stock.

Kiln run E was made on 4/4 elm from a southern Wisconsin farm woodlot. This stock was air dried for 20 days to a moisture content of 37 percent. Kiln drying was started at a temperature of 100° F., and the total drying time was 6-7/10 days. The air-dried material in run A was at 22 percent moisture content; therefore, it started at the higher temperature of 120° F., and total drying time was 3-9/10 days. The complete kiln schedule for kiln run E is shown in table 2.

**Recommended Drying Procedures**

The best procedure for reducing warp to a minimum during seasoning of American elm lumber for interior uses appears to be a combination of air drying and low-temperature kiln drying. Since elm is a very permeable wood and dries quite rapidly during air drying and low-temperature kiln drying, this procedure does not appear uneconomical. For general use, air drying to 18 percent moisture content may be enough.

Air drying should be done in roofed piles following good stacking practices (fig. 1). When package handling with fork-lift trucks is used, the general practice is to pile the packages horizontally. Open-type pile foundations should hold the bottom layers 12 to 16 inches above the ground and should fully support at least five tiers of stickers. The center supports can be removable to allow for passage of the fork-lift truck. Stickers should be in perfect vertical alignment above the supports.

Additional tiers of stickers will help control warping of lumber more than 10 feet long. Spacing between rows of packages should be at least 3 feet. Between piles within each row, at least 18 inches should be allowed. Watertight roofs should be used to reduce damage to top layers. Air drying preliminary to kiln drying generally should be continued until the moisture content of the lumber is down to 25 percent.
or less. Best kiln-drying results in the pilot studies were obtained with
the T2-D5 schedule. The final dry-bulb temperature with this schedule is
150° F., which was the temperature used during equalizing also. A
temperature of 170° F. was used during the final 24-hour conditioning
treatment.

Commercial kiln operators have reported satisfactory results when drying
soft elm from the green condition by using the T6-D4 schedule for
4/4 stock. Information on these kiln schedules, as well as details of
equalizing and conditioning treatments to obtain stock of uniform
moisture content free of drying stresses, is given in Forest Products
Laboratory Report No. 1900-5. Information on use of kiln samples to
follow the kiln schedules is presented in a separate report.

Other Considerations

For best production of high quality material, consideration should be
given to log preparation or bucking. The use of small logs from the
tree tops, however, may not be as desirable for elm as for other species;
since material from even reasonably straight logs from elm tops may
warp excessively. Attention also should be given to sawing procedure.
For a wood such as elm, in which warping is a major problem, sawing the
boards to a uniform thickness is very important.

To avoid spread of Dutch elm disease or other elm disease, standard
edging and trimming practice may have to be modified to remove all bark.
This would be especially desirable if lumber from an infected area is
going to be shipped out green or air dried before kiln drying. Beetles
that spread the disease live in the bark of both dead and dying material.
All slabs and edgings from infected areas should be burned. If logs
must be stored awhile or shipped some distance, local forestry authorities
should be consulted about removing the bark or spraying with DDT or Lindane
to prevent emergence of elm bark beetles. They also should be consulted
as to the advisability of burning or spraying with an insecticide all
slash and stumps left in the woods.

2U.S. Forest Products Laboratory. Kiln Schedules and Drying Time.
3U.S. Forest Products Laboratory. Use of Kiln Samples in Operating a
1954.
4Whitmore, R. A., Jr., and Jackson, W. L. Increase Your Profit in the
Woods. Central States Forest Experiment Station Tech. Paper 151
(Columbus, Ohio), 1956.
5Malcolm, F. B. A Simplified Procedure for Developing Grade Lumber from
<table>
<thead>
<tr>
<th>Kiln: Log</th>
<th>Moisture</th>
<th>Kiln 1 Temper:</th>
<th>Drying time for 4-foot lengths</th>
<th>4-foot lengths</th>
<th>Put in kiln:</th>
<th>Start:</th>
<th>Out full width:</th>
<th>Percent:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trunk and:</td>
<td>Air-dried</td>
<td>T2-D5:</td>
<td>120</td>
<td>3.9</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butt:</td>
<td>Green</td>
<td>T2-D5:</td>
<td>100</td>
<td>5.5</td>
<td>9.7</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>...do...:</td>
<td>...do...:</td>
<td>T8-D4:</td>
<td>130</td>
<td>3.5</td>
<td>7.2</td>
<td>29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trunk and:</td>
<td>Limb:</td>
<td>T8-D4:</td>
<td>130</td>
<td>3.5</td>
<td>7.0</td>
<td>45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butt and:</td>
<td>Second:</td>
<td>Air-dried</td>
<td>T2-D5:</td>
<td>100</td>
<td>5.0</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butt and:</td>
<td>Second:</td>
<td>Green</td>
<td>T2-D5:</td>
<td>100</td>
<td>5.5</td>
<td>9.7</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>...do...:</td>
<td>...do...:</td>
<td>T8-D4:</td>
<td>130</td>
<td>3.5</td>
<td>7.2</td>
<td>20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HARD-TYPE ELM

GRAY-TYPE ELM

1 U.S. Forest Products Laboratory Report 1900-5.
Table 2.--Kiln schedule T2-D5 as used on 4/4 American elm air dried to 37 percent moisture content

<table>
<thead>
<tr>
<th>Moisture content at start of step</th>
<th>Dry-bulb temperature °F.</th>
<th>Wet-bulb depression °F.</th>
<th>Wet-bulb temperature °F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 30</td>
<td>100</td>
<td>120</td>
<td>80</td>
</tr>
<tr>
<td>30</td>
<td>110</td>
<td>30</td>
<td>80</td>
</tr>
<tr>
<td>22</td>
<td>120</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>16</td>
<td>130</td>
<td>50</td>
<td>80</td>
</tr>
<tr>
<td>12</td>
<td>150</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Equalizing²</td>
<td>150</td>
<td>29</td>
<td>121</td>
</tr>
<tr>
<td>Conditioning³</td>
<td>170</td>
<td>8</td>
<td>162</td>
</tr>
</tbody>
</table>

1When drying green material, initial wet-bulb depression is 10° F. See U.S. Forest Products Laboratory Report 1900-5.

2Start when driest sample reaches 6 percent moisture content.

3Start when wettest sample reaches 8 percent moisture content; continue 16 to 24 hours.
Figure 1.—Good hand piling method for air drying elm lumber.

(ZN 72541 F)