Full-Cell Treatment of Kiln-Dried Douglas Fir Crossties With Creosote and Creosote-Coal Tar

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SUMMARY

Study was made of 72 kiln-dried Douglas fir crossties to compare retentions and penetrations in pressure treating with creosote-coal tar solution to results from treating with creosote only.

Adequate penetration and retention were found possible with creosote-coal tar, but extended treating cycles would be required for results comparable with creosote alone.
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INTRODUCTION

Creosote-coal tar solutions have been used for treatment of round and sawed Southern pine timbers for marine use and are now being specified for Douglas fir. Although sawed Douglas fir is treated regularly with creosote to retentions as high as 12 lb per cu ft (pounds per cubic foot), there is some question as to retentions that can be obtained with creosote-coal tar solutions.

Previous work at the Oregon Forest Products Laboratory with end-coated round Douglas fir sections had shown that round material would be more difficult to treat with coal tar solutions than with creosote alone. The present work was initiated to obtain data on penetrations and retentions that could be obtained in sawed Douglas fir timbers with both preservatives. Additional information also was desired on kiln drying timbers of large cross-section.

MATERIAL AND EQUIPMENT

Wood

Seventy-two 6- by 8-inch by 8-foot incised, unseasoned, Coast-type Douglas fir crossties were supplied by the Southern Pacific Company. The ties were predominantly heartwood; 68 per cent were boxed heart (pith present on one or both ends). Their average initial moisture content when received was about 41 per cent.

Preservatives

At 200 and 220 F, viscosities of unused creosote-coal tar and used creosote were similar, but there was marked increase in viscosity of creosote-coal tar at temperatures under 180 F. Used creosote-coal tar was much higher both in viscosity and in specific gravity than were unused creosote-coal tar and used creosote.
Treating plant

All charges were treated in an experimental plant having a cylinder 3 feet in diameter and 10 feet long. Treating cylinder and overhead Rueping tank were equipped with steam coils. Temperature was controlled manually, but pressure was regulated by a cam-operated control valve.

PROCEDURE

Kiln drying

All crossties were dried in one kiln charge in a reversible cross-circulation kiln. Initial drying conditions of 150°F and EMC (equilibrium moisture content) conditions of 12 per cent were maintained for 10 days. Final drying conditions of 150°F and EMC conditions of 8 per cent were maintained for 4 days.

A number of ties were weighed periodically during drying to measure drying rate. After kiln drying, moisture distribution was determined in 10 specimens at depths from 1/2 to 2 inches with a resistance-type moisture meter and nails for electrodes.

Checking after 10 and 14 days of drying was evaluated by the following rating system:

0--Little or none
1--Slight checking
2--Moderate checking
3--Severe checking

Typical examples of these ratings are shown in Figure 1.

Preservative treatment

Kiln-dried crossties were grouped into 6 charges of 12 specimens each. Three charges were treated with creosote-coal tar by the full-cell process. One creosote-coal tar charge was pressed to refusal (11.5 hours); remaining creosote-coal tar charges were pressed for 6 or 3.5 hours. Treating schedules were duplicated for creosote treatments. All charges were pressed at a maximum pressure of 120 psi, built up at a rate of 1 pound per minute.

Preservative recovery during the one-hour final vacuum was determined by draining the retort into a small pressure vessel that was isolated and drained at 15-minute intervals.

Retentions of individual pieces were determined by weighing specimens before and after treating. Penetration was determined from two borings taken from opposite faces near the mid-section of each piece. Solid-black and ringed (summerwood only) penetrations were measured to the nearest 0.05 inch.
RESULTS

Kiln Drying

Drying rate

At 150°F and EMC conditions of 12 per cent, average moisture content of the crossties was reduced from 39 down to 29 per cent in 10 days. Lowering the EMC conditions to 8 per cent accelerated drying, and average moisture content was reduced to 24 per cent in 4 more days.

Moisture distribution

Moisture content at crosstie surfaces was slightly less than 8 per cent, while moisture content at a depth of 1 inch was 22 per cent. Extrapolation of the average moisture content curve indicated that moisture content at mid-thickness was about 39 per cent.

Checking

Most of the ties were in good condition after kiln drying to a moisture content of 24 per cent, and were fairly free of large end checks (Figure 2). Surface checks were well developed at a moisture content of 29 per cent, although no severe checks were noted until the average moisture content had reached 24 per cent (Table 2). Seven per cent of the ties were rated as having severe surface checks at 24 per cent moisture content, and 10 per cent of the ties were twisted. Both twist and severe checks were limited to boxed heart ties. None of the ties contained splits, although one tie had a broken end.

Preservative Treatment

Treating did not increase checking, nor did the ties bleed during subsequent storage outdoors in hot weather. All ties were in good condition (Figure 3), although those treated with creosote-coal tar had grease-like surface deposits, particularly on the ends.

Retention

Retention rates were consistently higher with creosote than with creosote-coal tar (Table 1). Refusal was reached in 6.5 hours with creosote and in 11.5 hours with creosote-coal tar. Retention of creosote-coal tar increased with pressing.
time, ranging from 14 lb per cu ft at 3.5 hours to 19 lb per cu ft at 11.5 hours. There was only slight increase in retention of creosote with extended pressing time; from 20 lb per cu ft at 3.5 hours to 22 lb per cu ft at 11.5 hours.

Penetration

Deeper and more uniform average penetration was obtained with creosote than with creosote-coal tar (Table 1). Average penetration of creosote-coal tar increased from 0.9 to 1.5 inches when pressing time was increased from 3.5 to 11.5 hours. With similar pressing times, average penetration of creosote increased from 1.3 to 1.8 inches. Typical side and end penetrations are illustrated by Figures 4 and 5.

Preservative recovery

Preservative amounting to from 1 to 2.4 lb per cu ft of wood was recovered during final vacuum. Eighty-five per cent was recovered during the first 30 minutes. Creosote recovery was higher than was recovery of creosote-coal tar. Total recovery varied from 6 to 10 per cent of net retention.

DISCUSSION OF RESULTS

Kiln drying

Although average reduction in moisture content of the crossties was 1 per cent per day at 150 F and EMC conditions of 12 per cent and was slightly more than 1 per cent per day at EMC conditions of 8 per cent, drying time could have been accelerated by initiating the lower EMC conditions 2 days earlier. Excellent condition of the dried material indicated that accelerated drying schedules might not result in excessive checking and would likely reduce drying time.

Wood with a normal moisture gradient can be expected to have its average moisture content at a depth of 20 per cent of its thickness. The average moisture content of 10 ties at 1.2 inches below the surface of the wide face was 24.6 per cent, which compared closely with the estimated average moisture content of 24 per cent.

The number of ties rated with none, or slight, surface checking was surprisingly high at both 29 and 24 per cent moisture contents (Table 2). Even ties rated as severely checked in the study were usable.
Preservative treatment

High retentions obtained with creosote and low retentions obtained with creosote-coal tar undoubtedly reflected differences in viscosities of these preservatives at the temperatures studied. However, both retention and penetration of creosote-coal tar after a pressing time of 3.5 hours exceeded minimum requirements specified in American Wood Preserver's Association Standard C2 (minimum penetration of 0.5 inch and retention of 12 lb per cu ft) for Douglas fir timbers in marine waters.

Results indicated it may be possible eventually to increase both penetration and retention requirements for Douglas fir installed in waters where attack by marine borers is a serious problem. They also indicated that treatment to refusal may result in much higher retentions than are expected generally in this species.

Final vacuum periods of over 45 minutes appeared of questionable value.

CONCLUSIONS

Adequate penetration and retention of both creosote and creosote-coal tar can be obtained in incised Douglas fir ties dried to an average moisture content of 24 per cent.

Extended treating cycles will be required with creosote-coal tar solutions for results comparable to those obtained with creosote.

Kiln drying Douglas fir timbers under conditions more severe than were applied in this study merits further investigation.
Table 1. Results From Full-Cell Treatment of Incised Douglas Fir Crossties With Creosote and Creosote-Coal Tar.

<table>
<thead>
<tr>
<th>Pressing time</th>
<th>Retention</th>
<th>Final vacuum recovery</th>
<th>Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>By weight</td>
<td>Range</td>
<td>cu ft</td>
</tr>
<tr>
<td>Hours</td>
<td>Lb per</td>
<td>Lb per</td>
<td>cu ft</td>
</tr>
<tr>
<td>Creosote-coal tar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5</td>
<td>13.8</td>
<td>10-18</td>
<td>1.0</td>
</tr>
<tr>
<td>6.0</td>
<td>15.8</td>
<td>10-24</td>
<td>1.5</td>
</tr>
<tr>
<td>11.5²</td>
<td>19.2</td>
<td>14-26</td>
<td>---</td>
</tr>
<tr>
<td>Creosote only</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5</td>
<td>20.3</td>
<td>14-26</td>
<td>1.3</td>
</tr>
<tr>
<td>6.0</td>
<td>22.2</td>
<td>17-29</td>
<td>2.4</td>
</tr>
<tr>
<td>11.5³</td>
<td>21.8</td>
<td>17-26</td>
<td>2.3</td>
</tr>
</tbody>
</table>

1 Total, including ringed penetration in summerwood.

2 To refusal, as defined in par. 3.1, Standard M2-54, American Wood Preserver's Association Manual of Recommended Practices.

3 Refusal point was reached after 6.5 hours pressing.
Table 2. Seasoning Defects in Douglas Fir Crossties Kiln-Dried at 150 °F to Moisture Contents of 29 and 24 Per Cent.

<table>
<thead>
<tr>
<th>Average moisture content</th>
<th>Drying conditions</th>
<th>Pieces with surface checks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Temperature (°F)</td>
<td>EMC (% MC)</td>
</tr>
<tr>
<td>Per cent</td>
<td>Per cent</td>
<td>Days</td>
</tr>
<tr>
<td>29</td>
<td>150</td>
<td>12</td>
</tr>
<tr>
<td>24</td>
<td>150</td>
<td>8</td>
</tr>
</tbody>
</table>
Figure 1. Typical examples of ratings to define severity of surface checking in kiln-dried crossties.

Figure 2. Coast-type Douglas fir crossties kiln-dried to average moisture content of 24 per cent.

Figure 3. Kiln-dried and full-cell-treated Douglas fir crossties. Two top courses were treated with creosote. Two bottom courses were treated with creosote-coal tar.
Figure 4. Penetration in Douglas fir crossties treated with creosote-coal tar (left), and with creosote (right).

Figure 5. Side and end penetrations in Douglas fir crossties treated with creosote-coal tar (on left in each pair) and with creosote (on right in each pair).