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DETECTION AND RELIEF OF CASEHARDENING AND FINAL MOISTURE CONTENT TESTS IN KILN-DRIED LUMBER

Nonuniformly dried, casehardened wood will usually distort during machining. The distortion may be due to a change in moisture content, to unbalance of drying stresses, or both. Moisture content and the presence of drying stresses cannot be determined by visual inspection of the surface of the wood. They are easily determined, however, by simple tests. These tests are made from the kiln samples or from fairly representative boards selected from the kiln charge following the conditioning treatment.

From the samples or boards, three cross sections are cut (fig. 1, top, left). The sections should be cut from about the longitudinal center of a kiln sample and 20 inches or more from the ends of test boards.

Test for Moisture Content

Use one section (fig. 1, top, center) to find the average moisture content of the test piece. To do this, weigh the section, immediately after cutting it, on a balance or scale calibrated in grams, to 1/10 gram. Then dry it in an oven at 214° to 221° F. (101° to 105° C.) until it reaches constant weight. The weight lost during this drying is the weight of the moisture that was in the section. Divide this weight by the weight of the oven-dry section and multiply by 100. This value is the percentage of moisture that was present in the section at the time of test.

Example: Weight of section when cut.....27 grams
Weight of section after oven-drying..25 grams
Weight of water in section..... 2 grams

$$\text{Moisture content} = \frac{2}{25} \times 100 = 8 \text{ percent}$$

Another section is cut, as shown in figure 1, top row, right, to determine how uniformly the moisture is distributed. The core and shell are weighed separately, oven-dried to constant weight, reweighed, and their moisture content calculated.

Test for Casehardening

Preparing Test Sections

Use the third section for casehardening tests. This section is sawed parallel to the wide faces of the original board to form prongs (fig. 1, center and bottom). The saw cuts should extend from one edge to within 1/2 to 3/4 inch of the other edge of the section. Stock less than 6/4 inch should be sawed to produce 3 prongs of equal thickness, and stock 6/4 inch and thicker should be sawed into 6 prongs of equal thickness (fig. 1, left specimen, center and bottom rows). In a 3-prong test section the center prong should be broken out. Prongs 2 and 5 are removed from a 6 prong test section.

Evaluating Casehardening Test Sections

When the kiln operator believes casehardening has been relieved, the kiln should be shut off and some of the kiln samples or other boards removed and tested. If, at the time of sawing, the outer prongs of the test section turn away from the saw a distance about equal to the thickness of the prong or slightly more, the stock is usually free of casehardening and the charge can be pulled. If, however, the outer prongs remain straight or pinch the saw, the stock is still casehardened and the conditioning treatment should be resumed until subsequent tests show satisfactory relief.

After the preliminary evaluation is made, the test sections should be room dried for about 24 hours. The following conditions may then be observed:

- (1) The outer prongs have turned in considerably (fig. 1, center specimen, middle and bottom rows). This indicates that the stock is still casehardened and the conditioning treatment on subsequent charges of the same material should be extended.
- (2) The outer prongs are straight (fig. 1, left specimen, middle and bottom rows). This indicates that the lumber is free of casehardening and subsequent charges of the same material should have the same conditioning time.

Table 1.--Kiln sample moisture content and equilibrium moisture content (EMC) values for equalizing and conditioning a charge of lumber

| Desired final average moisture content | | Equalizing | | Conditioning | |
|--|--------------------|---|--------------------------|--------------------------|---------|
| Moisture content of driest sample at start | EMC for equalizing | Moisture content of wettest sample at end of equalizing | EMC values for softwoods | EMC values for hardwoods | |
| Percent | Percent | Percent | Percent | Percent | Percent |
| 5 | 3 | 3 | 5 | 8 | 9 |
| 6 | 4 | 4 | 6 | 9 | 10 |
| 7 | 5 | 5 | 7 | 10 | 11 |
| 8 | 6 | 6 | 8 | 11 | 12 |
| 9 | 7 | 7 | 9 | 12 | 13 |
| 10 | 8 | 8 | 10 | 13 | 14 |
| 11 | 9 | 9 | 11 | 14 | 15 |

(3) The outer prongs have turned out considerably (fig. 1, right specimen, middle and bottom rows). This indicates that the stock is reverse casehardened. Subsequent charges of similar material should be conditioned at a lower relative humidity or for a shorter time.

If the prong tests are made on stock that has cooled 24 hours or has been stored for some time, the outer prong reactions may be the same as those obtained on sections that have been room dried for 24 hours. Final evaluation, however, should not be made until after 24 hours of room drying.

Relief of Casehardening

Casehardening can be relieved in a dry kiln by a conditioning treatment at the end of the drying. To be assured of good relief of casehardening in all of the stock, the difference in moisture content between all boards in the kiln charge should not be too great. The desired uniformity of moisture content among boards can be obtained by an equalizing treatment.

Equalizing Treatment

The procedure for equalizing a kiln charge of lumber, using the values given in table 1, is as follows:

(1) Start equalizing when the driest kiln sample in the kiln charge has reached an average moisture content 2 percent below the desired average moisture content. For example, if the final average is 8 percent, start equalizing when the driest sample reaches 6 percent.

(2) When the driest sample reaches the moisture value stated in step 1, establish an equalizing equilibrium moisture content (EMC) in the kiln equal to that value. For the example given in step 1, this would be 6 percent. During equalizing, use as high a dry-bulb temperature as the drying schedule permits.

(3) Continue equalizing until the wettest sample reaches the desired final average moisture content. In the example given in step 1, the wettest sample should be dried to 8 percent.

Conditioning Treatment

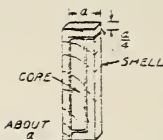
The conditioning procedure, using the data of table 1, is as follows:



METHOD OF CUTTING FINAL MOISTURE CONTENT AND CASEHARDENING SECTIONS FROM KILN SAMPLE AFTER KILN DRYING



MOISTURE SECTION



MOISTURE DISTRIBUTION SECTION

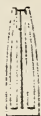
FINAL MOISTURE SECTIONS



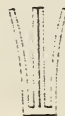
STOCK $\frac{1}{2}$ " AND THICKER SHOULD BE SAWED AS SHOWN SO AS TO PRODUCE SIX PRONGS OF EQUAL THICKNESS FOR CASEHARDENING TEST. PRONGS 2 AND 5 SHALL BE BROKEN OUT.



NO CASEHARDENING



SEVERE CASEHARDENING



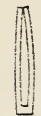
SEVERE REVERSE CASEHARDENING



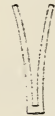
STOCK LESS THAN $\frac{1}{2}$ " THICK SHOULD BE SAWED AS SHOWN SO AS TO PRODUCE THREE PRONGS OF EQUAL THICKNESS FOR CASEHARDENING TEST. THE CENTER PRONG SHALL BE BROKEN OUT



NO CASEHARDENING



SEVERE CASEHARDENING



SEVERE REVERSE CASEHARDENING

CASEHARDENING SECTION: SECTION TO BE ROOM DRIED BEFORE CONCLUSION IS MADE AS TO CASEHARDENING

Figure 1. --Method of cutting sections for stress determinations in kiln-dried lumber.

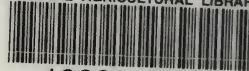
(1) As soon as the wettest sample reaches the moisture content stated in step 3 of the equalizing procedure, conditioning should be started. The conditioning EMC should be 3 percent above the desired final average moisture content for softwoods and 4 percent above the desired final average moisture content for hardwoods. For example, if a hardwood is involved and the final desired moisture content is 8 percent, the conditioning EMC is 12 percent.

(2) Continue conditioning until satisfactory stress relief is attained. This time may vary between 4 and 48 hours, depending upon the species and thickness of the stock.

It is advisable to hold conditioning time to a minimum to decrease steam consumption and avoid excessive moisture regain.

Equilibrium moisture content (EMC) is defined as the moisture content at which wood neither gains nor loses moisture when surrounded by air at a given relative humidity and temperature. It is also used to designate a set of relative humidity and temperature conditions which correspond to a certain equilibrium moisture content.

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