

## VARIABILITY IN AIR-DRYING RATES OF INCENSE CEDAR SQUARES

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### Introduction

Incense cedar, like many western coniferous species, is a difficult species to dry, especially green from the saw. Because of this it is usually initially air dried and then kiln dried. Total air drying time is highly variable, ranging from several to as much as 18 months. With increasing raw material costs and particularly inventory holding costs, there is a real need to reduce air drying time and obtain greater control of air yard throughput.

A large variability in drying rate is one of the reasons why incense cedar is a difficult species to dry. Smith and Berolzheimer (1957, 1959) found that incense cedar lumber and squares could be reasonably effectively green sorted into general drying classes on the basis of color and weight. The light colored faster drying sapwood could be color separated from the dark color slow drying heartwood. A further segregation could then be made of the heartwood material with the moderately slow drying lighter (weight) heartwood being separated from the slow drying heavy (weight) heartwood.

Resch *et al.* (1968) also reported upon the effectiveness of using a color and/or weight segregation of this species and identified four different sorts; one sapwood and three heartwood classes. In this case weight was expressed in terms of initial weight per unit volume (wt/vol) or weight per unit length (wt/ft). For the heartwood the greater the wt/ft the longer the drying time. Unfortunately the sample size was somewhat limited.

With a successful segregation, regardless of the exact technique used to carry it out, one can dry the different sorts obtained separately. One can then pull the material that dries faster considerably before the slower drying portion. This is in contrast to present practice where generally all material is left on the yard and pulled only when the slowest drying material has finally reached the desired final equilibrium moisture content. This results in the faster drying material being left on the yard much too long and reduces the overall yard throughput; a problem completely analogous to redry in kiln drying.

One should note that in terms of potential segregation techniques weight and length are relatively easy variables to measure and hence adaptable to use in a mill situation.

### Purpose

With the above background and logic in mind, the general purpose of this study was to investigate the technical and economic

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feasibility of introducing a drying rate segregation into an incense cedar air drying system.

The specific objectives were:

1. To determine the relative variability in air drying rates between incense cedar squares.
2. To determine if one can use either weight per unit length, or a sapwood-heartwood segregation, or a combination of the two, as a viable green segregation technique.

#### Material

Sample material was obtained from the green chain of a mill in northern California. All heartwood, all sapwood and mixed heart-sapwood squares were pulled, weighed to the nearest 0.05 lb and the wt/ft calculated. A total of 391, 16-foot long squares were selected (Table 1). Selection was made with the intent of having a reasonably uniform distribution of squares over the total range of wt/ft found.

Table 1. Number of 3-1/8 by 3-1/8 by 192" Long Squares Selected by Sapwood/Heartwood Classes.

Type of Material	Number of Squares
100% sapwood	61
75% "	57
50% "	56
25% "	82
0% sapwood (all heart)	<u>135</u>
Total squares	391

The distribution of squares by their green or initial wt/ft is shown in Fig. 1. The squares ranged from approximately 1.30 lb/ft to 4.9 lb/ft or 13 to 80 lbs for a 16-ft long square. The vast majority of squares were between 1.7 to 3.0 lb/ft. The squares represented by the hatched bars were squares of either 75 or 100 percent sapwood, which were the heaviest squares.

#### Procedures

Once the squares were selected they were taken to the University of California Forest Products Laboratory for air drying. The squares, stuck every 4 ft with 3/4-inch thick stickers, were periodically weighed to obtain each individual square's drying curve. Air drying was carried out from March to October. At the end of this period the squares were placed in a kiln and conditioned to a 13 percent equilibrium moisture content. The moisture content of each square was then determined with a resistance moisture meter at 4 points along the length, thus permitting the square oven dry weight to be calculated.

#### Results

The drying curves for the fastest, slowest, and all the squares averaged together are shown in Fig. 2. This data indicates the observed variability in drying rate typical of the species. It is interesting to note that fastest drying square which was all sapwood had an initial moisture content of 186 percent and only took 35 days to reach a final moisture content of 15 percent. The

slowest drying square (all heartwood) while only having an initial moisture content of 68 percent, had a projected drying time to 15 percent of 551 days. The total variation in drying rate and its distribution can be better seen in Fig. 3, which is a frequency plot of air drying time to 15 percent moisture content with drying time divided into 10 day classes.

Having established the extent of variability in drying rate does not reveal whether it is predictable or not. In order to establish if total drying time to final moisture contents of 30, 25, and 15 percent can be accurately related to either percent sapwood or initial weight/length, simple and multiple linear regressions were carried out by computer. The results of these analyses are summarized in Table 2.

Table 2. Results of Simple and Multiple Linear Regressions.

Drying Time to a Moisture Content of	Versus	Simple or Multiple Correlation Coefficient Squared
	<u>Percent Sap</u>	$R^2$
30		.016
25		.005
15		.152
	<u>wt/ft</u>	
30		.300
25		.153
15		.004
	<u>Percent sapwood &amp; wt/ft</u>	
30		.406
25		.360
15		.356

For the three final moisture contents used, there appears to be little correlation between drying time and percent sapwood with the highest correlation (as expressed by the simple correlation coefficient sapwood) only being 0.152. While a somewhat better correlation exists between drying time to 30 percent moisture content and wt/ft it is still not very high and was essentially zero for drying time to 15 percent final moisture content.

Combining both of these variables lead to significantly better correlations for all three final moisture contents. While there was improvement the levels of these correlations are still far below that which would be necessary to seriously consider this approach. From these results we have concluded that neither percent sapwood nor weight/ft used alone or together can be successfully used to predict air drying time and hence make reasonably accurate drying sorts or segregations on an individual square by square basis. We feel that the correlation between variables should be greater than  $R=0.90$  for technical feasibility.

One is thus left with the same challenge that existed prior to the study--how can one easily and accurately predict total drying time or if this isn't possible, how to minimize the problem. The seriousness of variability in drying rate as it affects air

yard throughout is demonstrated in Table 3. This gives the average length of drying time needed to bring varying amounts of the stock down to a final moisture content of 15 percent. One can see that 50 percent of all the squares will have obtained 15 percent moisture content or less in 150 days, and that 90 percent of all the squares will be at this moisture content in 310 days or less. It takes, however, 400 plus days, or an additional 100 days to bring the last 10 percent or slowest drying material to the desired final moisture content. The decrease in potential air yard throughput when all squares are left to reach such a moisture content is quite obvious.

Table 3. Length of Air Drying Time Needed for Varying Percentages of the Sample Material to Reach a 15 Percent Final Moisture Content.

Percent of Material Having 15% Moisture Content or Less	Length of Air Drying (Days)
0	0
10	80
20	97
30	110
40	125
50	150
60	184
70	208
80	244
90	310
100	400+

One alternative to this practice is to pull the material at an earlier time and sort out the still too wet stock which would have to be restuck and again placed on the yard. Finding the point of greatest economic benefit for the trade off between the additional resticking and redrying costs and greater air yard throughput is currently under investigation.

#### Summary and Conclusions

1. Incense cedar squares were found to exhibit extremely large variation in air drying rates.
2. This can be seen by comparing the fastest and slowest drying squares whose drying times to 15 percent final moisture content were 35 and 551 days, respectively.
3. Air drying times could not be sufficiently correlated to either percent sapwood, weight/length or a combination of these two variables. The highest  $R^2$  obtained was only 0.41.
4. It is therefore, concluded that incense cedar cannot successfully segregate into general drying classes using these relatively easy to measure variables.
5. The practice of leaving stock on an air yard until all has reached an equilibrium moisture content is shown to greatly reduce overall yard throughput.

Literature Cited

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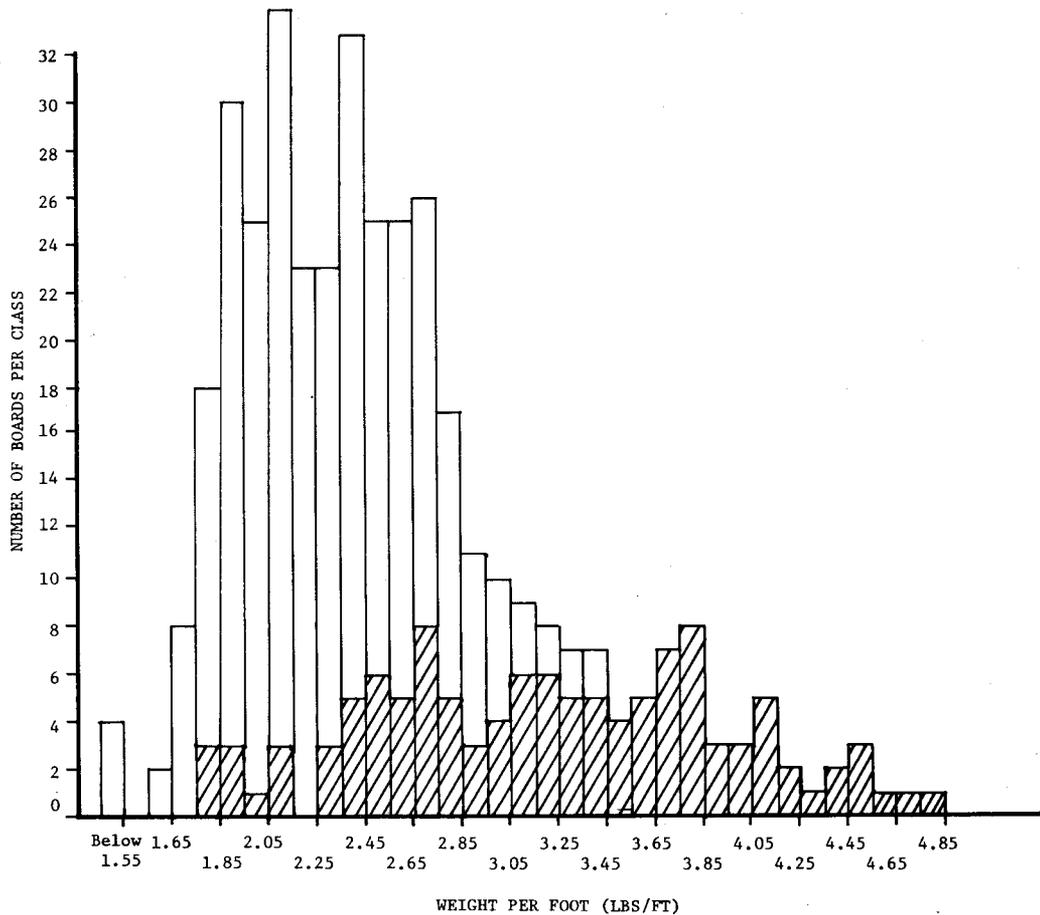


Figure 1. Distribution of squares by weight per foot

Figure 2. Selected drying curves for incense cedar squares

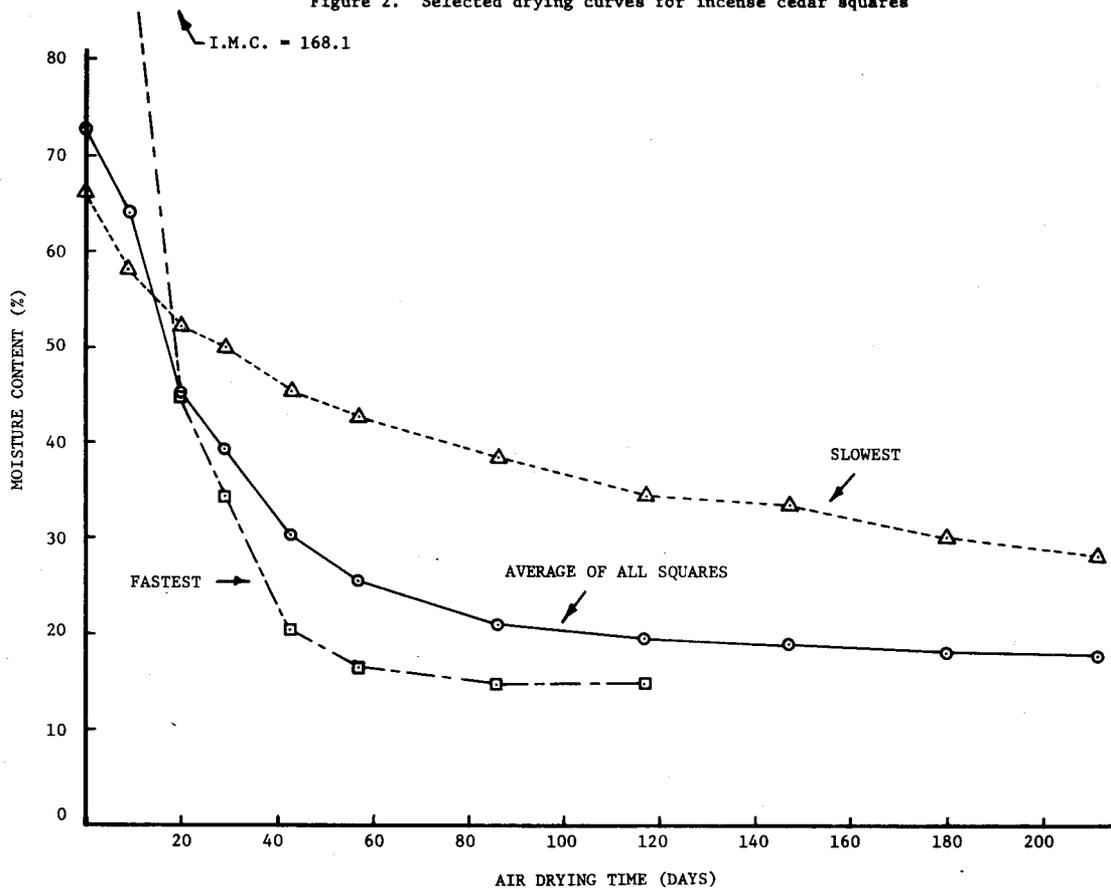


Figure 3. Frequency distribution of drying times to 15 percent

