A DRYING AND SURFACING DEGRADE TEST METHOD

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INTRODUCTION

Everyone involved with lumber drying has been concerned at one time or another with drying degrade. It is an essential part of drying. A number of degrade test methods have been used. Most of the early ones were aimed at quantifying the absolute value of degrade and were based on grade-in versus grade-out comparisons. In 1971 a comparative method was developed at Weyerhaeuser.[1] It was developed to more accurately evaluate competing technologies, for example, different kiln schedules. It has and continues to be quite successful for this purpose. With this success, why then are we again discussing a degrade test method? The answer lies in the particular type of data needed. We were seeking data that could be used in an economic opportunity analysis and which could address the specific degrade causes. We also needed to gather quite a bit of data so the test method needed to be relatively simple. The existing methods all fell short of these objectives, although you will recognize much similarity. The remainder of this paper will describe a drying and surfacing degrade test method that was developed to accomplish the above objectives. The test method is a very flexible tool with much broader potential than drying degrade analysis. However, this paper will concentrate on drying degrade and will describe in lesser detail the other uses of the test method.

Due to the large number of calculations involved in our analysis method, a computer program was written to perform the analysis. The computer allowed us to perform numerous calculations and extract information from the data that probably would not have otherwise been done. The analysis report that is generated by the computer on each degrade test is 25 pages long and when used properly can be a very valuable analysis tool. It can give information that can be used to identify problems/opportunities in drying, trimming, grading, planing, sawmilling and log quality. This method is not a complete diagnostic tool for the operation of a sawmill, but does give some information in all of these areas.

DEGRADE TEST METHOD

There are two components to the degrade test. They are the sampling technique and the grading technique. The sampling technique that was used was to systematically select boards from a kiln charge after the boards were planed and before they were graded and trimmed. Normally a kiln charge contains approximately 10,000 boards. For the degrade tests, our sample consisted of 500 boards. In an average size

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[1] G. L. Comstock and J. W. Kerns, "A Method for Evaluating the Effect of Different Drying Methods on Lumber Quality," Proceedings Western Dry Kiln Clubs, 22 Annual Meeting, May 14-15, 1971. pp. 3-8.

kiln, this would require the selection of every 20th board. These boards are pulled out of the normal flow immediately behind the planer. Later they are individually pencil trimmed, graded and their moisture content taken. This was always accomplished by the use of a qualified grader and was done on a separate grading table with good lighting. The grader was given as much time as was necessary on each board. This would vary between a matter of a few seconds up to a few minutes. The remainder of the kiln charge or the other 9,500 boards flow through the normal grading, trimming and packaging operations. A grade and length tally is taken on this output for comparison with the sample.

In all cases, the number of boards that were selected for the sample was approximately 500 and the sampling ratio was dependent upon the total number of boards in the kiln charge. The sampling ratio allowed us to get a systematic sample of the total kiln charge. As can be seen from Figure 1, the information that was generated by the individual grading of the sample boards and the planer mill tally were the inputs to the data analysis.

There was one major modification to our basic process used for the testing of clear lumber. Due to the large number of splits already in the green clear lumber, it was decided that the clear lumber should be pencil trimmed before drying. When testing clear lumber, we calculated a sampling ratio and then systematically pencil trimmed and numbered our sample boards at the stacking operation before the kiln. These same boards were then pulled out after being dried and surfaced and were then repencil trimmed, graded and the moisture content taken. The same procedure could also be used with common lumber.

DATA GATHERING

For the 500 boards in our sample that were individually pencil trimmed, graded, and moisture contents taken, the following procedure was followed. The first step was to determine the length of the board. The second step was to determine the length that the board would be after it was trimmed. The third step was to assign a reason for trimming the board if, in fact, it was trimmed. There were some 18 allowable reasons that we used in our test method. Table 1 lists the reasons to which trimming and grading defects were assigned. The fourth step was to determine the grade of the remaining board after it was pencil trimmed. The fifth step was to determine the grade that the board could have been (potential grade) if it had not been degraded. If a board was not degraded, the potential grade was the same as the actual grade. If a board was degraded, a reason was assigned for the degrade. There was a hierarchy of degrade reasons. If a board was degraded for a natural defect such as knot size, this was an overriding factor and was not considered as degrading. The second level of degrading factors were those that were caused by manufacturing. The third or lowest level of degrading factors were those which were caused by drying. If a board had both a manufacturing defect and a drying defect, the degrade was assigned to the manufacturing reason. The logic behind this was that if the degrade was assigned to the drying defect, it would overstate the drying degrade because if the degrade were not there, the board would still be degraded due to the manufacturing defect. The last step in data gathering was to take a moisture content on each piece. Figure 2 shows actual data that would be gathered for one board.

Table 1. List of Trim or Degrade Causes

Holes	Grain defect	Cup
Splits	Shake	Bow
Knots	Wane	Crook
Snipe	Face skip	Twist
Unsound wood	Edge skip	Manufacturing damage
Stain	Break	Other

DATA ANALYSIS

The following is a description of the logic and calculation steps that were performed to calculate the value losses for both trimming and grade loss. In addition to these calculations, several others were performed and they will be described later. The first step in calculating the value loss due to trimming for an individual board is to determine the value of the board before trimming. For this purpose, the grade of the trimmed piece was used. This is a ficticious grade, since if the board actually were that grade it would not be trimmed. The reason this grade is used is to determine the value loss that resulted from the trim cause. Given the initial length of the piece and using the grade of the piece after trimming, the price per thousand board feet is looked up in a price table. The price per linear foot is then calculated and the value of the piece is the multiple of the price per linear foot and the length of the piece. All of the value calculations that were made used a look-up price table, which gave price per thousand board feet by both grade and length. The second step is to calculate the value of the piece after trimming. This is performed similarly to the first step and uses the same grade. A credit is then calculated for the chips derived from the trim end. The credit for chips is calculated based on the price per bone dry ton of chips multiplied by a dimension conversion factor. The fourth step is to calculate the trim loss which is the initial value minus the final value plus a credit for the chips. After the trim loss is calculated for an individual board, it is then assigned to a trim cause. If a board was not trimmed, the above calculations obviously would not be made. After the calculations were performed on all of the pieces in the sample, the dollar losses for the various trim factors were summed and normalized to give the trim loss per thousand board feet.

In order to calculate the value loss due to degrade, a similar procedure was followed. First, the potential grade of a board was determined. The potential grade was the highest grade that the grader determined the board could be due to its natural characteristics. The length used was the length of the pencil trimmed board. Again, the price table was used to determine the value of the board. The loss was then the difference in value between the potential grade and actual grade. After the loss was calculated on each individual board, it was then assigned to a cause. Similarly to the trimming value calculations, the values were totaled up for the complete sample and were also normalized to a thousand board foot basis. Figure 3 shows an example and description of the above calculation steps. The sample uses the same board that was used in the data gathering steps.

ASSIGNMENT OF DRYING DEGRADE

After calculating the value losses due to trim and degrade, the next important step is to determine which portion of that degrade is assignable to drying. The approach that was developed was to use expert opinion to estimate the percent of each cause which is due to drying. An alternative to this would be to have the grader determine on an individual board by board basis, whether or what percent of a degrading factor was due to drying.

These percentages varied by species and also by the dimension of the lumber. The estimates were most difficult to make in the situation of splits and shake. Table 2 lists the percentages that were used for one species and dimension of lumber.

Table 2. Assignment of Defects to Drying

Cause	Percent Due to Drying
Face skip	20%
Edge skip	20%
Split	30%
Holes	10%
Cup	100%
Bow	95%
Crook	90%
Twist	90%
Shake	30%

After determining the percent of the cause which was due to drying, the second step is to multiply that percentage times the total drying loss in the sample due to that cause. The third step is to sum the drying losses by cause. Figure 4 shows an example of the steps involved.

The determination of the percentages above are a very vital part of the analysis procedure. To further increase the accuracy of this system, one could determine objectively through testing what these actual percentages are. The procedure for this would be to grade by cause boards both in the green and in the dry. This would then allow one to determine how much shake and splits, for example, were in a board before it was dried and what percent of the total shake or split in a dry board was due to drying. As was stated earlier, this was done for clear lumber because of numerous splits present in the green boards.

ADDITIONAL CALCULATIONS

Once the data are in the computer it is relatively easy to do a variety of calculations to provide additional information. As we stated earlier, total trim and degrade loss by cause was calculated and these values were normalized to show losses per thousand board feet. Also, the totals and losses per thousand board feet of all of the causes were calculated.

Since the final length and grade of each board was available, a report which generated a grade and length distribution of the sample and the average value per thousand board feet was calculated. In addition, the planer mill tally was used to give similar information on the population or the remainder of the kiln dry. The comparison between these allowed us to determine which boards were being trimmed differently between the population and the sample. It also showed the differences in grading practices. In all cases, there were value losses in the realization due to production-line grading and trimming. We attributed this to the line speeds in which production line graders were operating.

The total planer mill trim was calculated and this was valuable information as it allowed us to quantify the absolute magnitude of our planer mill trim. In addition, as this was also a surfacing degrade test method, data was gathered on face and edge skip. In all cases, the sum of face and edge skip was the second largest degrading factor. The degrade test method therefore would allow one to look at the trade-off in the grade loss between smaller target sizes and more face and edge skip.

Considerable calculations were made on moisture content data. A histogram of the total sample was generated as well as the mean moisture content calculated. The data were also generated by each defect cause. In addition, a histogram was made on all of the boards which had trim defects and a separate histogram was made on all of the boards which had grade loss. The same information was also generated on all the boards which had neither degrade nor trim loss. This information allowed us to compare the mean and the distribution between boards which were degraded and boards which were not, and for boards degraded for various causes.

The mean and standard deviations were also calculated by grade. This gave some very interesting information and in most cases, the lower the grade the lower the moisture content of the boards within the grade. Table 3 is an example of one degrade test which demonstrates this.

Table 3. Example of Moisture Content Grade Relationship

Grade	Mean
Select Structural	14.0%
#1	13.5%
#2	13.0%
#3	11.5%
Economy	9.1%
Total	12.4%

EXAMPLE OF RESULTS

Some of the specific results that were obtained that relate directly to drying are the following: (1) The absolute magnitude of the drying degrade to include trim losses in common lumber was between \$3 and \$8 per thousand board feet. (2) Specifically in 2x8 old growth Douglas-fir common, the major degrade factor was knot holes. (3) The major degrade factor in second growth Douglas-fir was splits. (4) Two similar tests were conducted using 2x8 old growth Douglas-fir dried to moisture content levels of 20% and 15%. The degrade was approximately \$3 more per thousand board feet for the lumber dried to the lower moisture content level.

CONCLUSIONS

In addition to being used to analyze drying degrade this test method can also be used to evaluate planer degrade, in conjunction with comparative degrade test methods, and to determine the net effect of sawmill variations on lumber production. The latter is one of the additional uses to which it has been applied at Weyerhaeuser. The specific example was a change in the sawing pattern and the critical question was "what effect would this have on <u>net</u> lumber production?"

There are several strengths and weaknesses to this degrade test method. Perhaps the most prevalent weakness is the aspect of interpretation where judgments are used to estimate the percentage of a cause due to drying. This can be overcome, however, by additional testing and determining what the actual percentages are. Another weakness is the statistical significance of using one kiln charge to generalize to a total mill's operation. Also, the small number of boards within the 500 that actually end up in a particular degrade or trim cause. These concerns should be overcome as this test method is used more and replicate tests made. The key strengths are that it gives degrade by specific cause and is easy to use, both in the sampling of the lumber and the data analysis. It is also a very flexible tool and can be used for various types of tests once the logic behind it is understood. The fact it generates a considerable amount of information is very valuable to both the drying of lumber and the operating of a sawmill.

Figure 1 DEGRADE TEST METHOD

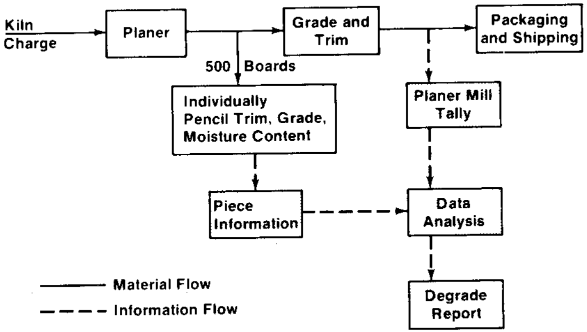

Figure 2 DATA GATHERING

Grading Steps	Example
1. Determine length of board	18 feet
2. Length after trimming	16 feet
3. Assign reason for trimming	Split
4. Determine grade of remaining board	#3
5. Determine potential grade	#2
6. Assign cause for degrade	Twist
7. Take moisture content	18%

Figure 3 DATA ANALYSIS

Calculation Step	Example
1. Value before trimming (Use grade of trimmed piece)	\$3.29 (18', #3) (From Price Table)
2. Value after trimming	\$2.86 (16', #3)
3. Credit for chips	\$ .04 (Price/BDT x Conversion Factor)
4. Trim loss initial value - final value - chip value	\$ .39
5. Assign to cause	Split = \$.39
6. Value of potential grade (final length)	\$3.62 (16', #2)
7. Value of actual grade (final length)	\$2.86 (16', #3)
8. Grade loss potential value actual value	\$ .76
9. Assign to cause	Twist = \$.76

Figure 4 ASSIGNMENT OF DRYING DEGRADE

Steps	Example
1. Estimate percent of cause due to drying	Splits 50% Twist 95%
2. Determine loss due to drying	.5 x \$.39 \$.20 .95 x \$.76 \$.72
3. Sum drying losses	\$.92