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SEASONING DEGRADE IN KILN DRYING PONDEROSA PINE IN SOUTH CENTRAL OREGON

By

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This report presents the results of a study to determine the loss in volume and value of lumber when kiln drying and surfacing the production from ponderosa pine logs. The study measured (1) the reduction in volume due to trimming and culling dry lumber after surfacing, (2) the reduction in grade due to seasoning defects, (3) the reduction in grade due to failure of lumber to remain on grade because of manufacturing defects, and (4) the loss in value of the lumber resulting from the degrade.

Site of this study was the American Forest Products Corporation mill in Lakeview, Oreg. It was conducted in January 1955 1/ in conjunction with another study to determine the volume and grade yield for the various grades and sizes of ponderosa pine logs. 2/ That study was based on a supply of 322,000 feet of logs, and the

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1/ Cooperative project with American Forest Products Corporation, White Pine Lumber Company, Fremont Sawmill Company, Western Pine Association, Oregon Forest Products Laboratory, and U. S. Forest Service participating.

2/ Matson, E. E. Ponderosa pine lumber recovery in Lakeview, Oregon area. Pacific Northwest Forest & Range Expt. Sta. Research Note 124, 13 pp. (Processed.) December 1955.

lumber produced from them was used in the seasoning and manufacturing degrade study reported here.

Method

Lumber was graded and marked in the sawmill when green, according to Western Pine Association rules for dry lumber. The green lumber was then sorted according to drying requirements into (a) selects, moulding, and shop, which were dried to a moisture content of about 8 percent, and (b) common grades, which were dried to about 12 percent.

After drying, the rough lumber was sorted into units by size and grade as originally marked when green. Then each unit was run separately through the planer and regraded and tallied.

Kiln drying

The green pine lumber was dried in a battery of three steam-heated, internal-fan, reversible cross-circulation kilns. These kilns provided the liberal circulation and ventilation commonly used in kiln drying ponderosa pine lumber and were operated on the standard schedules in use by the company (table 1). Stickers were of standard size and spacing.

High-humidity conditioning treatments were given the lumber following kiln drying. Shop grades were conditioned for about 8 hours in the dry kiln at temperatures up to 175 degrees F. and at a relative humidity of 80 percent. The other grades of lumber were conditioned by pulling the dry lumber from the kiln and loading it into a separate chamber where it was steamed for about two hours. The steaming chamber was not equipped with either heating coils or circulating fans. The dry lumber was then stored in the unheated mill for several days until planed.

Planing

Dry lumber was segregated according to the size and grade given it when green in the sawmill, was planed and trimmed, and then was graded by a Western Pine Association grade supervisor and tallied by the shipping clerk. A second tallyman recorded the grade and volume of each piece falling below the grade assigned

when green. He also recorded the seasoning or manufacturing defect that caused the drop in grade. This information was used in calculating the degrade values shown in tables 2, 3, and 4.

In grading rough lumber on the green chain, it was not possible to judge the size and effect of knots and other growth characteristics as accurately as after the lumber had been surfaced. Consequently, some boards were found after planing to have been misgraded when green. Since these changes in grade did not result from actual changes in quality of the boards, the green tally was corrected accordingly. A board was considered as having suffered degrade only when seasoning or manufacturing defects caused a reduction in grade from that given it when green.

A standard lumber-scale rule was used for tallying the volume of planed random-width select and shop lumber. The same scale rule had been used on this lumber when tallying the rough green volume in the sawmill. Since kiln drying to a moisture content of 8 percent involves a shrinkage in width calculated at 4.5 percent, the green mill tally of select and shop lumber was reduced by that percentage. This established the volume of these items before planing.

Discussion of Results

In analyzing the amount and cause of seasoning and machining degrade in the ponderosa pine lumber included in this study, it was noted that some items of lumber had been developed in such small amounts that their inclusion in tabulations would not be significant. Only items with volumes totaling 1,000 board-feet or more are included in this report.

Grade Recovery

Table 2 shows grade recovery after kiln drying and surfacing for each significant item of lumber in the study. The table shows the amount of lumber that remained on-grade as well as the amount dropping to each of the lower grades. For example, 6/4 D Select totaled 45,750 board-feet in the sawmill tally. Of this amount, 88.9 percent graded D Select after drying and planing, while 3.6 percent degraded to Moulding, 0.1 percent to No. 1 Shop, 2.7 percent to No. 2 Shop, 2.4 percent to No. 3 Shop, 0.4 percent to No. 4 Common and 0.1 percent to No. 5 Common.

Also shown is the loss in footage--cull and trim loss--developed between the green condition in the sawmill and the dry condition after planing. An appreciable cull loss developed in some lumber containing extremely short, irregular, and distorted grain, which bowed and warped severely in drying. Some of these boards broke up entirely while passing through the planer and were culled. Others became distorted at the ends, requiring trimming to maintain the remainder of the board on grade. Other boards suffered end checking and splitting, which also necessitated trimming. It was not possible to analyze accurately all of the causes for cull and trim.

Some pieces of green lumber had been tallied on a "paper-trim" basis. That is, a green board in the mill might require trimming to remove a knot, split, or other natural defect to develop the most economic grade for it. Actual trimming, however, was postponed until planing after drying. And it was not possible after planing to determine how much "paper trimming" had been done. In general, cull and trim loss was calculated for each item by subtracting the final shipping tally for dry surfaced lumber from the original green mill tally.

Severe warping, end checking and splitting, and broken knots at the ends of the board were responsible for most of the cull and trim loss. Negative trim values resulted where final trimming after planing was less than the paper trim assigned in the sawmill tally.

Seasoning and manufacturing degrade

The amount of degrade developed in kiln drying and planing the study lumber is shown, by defect, in table 3. Degrade is tabulated for each type of seasoning defect--checking, end and planer splitting, warping, crook, brown stain, broken grain, broken knots, and knotholes--and for manufacturing defect. In the case of 6/4 D Select, for example, checking reduced 4.6 percent of the volume to lower grades; splitting, 2.4 percent; warping, 1.1 percent; while broken grain and knotholes each caused an additional 0.1 percent of degrade. A total of 8.3 percent of the green volume of this item was reduced to lower grades after planing because of seasoning defects. Manufacturing degrade--lumber too thin and narrow-amounted to an additional 1.0 percent. Cull and trim amounted to 1.8 percent. Altogether, seasoning degrade, manufacturing degrade, and cull and trim loss amounted to 11.1 percent of the green volume.

It may be somewhat unrealistic to presume that pine lumber can be kiln dried without developing some seasoning defects. But, for comparison purposes, it is a useful mathematical basis for analysis of seasoning efficiency. Some defects--such as check, end split, warp, crook, and brown stain--develop while the lumber is drying and become visible. Others--such as planer split, broken knots, knotholes, and sometimes broken grain--develop as the dry lumber passes through the planer, where it is flattened and surfaced. Since these defects can be modified appreciably only by changes in the kiln schedule and final moisture content, and not by changes in the planer equipment, they also are classified as seasoning defects.

Checking defects were most detrimental to the select grades in 6/4 thickness. This type of defect caused considerable degrade as well as trim loss. Checking develops in kiln drying when a low-humidity schedule is used. A higher humidity schedule would be expected to reduce checking.

Splitting too may be caused by checking stresses, but it also occurs in wide plain-sawed boards that cup somewhat during drying. When they pass through the planer the boards are flattened by the feed rolls and planer splitting results. Planer splitting can be minimized by closer sticker spacing in stacking the lumber for the kilns and by drying the lumber to a moderate final moisture content. Common grades of lumber are kiln dried to a 12-percent moisture content at American Forest Products Corporation's plant. Stacking and final moisture content at this plant are considered satisfactory since degrade due to checking and splitting in this type of lumber was held to about 1 percent. The greater amount of degrade due to splitting in the select grades results from susceptibility to surface checking.

Brown stain developed in only a few items and only in moderate amounts. However, if higher humidity is used in the early stage of kiln drying to reduce surface checking, there is greater risk of increasing brown stain.

Warp, crook, and broken grain result largely from non-uniform shrinkage of the wood where sharply distorted grain occurs, such as around large knots. Compression wood also shrinks abnormally and often distorts the lumber. These defects can be minimized by modifying kiln drying conditions so as to halt drying at a higher moisture content. However, moisture content of both the select and common

grades was at the levels required for customer satisfaction. There seems little opportunity to reduce further the occurrence of these defects.

Breaking and dropping out of knots during planing is a common problem in surfacing kiln-dried knotty grades of lumber. Modification of kiln drying conditions offers little opportunity to reduce these sources of degrade except as it results in halting the drying at a higher moisture content. The level of dryness aimed at must again accommodate customer requirement and there is no indication that customer requirement for final moisture content will be revised upwards from the 12-percent level used in this study.

Another type of defect that determines the grade of the finished lumber is known as manufacturing defect. This refers primarily to lumber cut too thin or too narrow to be machined full size. This lack of size results in lowering the grade of the piece below that assigned it when rough and green in the mill. Actually the piece has not suffered degrade but, to correct the mill tally, values are tabulated as degrade. As shown here, manufacturing degrade may be unavoidable. The usefulness of these values is largely to indicate the extent to which attention may profitably be given to improving sawing procedures.

Losses in value

Reduction in sales value of the lumber due to seasoning and manufacturing defects is shown in table 4. These losses were based on the average mill price for ponderosa pine lumber for 1954, as shown in table 5. For example, the value of 6/4 D Select, dry and surfaced, is shown at $212.20 per M b.m. Degrade due to surface checking caused a loss equal to $4.49 for each thousand feet of lumber of this grade cut in the mill. Loss due to planer splitting amounted to $1.91 per thousand, warping $1.30, broken grain $0.10, and knotholes $0.04.

Altogether the loss in value for this item caused by all seasoning degrade amounted to $7.84 per thousand. In addition, manufacturing degrade loss was $0.50 per thousand and cull and trim $5.98. As would be expected, the higher priced grades--select and shop--suffered the greatest loss in value due to seasoning defects. This interpretation of degrade in terms of loss in value is useful in evaluating the potential benefit that might be realized by improving manufacturing and seasoning practices.

Table 1.--Kiln drying schedule for ponderosa pine, 1/

American Forest Products Corporation, 1955

Thickness and grade	Hours of drying	Temperature	
		Dry bulb	Wet bulb
		Degrees F.	Degrees F.
6/4 thickness:			
Selects and moulding	0	135	120
	36	140	120
	48	150	122
	60	160	125
	72	168	132
	120 (out)		
Common and box	0	160	124
	18	168	124
	60 (out)		
4/4 thickness:			
Selects and moulding	0	160	130
	30	162	130
	54	168	130
	60 (out)		
Common	0	160	138
	24 (out)		

1/ After kiln drying and before planing, all lumber was given a conditioning treatment.

Table 2.--Ponderosa pine lumber recovery, by grade; study run at American Forest Products Corporation, 1955

(In percent)

Thickness and grade	Green lumber: Width	Green lumber: Volume tested	Kiln-dried and surfaced lumber: B and Better	C Sel.	D Sel.	Moulding	No. 3 Clear	No. 1 Shop	No. 2 Shop	No. 3 Shop	No. 2 Common	No. 3 Common	No. 4 Common	No. 5 Common	Cull & trim loss	Total degrade loss
	Inches	Bd. -ft.														
6/4:																
B and better		16,270	61.7	26.4	5.6	1.8		0.2	0.1	0.2					4.0	38.3
C Select		27,753		77.6	12.3	4.3			0.6	0.3					4.9	22.4
D Select		45,750			88.9	3.6		0.1	2.7	2.4			0.4	0.1	1.8	11.1
Moulding		1,733				90.8			2.4	1.4				0.6	4.8	9.2
No. 3 Clear		5,462					80.2	11.8	3.2						4.8	19.8
No. 1 Shop		16,636						87.7	11.4	1.5					1/ -0.6	12.3
No. 2 Shop		38,225							95.1	5.2				0.1	-0.4	4.9
No. 3 Shop		23,785								100.0			0.2		-0.2	0.0
No. 2 Common	12	1,083									91.2	2.2			6.6	8.8
No. 3 Common	6	1,162										95.0	4.6		0.4	5.0
No. 3 Common	8	3,193										89.6	7.1	0.5	2.8	10.4
No. 3 Common	10	1,448										90.2	5.7		4.1	9.8
No. 3 Common	12	12,696										91.4	10.4		-1.8	8.6
No. 4 Common	6	2,772											91.0	6.9	2.1	9.0
No. 4 Common	8	7,291											92.4	5.3	2.3	7.6
No. 4 Common	10	4,691											93.7	5.5	0.8	6.3
No. 4 Common	12	24,398											97.4	0.4	2.2	2.6
No. 5 Common 2/	8	3,493												93.8	6.2	6.2
No. 5 Common 2/	10	2,332												96.1	3.9	3.9
No. 5 Common 2/	12	8,770												95.2	4.8	4.8
4/4:																
Moulding		1,009				90.3				0.7			2.8	1.3	4.9	9.7
No. 1 Shop		4,334						100.0					1.6	1.0	-5.6	-3.0
No. 2 Common	8	1,135									87.3	5.3			7.4	12.7
No. 2 Common	12	8,349									97.5	10.2	0.4		-8.1	2.5
No. 3 Common	8	2,170										97.8	3.5		-1.3	2.2
No. 3 Common	10	1,187										93.7	7.8		-1.5	6.3
No. 3 Common	12	24,638										87.9	9.7	0.2	2.2	12.1
No. 4 Common	8	999											94.7	7.7	-2.4	5.3
No. 4 Common	10	1,007											96.6	1.3	2.1	3.4
No. 4 Common	12	22,699											96.8	3.5	-0.3	3.2
No. 5 Common 2/	12	4,706												95.4	4.6	4.6

1/ Negative trim values developed mostly when dry, surfaced lumber trimmed less than indicated in the green mill tally.

2/ Degrade included in cull and trim.

Table 3. --Seasoning and manufacturing degrade and loss in ponderosa pine, by defect; study run at American Forest Products Corporation, 1955

(In percent)

Green lumber			Kiln-dried and surfaced lumber														
			Seasoning defect									Manufacturing defect					
Thickness and grade	Width	Volume tested	Check	Split	Warp	Crook	Brown stain	Broken grain	Broken knots	Knot-holes	Total	Thin	Narrow	Mechanical damage	Total	Cull and trim loss
	Inches	Bd. -ft.														
6/4:																
B and better		16,270	10.4	2.4	11.2	1.7	5.4	0.5			31.6	1.0	0.5	1.2	2.7	4.0
C Select		27,753	6.7	3.1	4.1	0.8	0.2			0.2	15.1	0.2	2.0	0.2	2.4	4.9
D Select		45,750	4.6	2.4	1.1			0.1		0.1	8.3	0.2	0.8		1.0	1.8
Moulding		1,733			2.4			0.3			2.7	0.4	0.5	0.8	1.7	4.8
No. 3 Clear		5,462	0.7	2.3	2.9		6.2				12.1	2.9			2.9	4.8
No. 1 Shop		16,636	0.5	0.7	2.4		7.4				11.0	1.9			1.9	1/-0.6
No. 2 Shop		38,225	0.4		1.8		1.5	0.5			4.2	1.1			1.1	-0.4
No. 3 Shop		23,785		0.1	0.1						0.2					-0.2
No. 2 Common	12	1,083								2.2	2.2					6.6
No. 3 Common	6	1,162			2.2				0.8	1.6	4.6					0.4
No. 3 Common	8	3,193		0.4	0.4			2.6	3.3	0.9	7.6					2.8
No. 3 Common	10	1,148							1.9	3.8	5.7					4.1
No. 3 Common	12	12,696	1.7							7.8	9.5	0.9			0.9	-1.8
No. 4 Common	6	2,772			0.6			2.0	0.7	2.4	5.7	0.6	0.6		1.2	2.1
No. 4 Common	8	7,291		0.2				2.0	1.1	1.9	5.2	0.1			0.1	2.3
No. 4 Common	10	4,691						5.5			5.5					0.8
No. 4 Common	12	24,398						0.1	0.3		0.4					2.2
No. 5 Common 2/	8	3,493														6.2
No. 5 Common 2/	10	2,332														3.9
No. 5 Common 2/	12	8,770														4.8
4/4:																
Moulding		1,009			2.7						2.7	2.1			2.1	4.9
No. 1 Shop		4,334			0.1			0.1			0.2	2.4			2.4	-5.6
No. 2 Common	8	1,135		1.1					1.1	3.1	5.3					7.4
No. 2 Common	12	8,349		1.1		0.2		1.3	0.5	7.5	10.6					
No. 3 Common	8	2,170						1.8		1.7	3.5					-1.3
No. 3 Common	10	1,187		1.3				2.6	2.6	1.3	7.8					-1.5
No. 3 Common	12	24,638	1.0	0.4	0.1			2.6	0.9	4.6	9.6	0.1	0.1	0.1	0.3	2.2
No. 4 Common	8	999							1.0	6.7	7.7					-2.4
No. 4 Common	10	1,007								1.3	1.3					2.1
No. 4 Common	12	22,699	0.1	0.1				0.2		3.1	3.5					-0.3
No. 5 Common 2/	12	4,706														4.6

1/ Negative trim values developed mostly when dry, surfaced lumber trimmed less than indicated in the green mill tally.

2/ Degrade included in cull and trim loss.

Table 4.--Loss in value of ponderosa pine lumber caused by seasoning degrade, cull, and trim; study run at American Forest Products Corporation, 1955

(In dollars per M.B.F.)

Green lumber				Kiln-dried and surfaced lumber													
				Seasoning defect									Manufacturing defect				
Thickness and grade	Width	Volume tested	Mill price	Check	Split	Crook	Warp	Brown stain	Broken grain	Broken knots	Knot-holes	Total	Thin	Narrow	Mechanical damage	Total	Cull and trim loss
	Inches	Bd.-ft.															
6/4:																	
B and Better		16,270	258.11	2.34	1.17	0.40	2.52	0.57	0.05			7.05	0.12	0.05	0.16	0.33	9.21
C Select		27,753	248.59	3.80	1.98	0.35	1.74	0.06	0.01		0.06	8.00	0.12	0.70	0.06	0.88	11.48
D Select		45,750	212.20	4.49	1.91		1.30		0.10		0.04	7.84	0.12	0.38		0.50	5.98
Moulding		1,733	175.54				2.70		0.24			2.94	0.47	0.59	0.57	1.63	8.40
No. 3 Clear		5,462	177.55	0.27	1.25		1.40	3.01				5.93	1.35			1.35	8.44
No. 1 Shop		16,636	135.02	0.14	0.28		0.87	2.53				3.82	0.58	0.01		0.59	1/-0.80
No. 2 Shop		38,225	104.76	0.13			0.58	0.46	0.18			1.35	0.34	0.01	0.01	0.36	-0.45
No. 3 Shop		23,785	73.26		0.07		0.02					0.09					-0.13
No. 2 Common	12	1,083	109.08								0.83	0.83					7.24
No. 3 Common	6	1,162	71.43				0.22			0.14	0.28	0.64					0.31
No. 3 Common	8	3,193	71.43		0.06		0.06		0.54	0.52	0.13	1.31					2.08
No. 3 Common	10	1,448	71.43							0.30	0.59	0.89					2.91
No. 3 Common	12	12,696	71.43		0.27						1.21	1.48	0.13			0.13	-1.27
No. 4 Common	6	2,772	55.96				0.15		0.50	0.19	0.60	1.44		0.30		0.30	1.13
No. 4 Common	8	7,291	55.96				0.06		0.52	0.29	0.49	1.36	0.03			0.03	1.15
No. 4 Common	10	4,691	55.96						1.42			1.42					0.44
No. 4 Common	12	24,398	55.96						0.03	0.09		0.12					1.22
No. 5 Common 2/	8	3,493	30.00														1.86
No. 5 Common 2/	10	2,332	30.00														1.18
No. 5 Common 2/	12	8,770	30.00														1.43
4/4:																	
Moulding		1,009	149.80				2.73					2.73	2.06			2.06	7.34
No. 1 Shop		4,334	131.82		0.05		0.06		0.07			0.18	2.11			2.11	-7.42
No. 2 Common	8	1,135	115.52		0.47					0.47	1.41	2.35					8.54
No. 2 Common	12	8,349	119.76		0.47	0.08			0.58	0.22	3.37	4.72					4.78
No. 3 Common	8	2,170	71.07						0.35		0.33	0.68					-0.98
No. 3 Common	10	1,187	70.02		0.23				0.47	0.47	0.23	1.40					-1.06
No. 3 Common	12	24,638	70.02	0.18	0.07		0.02		0.50	0.16	0.86	1.79	0.02	0.01	0.02	0.05	1.56
No. 4 Common	8	999	51.90							0.22	1.47	1.69					-1.24
No. 4 Common	10	1,007	51.90								0.30	0.30					1.09
No. 4 Common	12	22,699	51.90	0.03	0.03				0.05		0.68	0.79					-0.14
No. 5 Common 2/	12	4,706	30.00														1.37

1/ Negative trim values developed mostly when dry, surfaced lumber trimmed less than indicated in the green mill tally.

2/ Degrade included in cull and trim loss.

Table 5.--Mill value [1/] of surfaced, dry ponderosa pine lumber, 1954

Grade	Width	Value per M board-feet		
		4/4	6/4	5/4
		------- Dollars -------		
B and Better	-	261.77	258.11	
C Select	-	250.01	248.59	253.11
D Select	-	210.99	212.20	218.71
Moulding	-	149.80	175.54	175.54
No. 3 Clear (Factory Select)	-	131.82	177.55	177.55
No. 1 Shop	-	80.21	135.02	136.17
No. 2 Shop	-	63.43	104.76	105.79
No. 3 Shop	-	70.00	73.26	-
No. 1 Common	-	132.62	109.08	-
No. 2 Common	4 and 6	119.26	109.08	-
	8	115.52	109.08	-
	10	117.32	109.08	-
	12	119.76	109.08	-
	14 and wider	132.39	109.08	-
No. 3 Common	4 and 6	66.92	71.43	73.80
	8	71.07	71.43	-
	10	70.02	71.43	-
	12	70.02	71.43	-
	14 and wider	86.34	71.43	-
No. 4 Common	-	51.90	55.96	57.60
No. 4 Common	-	30.00	30.00	-
Pitch Select	-	-	146.31	-

1/ Price summary issued by Western Pine Association.