ARE ESTIMATED SHIPPING WEIGHTS RELIABLE TO DETERMINE MOISTURE CONTENT?

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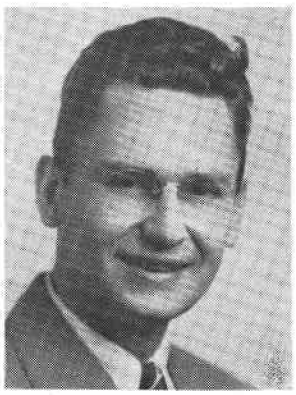
Presented to Annual Meeting of Western Seasoning Clubs, Missoula, Montana, June 23, 1960



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Introduction

A very common concern of lumbermen is shipping weights. Different ideas and opinions are expressed of the weight of lumber per M bd. ft. for each type of stock shipped. It appears that differences of opinion are based on an obvious measure; that of weight indicating a moisture condition. If the actual shipping weight is below the estimated shipping weight, the stock is assumed to be dry; if the actual shipping weight is above the estimated shipping weight, the stock is assumed to be wet. The relationship may not—and many times is not comparable.

The estimated shipping weights make no reference to moisture content, density, grade concentration within a shipment, specific finished sizes, pencil trim and rip. etc. Therefore, this estimated weight is difficult and sometimes impractical to associate with moisture content. The estimated weights are just as stated; estimated. They were averaged on the basis of a large quantity of reported weights. The purpose of which is to estimate the freight bill within the terms of a sale.

Purpose of This Report

Weight has no accurate reference to the per cent of moisture content, unless we know (1) the moisture content at an actual current weight, and (2) the weight when no moisture is present. A per cent of moisture present will show a change of weight as related to the oven dry weight of wood. For example, if moisture content changes by one per cent, the weight will change by one per cent of the oven dry weight of the wood.

It is the purpose of this paper to point out the properties of wood which cause weight variation, to illustrate the significance of a typical weight variation and to show a method to determine a basic weight which can be used as a guide for moisture content determination.

Weight Properties

The weight of wood includes three basic properties which cause weight variations.

First, there is the actual wood substance or, in technical terms, the density. It is measured as a ratio between the oven dry weight of wood and the weight of an equal volume of water. The density varies according to (a) the size of the cells, (b) the thickness of the cell walls and (c) the variability of these two conditions of cell structure. For example, density varies by the percentage of summerwood and springwood in relation to the annual growth ring. The cell walls of summerwood are very thick containing much wood fibre, whereas the springwood cell walls are thin, containing lesser wood fibre. More summerwood growth means more weight because of greater amounts of wood fibre present in the summerwood.

A second property of wood which causes weight variations are the extraneous materials infiltrated in wood. They are of two sorts: (a) mineral and (b) organic. Wood ashes are the minerals present in wood when it is burned. These are primarily calcium, potassium and magnesium plus smaller amounts of other minerals. The organic materials are such things as gums, resins, dyes, tannins, etc. Dark colored woods and heartwood of all species contain larger amounts of these mineral and organic infiltrations than light colored woods and sapwood. Because the amounts of these extraneous infiltrations in wood are sometimes insignificant and impractical to separate, the relative density includes both wood substance and extraneous materials referred to as the specific gravity.

A third variable wood property is moisture content. It is expressed as a percentage of the oven dry weight of wood. It is not unusual on this basis to have green moisture contents in excess of 100%. A butt log may sink when its weight per cubic foot exceeds the weight of an equal volume of water (62.4 pounds per cubic foot). The moisture varies within the tree from stump to top, from heart center to the bark and is variable from site to site according to the growth environment. For example, a quantity of corky heartwood will be lighter weight than sapwood when green.

Each of these separate properties are variable. The weight of wood substances and extraneous materials are variable within a given volume but water remains at a constant weight of 62.4 pounds per cubic foot.

Typical Weight Variability

To illustrate the variations, here is an example of the differences between the weights of Ponderosa Pine at the same moisture content from data at three sawmills. In these cases, moisture content was tallied and related to the actual weight of the shipment. These weights were calculated for the indicated moisture con-

tent based on a calculated oven dry weight for that lumber.

Weight of 6/4 S2S Ponderosa Pine
in Pounds Per M bd. ft.
As Related to Moisture Content

	Weight Per M bd. ft.		
Moisture Content	Mill A	Mill B	Mill C
0% (Basic Weight)	2104 lbs.	1900 lbs.	2017
2	2146	1938	2057
4	2188	1976	2097
6	2230	2014	2137
8	2272	2052	2177
10	2314	2090	2217
And so on	Per Cent of Grade in Shipments		
Representative Grades	Mill A	Mill B	Mill C
#3 Clear	1.0%	26.0%	.....
1 Shop	15.0	74.0	18.0%
2 Shop	68.0	.....	56.0
3 Shop	16.0	.....	26.0
	100.0%	100.0%	100.0%

There are some significant observations to make here. Mill B lumber would have to be 15.8% moisture content to equal the 2200 pounds estimated lumber weight. Mill A lumber would have to be nearly 6% moisture content to equal this estimated shipping weight. If these moisture contents were matched to the estimated shipping weight, there would be ultimate consumer complaints on moisture content, versus excessive degrade more costly to the mill than savings from underweights.* Overweights at Mill A would be a concern. The variables of wood growth properties are quite vividly displayed by this example.

It is also important to note the percentage of grades within a shipment. Mill B was heavy to #1 Shop and #3 Clear, whereas Mill A and C were heavy to #2 Shop. They reflect heartwood or sapwood content, perhaps the size and quantity of knots, pitch content, etc. This indicates a factor of variability in the density of the wood substance, in the extraneous materials as location of the lumber from the tree changes and in the difference of timber site-growth.

Moisture content cannot, therefore, always reflect overweights or underweights. The variables must first be detected and applied for the timber being harvested.

Determining a Basic Lumber Weight

A method can be applied which will give a more accurate indication of the moisture content on the basis of weight. The principal idea related to determination of lumber weight as a guide for moisture content is calculation of an oven dry weight or, a weight at zero per cent moisture content for a certain grade type, species and area. The method is illustrated by an example.

Determine:

1. Average moisture content of from 100-400 samples of the shipment with a moisture meter as the car is loaded; this found to be 9% M.C. The readings are taken so that samplings are included from each portion or unit package of the entire shipment.
2. Footage in car=27,120 bd. ft.
3. Actual weight of shipment=62,800 lbs.
4. Weight per M bd. ft. at 9% moisture content= $\frac{62,800}{27,120}$ = 2316 lbs/M sq. ft.
5. Find the oven dry weight. Because 2316 pounds equals the weight of wood and water, lets say that 100% represents wood and 9% represents water. By this means the moisture is excluded from the weight and we have the weight of actual wood substance remaining.

Calculate the oven dry weight:

$$\frac{\text{Oven dry wt.}}{100\% \text{ wood}} = \frac{2316 \text{ lbs. /M bd. ft.}}{100\% \text{ wood} / 9.0\% \text{ water}}$$

$$\text{Oven dry wt.} = \frac{2316 \times 100}{109.0\%} = 2125 \text{ lbs./M bd. ft. at zero per cent moisture content}$$

This includes the actual weight of the wood substance, extraneous organic materials and minerals. For each one per cent change of moisture content from this oven dry weight, the weight of 1000 board feet will change 21.25 pounds.

A few important points should be emphasized. A series of tests and recorded data on the same material, when averaged, will provide a more accurate picture of the basic weight than one test. The data obtained should be applied only as a guide for the moisture content. A basic weight for each species and grade type, such as select, shop, common and dimension should be determined when greater accuracy is desired.

A change of logging area would indicate a need to recheck the original basic weight. If several logging sites are involved, an average basic weight of all areas would be simpler and satisfactory as long as shipments are of equal proportions and basic weights do not vary extremely.

Applying the Basic Weight

For example, let us assume that 2125 pounds was an average oven dry weight of typical shipments. An actual weight of 2385 pounds per M bd. ft. was reported from a shipment of the same stock. Knowing that 21.25 pounds equals a 1% moisture change, the average moisture content of this shipment is:

$$\frac{2385-2125}{21.25} = 12.2\% \textbf{ average moisture content.}$$

Or, a glance at a prepared chart of weights related to per cent moisture content determined from the oven dry weight may be simpler. Compute as follows for each moisture content.

2125 x (1.00 / 10%)=2125 x 1.10=2338 lbs/M bd. ft. @ 10% M.C.

The use of scales on fork lift trucks could be used to estimate the moisture content by calulating the basic oven dry weight in the same manner explained. Western Pine Association Research Note No. 4.414 **Determining Moisture Content with Lift Truck Scales** outlines this procedure in detail.

Conclusions

This paper concludes that:

1. Comparing published shipping weights with actual shipping weights is not always a reliable guide of the average moisture content of a lumber shipment. Primarily because schedules of shipping weights were estimated from reported average weights without rela-

*Research Notes No. 4.5211, 4.5212, 4.5213, 4.5214 Western Pine Association "Degrade Related to Moisture Content."

tionship to moisture content, and other variable properties.

2. Three wood properties are variable due to growing conditions; density, extraneous materials, and moisture content cause variations of weight. The weight of water can be excluded by finding current moisture content and weight of a series of lumber shipments for calculation of a basic weight per M bd. ft.

3. A basic weight for each mill can be and should be developed because weights vary due to the wide range of growing conditions.

4. Improved accuracy can be had by developing basic weights for various types of lumber (Select, Shop, Common and Dimension) as well as each species.

5. Basic weights should be checked and corrected if necessary when logs are received from a different logging site.

In closing, comparing actual shipping weight with a calculated basic weight per M bd. ft. is a reliable method to determine the moisture content of a lumber shipment.