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SHRINKAGE OF WHITE OAK AS AFFECTED BY POSITION IN THE TREE

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This study, together with those previously made on overcup oak, indicate that the shrinkage of the wood increases with its age in the tree; that is, the wood near the center and base of the tree shrinks more in the older trees than in the younger ones. Why that is the case has not been determined, but the indications are that the tendency to collapse, which here is included as shrinkage, increases as the wood grows older, possibly on account of the infiltration of additional material with time in the fine interstices of the pit membranes thereby making them still smaller and more resistant to the withdrawal or rupture of water films in them.

IN a discussion of shrinkage of delta hardwoods appearing in the JOURNAL (32: 871-872) , it was pointed out that the greatest change in volume accompanying drying took place in the inner heartwood of overcup oak *(Quercus lyrata)* and was partly due to shrinkage and partly to an actual distortion or collapse of the cell structure. It was shown also that there was a general increase in shrinkage from the outer (sapwood) to the inner portion of the trees, not entirely due to the change from sapwood to heartwood as the shrinkage progressively increased in the heartwood all the way to the center of the heartwood, being the greatest in the older trees. A maximum shrinkage as high as 35 percent was found in individual specimens close to the pith.

Subsequent to the study of delta oaks a similar study of several upland species of oak has been made. This latter study included old-growth white oak *(Q. alba)* from the Cumberland Mountains in Tennessee. The trees were 230 to 290 years old and averaged 29 inches diameter breast high. The volumetric shrinkage values for five of these old-growth Cumberland Mountain oaks when arranged according to the position of the samples in the trees, like the delta overcup oak, showed a Progressive increase in shrinkage from the circumference toward the center of the trees, the highest shrinkage being found near the center in the lower part of the older trees. The increase in shrinkage toward the pith of these trees was so regular that it was possible to make a shrinkage map, or diagram, from the composite shrinkage values showing zones of progressively greater volumetric shrinkage from the outer to the central portion of the trees (Fig. 1) .

From this diagram it may be seen that the volumetric shrinkage of the outer zone (sapwood) was less than 15 percent (the minimum value was 10.5) . Within are other zones showing an increase in shrinkage toward the pith. The second zone of the diagram shows the portion of the trees having a shrinkage range of 15 to 18 percent; the third zone, of 18 to 21 percent shrinkage, the apex of which is not shown, reaches the pith at the top of the fourth log, or 64 feet above the stump; the fourth zone, 21 to 24 percent shrinkage by volume, occupies the central portion of the trees from 29 to 64 feet above the stump and extends downward around a fifth zone of over 24 percent shrinkage ranging up to a maximum of 30 percent, which comprises a cone in the center of the trees. The base of this central cone was about 9 inches in diameter.

In addition to the old-growth upland oaks studied, the volumetric shrinkage was determined for 38 second-growth white oak trees 50 to 80 years of age representing seven localities of the southern Appalachian region. Samples from these second-growth trees did not show any definite zonation of shrinkage from the circumference to the center of the trees. Also, the range of volumetric shrinkage in the second-growth

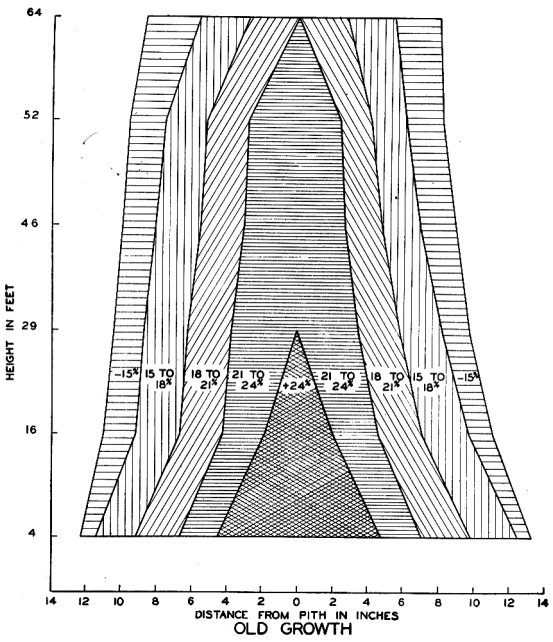

Fig. 1.—Zones of progressive shrinkage increase toward the pith in old-growth, upland white oak. Based on composite shrinkage values from five trees.

[1]Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

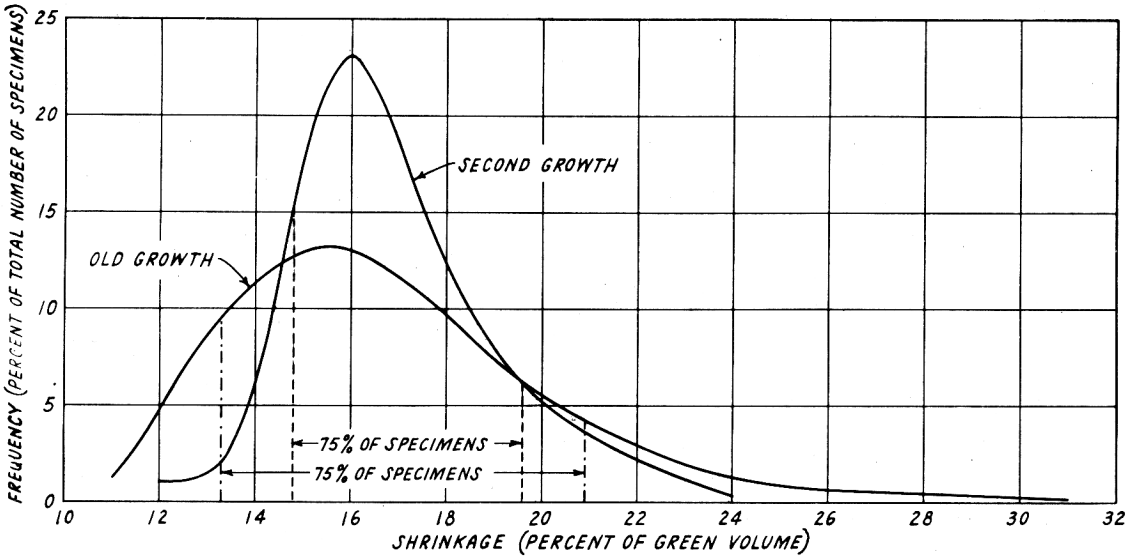

Fig. 2.—Variability in volumetric shrinkage in old-growth and in second-growth, upland white oak.

trees was considerably smaller than in the old-growth trees as is shown by the variability curves in Figure 2.

In the second-growth trees the wood having the highest volumetric shrinkage was contained in the samples taken from the sections 1 foot in length cut just above the stump. Seventy-five percent of the specimens shrinking 18 percent or more by volume came from this position in the trees. The maximum shrinkage was 24 percent. Only 0.9 percent of the specimens originating 4 feet or more above the stump had a shrinkage value of 18 percent or more. This places a high percentage of second-growth white oak lumber in that part of the trees devoid of excessive shrinkage.

For example, Figure 2 shows that the middle 75 percent of the 1,484 specimens from the 38 second-growth trees had volumetric shrinkage values between 14.8 and 19.6 percent, a range of 4.8 percent. In the ten old-growth trees, the middle 75 percent of 635 specimens had a shrinkage range between 13.3 and 20.9 percent by volume, a range of 7.6 percent.

The shrinkage behavior of old-growth and second-growth white oak does not closely follow the accepted theory that the heavier wood shrinks more than lighter wood since the specific gravity of second-growth white oak averaged 12 percent heavier than old-growth white oak (Fig. 3), therefore the shrinkage of the wood from second growth might be expected to be considerably higher than that of old growth. As a matter of fact, old growth with an average specific gravity of 0.58 and second growth with an average specific gravity of 0.65 had approximately the same average volumetric shrinkage, 17 percent.

Although it appears likely that as a rule the wood of second-growth white oak will be found to be heavier than much of the old-growth material, there is a distinct advantage with respect to lower shrinkage on account of the relatively young heartwood. At one extreme the second-growth timber will lack the highly prized soft-textured material which comprises the outer low shrinkage zones of the virgin-growth trees and at the other extreme material of unusually high shrinkage from the older heartwood of the old-growth trees likewise will be absent.

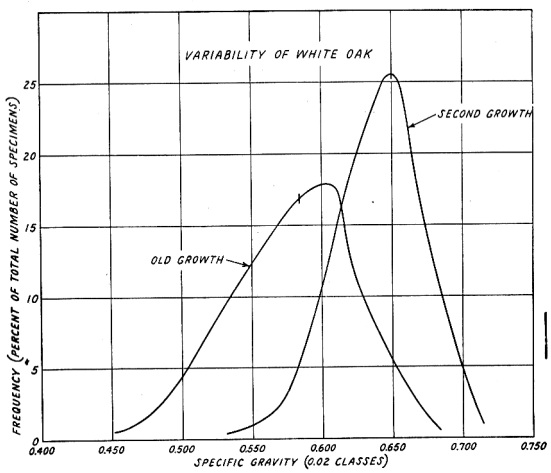

Fig. 3.—Variability in the specific gravity of old-growth and second-growth, upland white oak.