

TECHNICAL NOTES

FOREST PRODUCTS LABORATORY

U. S. FOREST SERVICE

MADISON, WISCONSIN

No. 111

DRYING LUMBER WITH SUPERHEATED STEAM

A kiln-drying process which will dry 1-inch softwood lumber green from the saw to 10 per cent moisture content in 24 hours or less has been developed at the U. S. Forest Products Laboratory, Madison, Wisconsin. The novel feature of the process consists in forcing superheated steam at high velocity first in one direction and then in the opposite through the pile of lumber in the kiln. This treatment dries the lumber very uniformly and rapidly with a minimum of checking and warping.

The superheated steam process has been found applicable to Douglas fir, firs of all kinds, western hemlock (not eastern), white cedars (not western red), sugar pine, western yellow pine, and southern yellow pine. It is entirely unsuited for some softwoods on account of collapse.

Drying lumber by this process consumes more steam per thousand feet of lumber than ordinary kiln-drying processes, and is recommended only where economy in fuel is not essential. As it is deleterious for lumber to be exposed for more than 2 or 3 days to the temperatures used, the superheated steam kiln is not adapted to the drying of lumber in thicknesses of more than 2 or possibly 2½ inches. It should be stated, furthermore, that the treatment somewhat reduces the toughness of the lumber, so that where this quality is of prime consideration, as in airplanes and wagons, a low temperature process of drying should be used. On the other hand, the superheated steam method reduces the "working" of the board and the hygroscopicity of the wood and also "fixes" the resin and gum. The effect upon knots as compared with low temperature drying has not been fully determined, but apparently there is not much difference. A slight darkening of the sapwood occurs, increasing with the length of time of exposure, and in periods much over 24 hours the heartwood may darken also.

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HOW TO TELL WHEN LUMBER IS READY TO BE TAKEN FROM THE KILN

The two things which a dry kiln operator must be able to prove at the end of a kiln run are that his lumber is as dry as is required and that it is free from invisible seasoning stresses which would cause warping when the wood is resawed and shaped into furniture or other products. Neither of these points can be proved by examination of the outside of the lumber. They are easily determined, however, by the following tests which have been devised by the U. S. Forest Products Laboratory, Madison, Wisconsin:

Before the lumber is removed from the kiln, choose a fairly representative board from each truck load of stock. Cut four 1-inch cross-sections (A,B,C,D) from the board at least 2 feet from the end.

Use section A to find the average moisture content of the dried stock. To do this, weigh the section immediately after cutting, on a balance accurate to 1/10 of 1 per cent, and then dry it on a steam pipe or in an oven at 212° F. until it reaches constant weight. The weight lost during this drying is the weight of the moisture which was in the section. Divide the weight of the moisture by the weight of the oven-dry section and multiply by 100. This will give the percentage of moisture in the section and also in the stock in that part of the kiln from which the sample was taken.

For furniture manufacture and other high grade uses, the moisture content of any board in the kiln should not vary by more than 2 or 3 per cent from the final moisture content specified.

Use section B to find out whether the stock is uniformly dry from center to outside. In order to do this the section must be cut apart and the moisture content of the inside and outside found separately. If the stock is $1\frac{1}{2}$ inches or more in thickness, cut the section parallel to its edges to get an outer shell of material $\frac{1}{4}$ inch thick. Trim the remaining block equally on all four sides to leave a core $\frac{1}{2}$ inch thick. If the stock is less than $1\frac{1}{2}$ inches thick, cut section B so as to get an outer shell and inner core each $\frac{1}{5}$ the total thickness of the section. Find the moisture content of each piece by the method used for finding the moisture content of section A. If the core is more than 2 or 3 per cent above the desired moisture content, the drying should be continued.

Use the third and fourth sections, C and D, for case-hardening tests. Saw section C parallel to the wide faces of the original board to form tongues or prongs, leaving about $\frac{1}{2}$ inch of solid wood at one end of the section. If the stock is less than 2 inches thick, make two saw cuts; if it is more than 2 inches thick, make five saw cuts. From sections having three prongs break out the center one, and from sections having six prongs break out the second prong from each side, leaving two outer and two central prongs. In section D saw one central saw kerf, so that the section will represent resawed stock. Stand the sections on end in some convenient, warm place in the shop to dry.

Observe carefully the action of the prongs from the moment of sawing. Do they bow in or out or remain straight on the saw? Do they change shape after drying in a warm room (not in an oven) to a uniform moisture content?

If the prongs remain straight both on the saw and after room drying, the lumber is perfectly seasoned, being free from stresses and uniformly dry throughout.

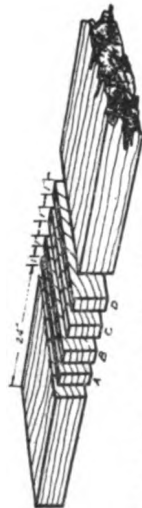
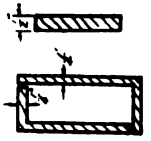
If the prongs do not curve, or if they curve out on the saw but turn in after room drying, the moisture content of the lumber is uneven, and the surface has dried without full shrinkage. In other words, it is set in an expanded condition or "casehardened". Steaming the lumber in this stage at about 165 degrees F. and 100 per cent relative humidity for from $\frac{1}{2}$ to 3 hours will soften the outer fibers and permit them to shrink normally on redrying. This should relieve all stresses.

If the prongs turn in on the saw and do not turn out after room drying, the lumber is "casehardened", but its moisture content is fairly uniform. Use a temper-

ature of 160 to 180 degrees and humidity just high enough to moisten and soften the surface. This usually takes from 6 to 24 hours. The shrinkage of the outside in redrying should relieve the interior tension and cause the stresses to disappear. Caution: do not allow surface to take on too much moisture in this stage or the stresses will be reversed on drying.

After any steaming treatment the lumber should be cooled to operating temperature at a humidity high enough to prevent drying.

MOISTURE CONTENT SECTIONS



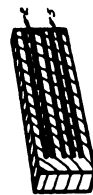
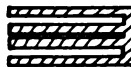
METHODS OF CUTTING TEST SECTIONS FROM PLANK

SEC. B"
MOISTURE DISTRIBUTION SECTION
 Outer margin sawed off as shown. Outer & center portions weighed, dried & re-weighed separately to determine true moisture content.

SEC. A"
MOISTURE CONTENT SECTION
 To be weighed, oven dried & reweighed to determine moisture content.

SECTIONS TO BE ROOM DRIED BEFORE CONCLUSION AS TO CASE HARDENING IS MADE

SEC. C"
 Thick stock sawed as shown for Case Hardening test. Planks 2 & 5 to be broken out.



Effect of over steaming. Not Permissible

"Case Hardened" Not Permissible

"Case Hardened" Permissible

Not "Case Hardened"

SEC. D"
 Resawed test for Case Hardening. One 30W test

Effect of over steaming. Not Permissible

"Case Hardened" Not Permissible

"Case Hardened" Permissible

Not "Case Hardened"



Resawed test for Case Hardening. One 30W test

TEST SECTIONS FOR MOISTURE CONTENT & CASE HARDENING