Handling Native Timber.

Formerly the bulk of our softwood supplies were received from the Baltic countries and arrived square sawn in a sufficiently seasoned state to be immediately useable for most purposes. Merchants who dealt solely with imported timber had no need to concern themselves with the preliminary processes of felling, sawing and drying which the timber had to undergo before reaching their yards, and their knowledge of them was frequently rudimentary and even non-existent. Consequently when all imports ceased they were forced to turn to native woods for their supplies and to enter upon a section of the trade for which, by lack of previous experience, they were exceedingly ill equipped.

It should be generally known, though the amount of ignorance on this point is surprising, that timber when freshly sawn from the tree contains an excess of moisture which renders it unfit for immediate use. Removal of this excess is known as seasoning and it is the lack of the requisite knowledge as to when seasoning should begin and how far it should continue which has contributed to the prevalent notion that native timber is inferior to imported. This inferiority complex is not shared by those who have spent their working lives in growing timber and the blame for any dissatisfaction with the use of the native product lies at the door of those operators who have not troubled to acquaint themselves with the correct procedure.

Moisture content is something which has to be carefully watched at all stages of manufacture and up to the final situation in which the sawn timber will be used. At the very outset it would be as well to dispose of some old wives' tales. First about the sap going down in winter. The amount of moisture in a tree is relatively constant both in summer and winter, the only difference being that in summer the sap is in motion and in winter it is practically static. Another queer idea is that timber seasons in the log; this is completely erroneous, as timber does not season in that condition but merely decays.

Handling after felling. Logs should not be allowed to lie in the woods but should be removed immediately to the sawmill for conversion. If such a course be impracticable they should not be allowed to lie in contact with the ground but should be raised clear on cross billets so that air may circulate freely underneath them. This is particularly important in summer when the higher temperatures favour the growth of those fungi which cause decay. Such timbers as Oak and Larch are fairly resistant to decay and may not deteriorate too much as a result of careless handling, but Scots Pine is very liable to sap stain if not dealt with at the earliest possible moment.

At the sawmill. The faces of freshly sawn timber should not remain in contact, otherwise moulds well develop. As soon as it leaves the bench the timber should be piled with seasoning sticks between the layers of the pile. These sticks should generally be 1″ x 1″ of clean dry stuff and should be placed vertically above one another in the pile and about two feet apart. As the rate of drying is influenced by the thickness all timber should be broken down to the thickness at which it will ultimately be used. Drying rates also vary according to species and each pile should only contain one species of one thickness.

Drying takes place more rapidly at the ends than at the faces or edges. Consequently if timber is drying in the pile over an extended period the ends will become much drier than the rest of the timber. Once this drying has proceeded beyond the point at which appreciable shrinkage occurs end splitting will develop. This may be counteracted by coating the ends with a good waterproof paint, or if this be not possible the ends of the piles should be protected against sun and wind by sacking. At the time of stacking short sample pieces should be built into the pile in such a way that they can be extracted from time to time without disturbing the rest. If they have been weighed before stacking and their moisture content ascertained it will only be necessary to weigh them at intervals in order to gauge the state of dryness of the rest of the pile. When the timber has reached a moisture content of approximately 30% it is then sufficiently dry for shipment. This preliminary drying is important from two standpoints. Firstly, it will be sufficiently dry to discourage the growth of moulds wherever the faces come into contact so the buyer will receive it in good condition, and, secondly, the saving in weight. This latter consideration will not greatly concern the miller who disposes of his product at prices F.O.R., but it is of importance to the buyer who would be paying rail carriage on a good deal of useless moisture. For instance, a ton of freshly sawn spruce at approximately 80% moisture content would only weigh about 14 to 15 cwts. at 30%, a reduction in weight of anywhere between 25% and 30%.

Times of drying vary with the species and the thicknes of the timber. Softwoods are more tolerant of rapid drying conditions than are the hardwoods. Native Scots Pine, Spruce, Douglas and Silver Fir dry rapidly, but Larch is more refractory. Generally speaking, these will dry without serious degrading up to 2″ thickness, but the hardwoods should be stacked with ½″ to ¾″ sticks, the thinner sticks being used for such refractory species as Oak. Thickness of the material has an important bearing on the rate of drying. Below 2″ it may be assumed that the time required is roughly proportional to the thickness, but 3″ stuff would require at least twice the time of 2″. Under normal weather conditions hardwoods stacked in the autumn and softwoods stacked in the spring would be fit for shipment by the following autumn.

Frequent reference has been made to moisture content, so it will be advisable to go into greater detail as to what is actually meant by that expression, how it is determined and to what extent moisture may be permitted to remain in timber without impairing its usefulness for the purposes for which it is intended.

In the first place it is necessary to adopt a standard of measurement to which moisture contents may be related, and this standard is known as the oven-dry weight. If a sample of the timber be weighed and then placed in a drying oven it will be found to lose weight as the moisture is driven off. Finally, a stage is reached when further drying is not accompanied by further loss of weight and the sample is then said to be oven-dry. The original moisture content of the sample is then ascertained from the following formula:

$$\text{Moisture Content} = \frac{\text{Green weight—Oven-dry weight}}{\text{Oven-dry weight}} \times 100 \text{ per cent.}$$

If, for example, the original weight of the sample had been 35 gm. and the oven-dry weight 20 gm. then the difference of 15 gm. would represent the weight of the moisture driven off, and the moisture content at the time of testing would be:

$$\text{Moisture content} = \frac{35—20}{20} \times 100 = \frac{15}{20} \times 100 = 75\%.$$

It will be seen from the above formula that moisture content is expressed as a percentage of the oven-dry weight and not of the original weight of the material.

If at the time of stacking a preliminary test for moisture content were made and the sample pieces weighed as they were built in to the pile it will be possible to find the state of dryness of the timber in the pile at intervals. Suppose that at the time of stacking the weight of a sample piece were 45 lbs., and its moisture content 75%, then its oven-dry weight could be calculated from the following formula:

Oven-dry weight=

$$\frac{\text{Wet weight} \times 100}{\text{Mosture content} + 100} = \frac{45 \times 100}{75 + 100} = \frac{4500}{175} = 25.7 \text{ lbs.}$$

Each sample piece should be weighed separately and its oven-dry weight calculated. At intervals, as drying proceeds, they can be taken out of the pile and weighed. Their current weights will determine the stage of dryness from the following formula:

$$\text{Moisture content\%} = \frac{\text{Current weight—Oven-dry weight}}{\text{Oven-dry weight}} \times 100$$

Suppose that, at the time of testing, the sample piece which originally weighed 45 lbs. in the green state now only weighed 34 lbs. The calculated oven-dry weight was 25.7 lbs. and its moisture content would be

$$\frac{34.0—25.7}{25.7} \times 100 = \frac{8.3}{25.7} \times 100 = \frac{8300}{257} = 32.3\%$$

As air seasoning is entirely dependent upon the state of the weather, over which the operator has no control, it need occasion no surprise that the results obained will be variable. As a general rule thoroughly air-dried timber will assume a final moisture content of between 23% and 17%. Under exceptionally favourable conditions a state of dryness as low as 15% may be reached. For certain environments, such as interiors which are subjected to a high degree of central heating, lower percentages will be required and these can only be attained by kiln-drying.

Kiln-drying. The underlying principles of this process are not sufficiently understood and it has frequently been condemned by the unthinking as an artificial and forcing method. Apparently air-seasoning is regarded as a so-called natural method, but such is not the case, as sawn timber does not occur in the natural state. Kiln-drying is not forcing, but it does augment and accelerate those conditions found in nature which are conducive to the extraction of moisture from timber. There are various factors which govern the time required for seasoning and they are applicable to both processes. These factors are:

(1) Original and final moisture contents,
(2) The density of the timber,
(3) The thickness of the stock,
(4) Air temperature,
(5) Relative air humidity,
(6) Velocity of air currents,
(7) Length of air travel,

and it will be advisable to examine them in turn. For the sake of uniformity it will be assumed that Scots Pine 2″ thick is being treated.

Original and final moisture contents. In the green state home grown Scots Pine has a moisture content of about 85%. Obviously it will require much longer to reduce it to a 12% moisture content than to 30%. It will be found that successive stages of dryness require longer times and if these were plotted in a graph they would form a steeply ascending curve. In a continuously working overhead fan kiln it would probably require 35 hours to reduce to 60% from the initial green, the next stage to 50% would require an additional 20 hours, to 40% an additional 25 hours, to 30% a further 30 hours, to 20% about 40 hours and from 20% down to 12% a further 90 hours. These times are merely approximate and amount in all to some 240 hours and they may be shortened slightly, but it is the attempt to shorten them unduly and to telescope the schedule which constitutes the forcing by which kiln-drying has been unjustly condemned.

The density of the timber. Hardwoods are much denser than the softwoods and in consequence require much longer periods for drying. Taking Scots Pine as our unit it would be necessary to multiply the drying times given above by the approximate factors quoted for the following species:

Ash, Beech, Elm and Poplar	3 to 3½
Spanish Chestnut	5
Oak	8 to 8½

The softwoods also show variations in this respect and the following approximate factors would be required:

Corsican Pine, Norway Spruce and Douglas Fir	$1\frac{1}{4}$
Larch (European)	$1\frac{1}{2}$
Hemlock	$1\frac{3}{4}$

Thickness of Stock. This has an important bearing upon the time needed for drying. Obviously thick stock would take longer to dry than thin, but the times required are not proportional to the thickness. Taking 2'' stuff as our unit the following factors would need to be applied for various thicknesses:

Thickness	$\frac{1}{2}''$	1''	$1\frac{1}{2}''$	$2\frac{1}{2}''$	3''
Time factor	0.2	0.425	0.700	1.400	2.00

Air temperature. Kilning may be commenced at much higher temperatures than are available in air drying. All timbers are not alike in their reactions to kilning and some prove much more refractory than others. Such timbers as Elm and Sycamore would require a comparatively low initial temperature of about 105° Fahrenheit whereas the more tolerant softwoods such as Scots Pine and Norway Spruce could bear an initial temperature of 140° to 150° Fahrenheit. At successive stages of drying the temperatures would be raised, but the maximum permissible in the case of very refractory timbers would not exceed 120° Fahrenheit. The more tolerant softwoods could reach as much as 180° in the final stages.

Air Humidity. The higher temperatures in kilning will greatly accelerate the evaporation of moisture from the timber as compared with air drying and if very dry air were used at these temperatures the greatly increased rates of drying would set up stresses in the material giving rise to very serious defects such as case-hardening, splitting, honeycombing and so on. To counteract this tendency it is necessary to raise the humidity of the air above normal at the commencement of the run. This can be done by introducing a fine jet of steam into the drying chamber and checking the humidity by the difference of the readings of a wet and a dry bulb thermometer. As the relative humidity at the beginning should be about 80% the wet bulb should have a reading about 6% less than that of the dry bulb. The actual temperature readings are not in themselves so important but that percentage difference should be maintained. As drying progresses the temperatures can be raised and the humidity lowered. When the moisture content (%) of the wettest timber has been reduced to, say 60% the temperature could be raised another 5° and the humidity reduced to 70%; at this stage the difference in the bulb readings should be in the order of about $8\frac{1}{2}$%. This process of raising the temperature and lowering the humidity would proceed by successive stages until the desired moisture content (%) was reached.

Velocity of air currents. Air in motion causes more evaporation than still air and the higher the velocity the greater the rate of drying. Too high a velocity would cause rapid drying of the timber on the inlet side of the pile and the rapid saturation of the air would mean that the timber on the outlet side would be much wetter. To counteract this tendency it would be necessary to raise the relative humidity of the air in the drying chamber and thereby retard excessive evaporation. Any advantage gained by the higher air speed would thereby be neutralised. In a fan-driven kiln an air speed of between three and four feet per second should be sufficient. Natural draught kilns which depend entirely upon convection currents for the flow of air could not provide such air speeds, consequently they can work at a 10% lower air humidity than the fan kiln to assist evaporation. One important advantage possessed by the fan-driven kiln is the fact that the air flow can be reversed and the timber pile be dried equally from each side.

Length of air travel. Air entering on the inlet side becomes progressively wetter as it travels through the pile and if the pile were unduly wide a stage would be reached where no drying would occur on the outlet side. In the double stack type of overhead fan kiln a width of six feet should not be exceeded, but up to seven feet would be permissible in a single stack kiln.

It has not been possible to do more than sketch in merest outline the principles which govern kiln-drying, but enough has been written to show that it is no haphazard process of merely placing timber in a kiln, leaving it there for a while, and then taking it out. On the contrary, it is a highly skilled operation in which all the governing factors have to be carefully balanced. Much depends upon the operator and an experienced man can secure satisfactory results even with a poor type of kiln. On the other hand, with an inexperienced operator in charge of a good kiln anything might happen. In good hands the results from kiln-drying are more dependable than from air seasoning as all the factors are under control at every stage of the process. J.A.K.M.