

# AN INVESTIGATION INTO CERTAIN ASPECTS OF THE AIR-DRYING OF TIMBER.

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**(Editor's Note:** This investigation was performed as a special study for the B.For.Sc. degree. The study comprises: First, a discussion of modern air-drying methods. Second, critical descriptions of the methods in use at a timber yard in Christchurch, and at a sawmill in Ongarue, King Country. Third, a presentation of data resulting from a study of moisture content, shrinkage, and drying time, made at Christchurch and Ongarue. It has been necessary to omit the first two sections, and to condense the third section greatly, omitting much discussion of methods and results, and a number of graphs and tabulations. The Editor has therefore had to make, with Mr. Collier's permission, a number of changes in sequence and wording. Standard abbreviations used throughout are: M.C., moisture content; F.S.P., fibre saturation point.)

## **Introduction:**

This study was undertaken to gather data on the moisture content equilibria attained by air-seasoning in Christchurch and Ongarue, the length of time taken to reach equilibrium in rimu, and the suitability of air-dried timbers for various lines of use. It had been planned to obtain data on the second point by tests on timber in stacks of known age. This proved largely impracticable in Christchurch. Trade was badly depressed, and no stacks were going up or coming down, while it was not found possible to extract pieces for testing from flat stacks in situ. The method was changed, therefore, and arrangements made to have a stack erected by a co-operating firm, from which sample pieces could be removed for testing at will. Owing to trade depression the stack was not erected until the end of July, and this experiment is therefore still in progress.

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## **Stacking Methods:**

The methods employed by the two co-operating firms were as follows:—In Christchurch the timber is received

rough-sawn green from Westland. The moisture contents on receipt range from 90 to 130 per cent. for heart timber, to as low as 25 per cent. for 3 x 2 sap timber where some time has elapsed on the skids in Westland prior to shipment. On arrival the timber is piled in flat stacks, end-piled 6ft. wide, 16ft. high, 20ft. long, square both ends, with 1" fillets, the stack roofed with one layer of old boards.

At Ongarue the timber goes from the saw straight to upright racks 6ft. wide, holding about 2,500 feet. No segregation of lengths is made.

#### **Climate:**

The chief point to be stressed is the windiness of Christchurch, particularly the effect of the low humidity westerlies, so that warping and checking are serious defects, and one of the chief problems is preventing overgreat circulation. On the other hand, Ongarue is characterised by a winter of rain and hanging fog, with high humidities and little wind, so that stacking methods must aim for maximum circulation.

Both equilibrium M.C. attained, and length of time required to dry to equilibrium will be affected by this point.

#### **Equilibrium M.C. Attained in Stacks, Christchurch:**

Tests on material in stack, or in stack and open air covered shed for two and more years showed a M.C. of 15.5 to 16.0 per cent. at the beginning of March. At the end of March, tests on a stack of 6 x 1, three years eight months stacked, showed heart, 15.7 per cent., sap 16.3 per cent., the sap evidently responding rather more quickly to the rising average humidity. On June 23rd material 20 to 24 months in covered open air shed tested 18 to 19 per cent. with no difference between heart and sap.

Air dried timber in Christchurch will therefore have an average M.C. of from 15½ per cent. in early autumn to 19 per cent. in mid-winter, when taken from roofed stacks or covered shed.

#### **Equilibrium Obtained in Stacks, Ongarue:**

The data available for this were a number of tests made on racks of various ages in August. The results showed that the equilibrium in the covered drying shed was between 17½ and 19 per cent., but that it was impossible to obtain this during the winter in the upright racks, open to entry by frequent rain. Nothing under 21 per cent. was found in the racks at this time, though the tests were taken after four days' dry weather.

### **Time Taken to Reach Equilibrium, Christchurch:**

As explained in the introduction, this experiment is not complete. Regular tests are being made on a stack of 1" material (rimu) erected in July. These are still in progress. It was not found possible to study other thicknesses nor other species, nor to test the time of drying of stacks erected in midsummer. Tests are being made on eight pieces (five heart and three sap) in five different positions in the stack at fortnightly intervals, while current weather records are being filled. From July to September the average humidity was about 5 per cent. higher than the mean monthly figure. In October it was 4 per cent. lower than the mean. Results to 20th October are summarized thus:—

1. Sap timber dries more rapidly than heart to about F.S.P., below which rate of drying seems equal.

2. The pieces in the top tiers of the stack dried much more rapidly than those in the lower in the early months. The lower tiers have now caught up, and will probably attain equilibrium at the same time.

3. After three months' drying, four of the test pieces are already below 20 per cent. M.C.

4. The last two weeks of low humidity caused a check to open in a heart piece, bottom centre, with M.C. of 24 per cent. Other pieces with lower M.C.'s developed no visible defect.

5. In all cases shrinkage began before F.S.P. was reached, probably indicating some degree of case hardening. (No tests for case hardening were made.)

6. No definite relation between shrinkage and moisture content was evidenced. This may be due to slight cupping in some pieces, but probably is the result of a very steep moisture gradient or incipient case hardening, with unbalanced stresses undergoing slow adjustment.

The results given under points 4, 5 and 6 would point to the drying rate being somewhat over-rapid. A restriction of circulation may be justified. (The co-operating firm normally space closer than in the test stack, erected to comply with a project plan of the State Forest Service.)

### **Time Taken to Reach Equilibrium, Ongarue:**

This was obtained by test pieces taken on 29th August from racks of various ages. As stated above, none of the pieces had reached equilibrium due to the entry of rain during the winter. One inch sap timber

was as low as it could get at this time of year in upright racks in 30 weeks and heart in 50 weeks the M.C.'s being between 21 and 25 per cent.

### **Response of M.C. to Fluctuating Humidities:**

The relation of M.C. to relative humidity has been expressed graphically by the Forest Products Laboratories of both Britain and U.S.A., the two curves showing considerable difference. A test on a piece of kahikatea rotary cut veneer gave results closely approximating to the American curve. A rather surprising time lag in response to changing humidities was revealed, in view of the thinness of the piece. Further tests were made with pieces of 1 inch and  $\frac{1}{2}$  inch rimu, both heart and sap, out doors under cover, and in a heated room. The object was to determine both the equilibrium, and the extent of fluctuation above and below the equilibrium in the two environments.

In the open air, rapid fluctuations were recorded. A fall of 3.6 per cent. in three days was followed soon after by a rise of 4.5 per cent. in three and a-half days. The  $\frac{1}{2}$  inch timber showed a quicker response than the 1 inch timber, and a slightly higher range of M.C. The out door figures for the first half of July ranged from 17.4 to 19.2 per cent.; for the second half from 14.4 to 20.0 per cent.

In the heated room fluctuations were within a much narrower range. During July and August, when the heat was on, the M.C. for 1 inch timber varied only from 11.9 to 13.5 per cent., being almost constant at 13.1 to 13.5 for the first half of July, falling to a range of 11.9 to 12.9 for the latter half of July and first half of August. The heat was then cut off, and September figures showed an M.C. of 13.7 to 14.5 per cent., the indoor humidity rising, but still ranging considerably below outdoor humidity at most times of recording. A piece of 1" timber at out door equilibrium brought inside took ten days to reach indoor equilibrium. No difference was discernible between heart and sap.

This study is incomplete in that observations are required over at least a full year to determine extent of fluctuation, and also to correlate the official humidity readings, taken at 9 and 5 daily, with actual fluctuations, to obtain a constant by which probable monthly equilibria, and range of M.C. in different localities might be predicted by comparison of monthly average weather records as published by the Government Meteorologist.

### Relation of Shrinkage to M.C.:

This was tested on four flat sawn pieces, two 1" and two ½" thick, one being heart and three sap. The results were expressed in change per inch of width per 1 per cent. change in M.C. The average figure was .0021" per inch. The heart piece showed a figure of .0015", considerably less than the sap pieces, which ranged from .0020" to .0026", but the result is from one piece only. There was no difference discerned between ½ inch and 1 inch sap timber.

The practical significance of this may be expressed as follows:—A 6-inch board air-dry at July equilibrium of 18 per cent. M.C. if made up into furniture at once, and placed in a heated building where the equilibrium was 12½ per cent. would shrink .07" or 1-14". As much furniture timber is used in wide widths such shrinkage is serious. For interior conditions the range of M.C. experienced is rather narrow, from 11 per cent. to 15 per cent. being probably extremes not often experienced. This would give a maximum working of 1-20" in a 6" board—not sufficient to cause trouble with drawers, interior doors, etc. The range of outdoor M.C., however, is wider—from a maximum of 20 per cent. in July to a probable midsummer minimum of 13 per cent. (From average humidity figures. Not covered by actual tests.) The range of hygroscopic working here is sufficient to have a marked effect on windows and exterior doors, a point well borne out by experience.

### Summary:

The results so far obtained may be summarized thus:

Outdoor equilibria have been determined for Christchurch covering autumn, winter and spring months, and for Ongarue in late winter.

It has been shown that it is not possible to obtain equilibrium in upright racks during winter months at Ongarue.

The actual M.C. of air-dry timber out doors under roof may vary as much as 4½ per cent. almost from day to day, and 6 per cent. within the month. Nevertheless, the correlation with meteorological records as carried to date indicates that the average M.C. that will be held in any month can be closely predicted from the average humidity for the month from the 9 and 5 readings of the Government Meteorologist, using the U.S.F.S. graph of M.C. equilibria.

It appears that timber taken from flat stacks at outdoor equilibrium in July should be stored in a heated room for at least ten days prior to making up for furniture, interior joinery and cabinet-making.

The value of hygroscopic working in rimu was determined as .0021 inches per inch of width per 1 per cent. change in M.C. The result needs further testing as an unexplained difference between heartwood and sapwood was evidenced. The value can be expected to vary with density, which was not tested; and, according to various writers, with the temperature and conditions of drying, though quantitative expressions of effect of drying conditions on hygroscopicity are lacking, and negative results have been obtained at Canterbury College in all attempts to demonstrate that oven-dried pieces, after regaining equilibrium, show less change in volume than air-dried pieces with changing M.C.

