C.S.I.R.O.

Forest Products Newsletter

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The Effect of Moisture Change on Wooden Floors

By G. S. CAMPBELL, Timber Seasoning Section

DURING the postwar years the Division has received repeated requests for assistance where wooden floors in private homes, factories, and halls had distorted soon after installation. In some cases the distortion was found to be due to shrinkage of the flooring, which obviously had been machined from insufficiently dried timber. Gaps between boards up to ¼ in. wide have been observed, and in some cases the shrinkage of the flooring was accompanied by cupping.

There were a few cases, however, where for various reasons the floor had absorbed moisture, and swelling and ridging at joints had occurred. This ridging was particularly noticeable where this condition had developed under linoleum. In extreme cases, the whole floor had lifted—that is, the swelling of the floor had lifted the floor joists, causing them to arch. In one factory floor, the swelling was so severe that the bearers were also lifted and had broken the brick pier supports. In this instance the moisture content of the flooring at the time of installation was apparently correct, but, because of inadequate ventilation of the foundations, the timber was able to absorb moisture from damp ground underneath. Tight cramping during laying had accentuated the distortion.

Most branches of the timber industry, and probably the majority of our readers, take their annual leave over the Christmas–New Year period. It was therefore decided not to publish a January issue of the Newsletter this year.

The moisture content to which timber should be seasoned to ensure satisfactory performance as flooring will depend on its environment during its service life. For normal use, it should be seasoned to a moisture content approximately midway between the extremes of moisture content to which it will approach in summer and winter, so that movement (shrinkage and swelling) will be kept at a minimum. It should, therefore, be dried to the average equilibrium moisture content (e.m.c.) condition for the area of its likely use. For example, the average e.m.c. condition for unheated indoor conditions in Melbourne is about 12 per cent.

Information on e.m.c. values for other localities can be obtained on enquiry from The Chief, Division of Forest Products, C.S.I.R.O., P.O. Box 18, South Melbourne, S.C.5, or from the State Forest Services.

If air-conditioning is to be used in a building, the flooring may need to be at a different moisture content than is normal for unheated or non-conditioned buildings. Tests have shown, for example, that the e.m.c. conditions in air-conditioned buildings in Melbourne usually stabilize at about 8 or 9 per cent. in winter: the winter "normal" for unheated buildings in Melbourne is about 13 to 14 per cent. As in the case where sub-floor heating is used, however, it would be unwise to dry the flooring just to suit this particular condition. With sub-floor heating, particularly, there are usually times when it is inoperative, for instance in kindergartens during vacation periods. During winter "shut-off" periods, the moisture content of such flooring will increase, swelling will occur, and possibly ridging at the joints if the floor has been cramped tightly. In this instance it would be better to have the flooring dried to slightly below the normal e.m.c. condition for unheated buildings, i.e. to an average condition of approximately 10 to 11 per cent., so that while some slight shrinkage will occur when the heating is in operation, there will be no adverse effects due to swelling when it is switched off.

The amount of shrinkage and swelling which accompanies change in moisture content in flooring during service can be reduced in several ways. First, as already discussed, ensuring the flooring is at the average e.m.c. condition for its environment is probably the most important. Secondly, there will be less change in width if *only* quartersawn stock is used, as shrinkage across the width of a quartersawn board is only about half that across the face of a backsawn board. Thirdly, the narrower the flooring, the smaller the change in each board. For instance, shrinkage in 2¼ in. flooring would result in smaller gaps between individual boards than in, say, 5¼ in. flooring under the same range of changing conditions.

One other factor likely to affect appearance and which must be considered is the way in which the floor is cramped. The normal method is to cramp about 6 or 7 boards at a time tightly together (this will vary according to width of flooring but is the usual number for 4¼ in. boards), cramping being continued to the point where the floor just begins to arch. However, there may be circumstances where it is known that sub-floor ventilation is bad or that the timber has been over-dried. Then tight cramping would only accentuate the movement due to swelling as the moisture content of the timber increased. In such cases it is necessary to try and provide for this expected movement by cramping the boards loosely, that is, bringing them together until they just touch but without obvious gaps. Open joints which occur with insufficiently dried flooring can at least be filled with putty or thin slivers of wood, but it is difficult to do anything about the cupping and ridging in flooring which can result from bad ventilation, or the use of over-dried timber, or over-cramping.

The amount of shrinkage likely to occur under a given set of conditions in flooring which has been milled from wet timber can be quite easily calculated provided the following factors are known:

(1) The moisture content of the timber at time of installation;

(2) The species;

(3) The direction of the growth rings with respect to the face;

(4) The moisture content at which normal shrinkage commences for the particular species;

(5) The shrinkage value to 12 per cent.; and

(6) The moisture content to which the timber will eventually dry.

If, for example, the timber species is one in which normal shrinkage commences at approximately 30 per cent., and the moisture content at the time of machining is 20 per cent., the actual amount of shrinkage and hence width of gaps between boards can be calculated for any size flooring. In drying to a moisture content of 12 per cent., a typical quartersawn hardwood floor may have undergone a total shrinkage in width of 4 per cent. (This amount, of course, varies with species, and information on total shrinkages and the moisture content at which shrinkage commences in any species can be

The Likely Movement in Wooden Floors with Moisture Content Change*

Example No.	m.c. of Flooring when Laid (%)	How Cramped	Season when Laid	Average e.m.c. for Season when Laid (%)	Likely Movement	Following Season	Average e.m.c. during Following Season (%)	Likely Movement during Following Season
1	14	Tight	Winter	14	None	Summer	10	Shrinkage with slight gaps between boards
2	14	Loose	Winter	14	None	Summer	10	Shrinkage with gaps more pronounced than in (1)
3	10	Loose	Winter	14	Swelling and possibly slight cupping	Summer	10	Shrinkage back to original width—slight cupping may remain if previously present
4	10	Tight	Winter	14	Swelling with cupping more pronounced	Summer	10	May shrink to a little less than normal width with permanent cupping more likely than in (3) above
5	18	Tight	Winter	14	Slight shrinkage and gaps	Summer	10	Pronounced shrinkage—moderate gaps between boards
6	18	Loose	Winter	14	Slight shrinkage and gaps	Summer	10	Gaps more pronounced than in (5) above
7	16	Tight	Summer	10	Shrinkage with obvious gaps between boards	Winter	14	Floor could take up almost to normal although some slight openings between boards may still be apparent
8	16	Loose	Summer	10	Shrinkage with gaps more pronounced than in (7) above	Winter	14	Floor almost takes up but openings are probably more obvious than in (7) above
9	12	Tight	Summer	10	Nil to slight shrinkage	Winter	14	Slight swelling but negligible risk of cupping
10	12	Loose	Summer	10	Nil to slight shrinkage	Winter	14	Slight swelling but with no risk of cupping
11	8	Tight	Summer	10	Nil to slight swelling	Winter	14	Further swelling and obvious cupping
12	8	Loose	Summer	10	Nil to slight swelling	Winter	14	Further swelling, but cupping not as severe as (11) above

* This table does not take into account the possible effects of any surface finish or covering on the floor.

obtained on application.) If backsawn flooring is used, the percentage shrinkage is almost doubled for the same change in moisture content.

Let us now consider a case where the quartersawn hardwood flooring mentioned above is machined to $4\frac{1}{4}$ in. face width out of partly air-dried timber in which almost full normal shrinkage has yet to occur, i.e. timber above 30 per cent. moisture content. By the time it has shrunk to 12 per cent. moisture content the flooring will have shrunk 0·04 in. for every inch in width. Therefore, the total shrinkage in each board will be $4 \times 0{\cdot}04$ in., i.e. 0·16 in., which is equal to a little over $\frac{5}{32}$ of an inch. If the timber has been air-dried to, say, 20 per cent. before machining, then the shrinkage would be just over $\frac{1}{16}$ of an inch, i.e. less than half. Obviously, this also is more than can be accepted and the only way to avoid gaps between boards after laying is to ensure that the timber is at the correct moisture content when machined.

Some present-day building techniques use the undesirable practice of laying the floor before roof protection is provided. In such cases, it is essential for the floor to be given temporary protection against rain-wetting—preferably by the use of a suitable protective coating or a tarpaulin. Excessive absorption of moisture by unprotected laid flooring can cause the timber to shrink back on subsequent redrying to below its normal dimensions.

The popularity of window-walls and large glass windows in modern home construction can also be a source of trouble in flooring in rooms with northerly or westerly aspects unless adequate care is taken. A hot sun beating in through the glass can cause the timber to dry further than expected and to shrink excessively, so that whereas the flooring may be satisfactory in other parts of the home, the boards close to such windows may show pronounced gaps. In such cases, care should be taken to shield windows if there is a delay in the fitting of blinds and curtains.

An attempt has been made in the table on page 3 to give at a glance some idea of the movement that might be expected to take place in a floor under the various stated conditions.

It behoves the building contractor to take into account both flooring moisture content and time of year and to cramp his floors accordingly. If he pays proper attention to these factors and to adequate under-floor ventilation and drainage, he can then anticipate little trouble from unsatisfactory floors.

OVERSEAS VISITS

MR. STANLEY A. CLARKE, Chief of the Division, left on December 31 for Europe. While overseas he will carry out some pulp and paper investigations in England. He will return through New Zealand.

MR. R. F. TURNBULL, Officer-in-Charge, Utilization Section, recently returned from visiting institutes engaged in forest products investigations in South Africa, Europe, North America, and New Zealand. He enquired into recent developments in sawmilling, residue utilization, and investigation of wood-using industries.

DONATIONS

THE following donations were received by the Division during November and December:

Hansen Consolidated Industries, N.S.W.	£150 0 0
Lawson & Sons Ltd., Mareeba	£50 0 0
North Queensland Sawmillers Association	£105 0 0
Pioneer Forest Products Pty. Ltd., Sydney	£21 0 0
Sidney Myer Charity Trust ..	£210 0 0
Henry Machin & Sons, N.S.W.	£10 10 0
Safanco Co., Johannesburg ..	£6 5 0
Alsop & Duncan, Hawthorn ..	£26 5 0

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RELATIONSHIP BETWEEN HEARTWOOD EXTRACTIVES AND DECAY RESISTANCE

By P. RUDMAN, Wood Preservation Section

FOR MANY YEARS it has been believed that the natural decay resistance of heartwood is due to the presence of extraneous substances (extractives) which are toxic to wood-destroying fungi. Those heartwoods which have a high decay resistance have been considered to contain relatively large amounts of toxic extractives or moderate amounts of highly toxic extractives. Such beliefs have been strengthened over the years by the isolation, in the pure state, of substances which ultimately have been shown to be toxic to wood-destroying fungi. However, in most of these experiments, it has been the aim of the research worker to isolate and identify heartwood extractives, their function in wood being of only secondary importance. Nevertheless, certain interesting features have been demonstrated.

In the late 1930's, workers in the Royal Technical University of Stockholm were investigating the cause of inhibition of sulphite pulping in *Pinus sylvestris* and ultimately isolated the trouble-maker, a compound which they named pinosylvin. It was later shown that this compound and near relatives of it were toxic to fungi. This initiated a more detailed study of the *Pinus* genus and to date the heartwood extractives of 50 or more species have been studied. This has further led to the isolation and identification of more heartwood extractives, some of which are toxic to fungi. The results have shown that a broad chemical relationship exists between the species of this genus.

More recently the Cupressaceae have received attention and in particular the subfamily Cupressoideae. Here again some interesting fungi-toxic compounds have been found and there are signs of a family relationship. One interesting point arising from the study of toxic heartwood extractives is that nearly all are members of a large chemical group of substances called phenols. Some of these phenols have been used for years as antiseptics, e.g. carbolic acid and lysol, whilst the wood preservation industry makes use of creosote (containing phenols) for the protection of timber against wood-destroying fungi.

Though this type of work has furnished very interesting results, little of it was primarily intended to give an answer to the question: are extractives responsible for the high decay resistance of some heartwoods? To satisfy such a question three major points must be demonstrated:

- The natural heartwood must have a high decay resistance.
- The extracted heartwood must be decay-susceptible.
- The heartwood extractives must be toxic to wood-destroying fungi, not only in agar (the classical method of determining toxicities) but also when incorporated into a decay-susceptible wood.

percentage loss in weight similar to that of mountain ash indicates decay susceptibility.

It can be clearly seen in Table 1 that an ether extraction (which de-fats) of tallow-wood produces no change in the decay resistance, but the next extraction, that is, with methanol, causes tallowwood to become as decay-susceptible as mountain ash. The extractives from this latter stage are also highly toxic to the fungus, since mountain ash containing these is rendered as decay-resistant as the unextracted tallowwood.

TABLE 1

Percentage Weight Losses of Tallowwood and Mountain Ash Sawdusts after Incubation with *Coniophora cerebella*

Mean for four trees which behaved almost identically

Untreated Tallowwood	Tallowwood after Successive Extraction with			
	Ether	Followed by Methanol	Followed by Acetone	Followed by Water
0	0·1	46·0	44·1	46·7
Untreated Mountain Ash	**Mountain Ash Containing Tallowwood Extractives**			
	Ether Extractives	Methanol Extractives	Acetone Extractives	Water Extractives
50·6	49·0	0·9	50·7	48·5

Work in this Division has been designed to test the above and one of the more highly decay-resistant eucalypts was chosen, namely *Eucalyptus microcorys*, tallowwood.

Tallowwood was extracted, first with ether, then with methanol, then acetone, and finally with water, and the extractives from each stage were incorporated individually into the decay-susceptible *Eucalyptus regnans*, mountain ash. The typical results as given in Table 1 show the percentage weight losses of the various sawdusts used after incubation with the brown-rot fungus *Coniophora cerebella*. No loss in weight after incubation indicates high decay resistance, whilst a

These results indicate that the tallowwood trees had sufficient toxic extractives to give them complete protection.

With *Eucalyptus sieberiana*, silvertop ash, although methanol extraction again produced a significant change in decay resistance, the results were extremely variable between trees. Table 2 illustrates this variability and its relationship to the extractives removed by methanol.

Attention is now being directed to a study of *Eucalyptus camaldulensis*, river red gum, where preliminary work has indicated that the extractives are highly toxic. At the same time the tallowwood extractives are being

TABLE 2

Percentage Methanol Extractives and Percentage Weight Losses of Silvertop Ash and Mountain Ash Sawdusts after Incubation with *Coniophora cerebella*

Tree No.	Methanol Extractives (%)	Weight Losses			
		Untreated Silvertop Ash (%)	Methanol-Extracted Silvertop Ash (%)	Methanol Extractives in Mountain Ash (%)	Untreated Mountain Ash (%)
1	12·41	0	52·0	7·6	
2	11·42	26·8	46·0	23·0	
3	10·68	38·0	47·8	34·6	
4	5·09	45·1	52·0	37·0	
					45·2

subjected to a detailed study. Recent work with *Tectona grandis*, teak, has confirmed that the heartwood extractives are responsible for the natural decay resistance, but that both extractives and decay resistance may be low in the heartwood adjacent to the pith. In view of this, the effect of growth rate on decay resistance is now being studied.

Forest Trees of Australia

THE Forestry and Timber Bureau, Canberra, has recently published a book which illustrates the wide range of forest tree species native to Australia. It contains a general description of the forest vegetation and describes in detail the natural occurrence and botanical characteristics of 82 individual species, including brief notes on the timber and its uses. A series of plates illustrates the tree, its bark, leaves, buds, and fruits. A number of coloured plates has been included in the book.

"Forest Trees of Australia" has been made available to booksellers for sale to the public at 42*s*. per copy, and may also be purchased direct from the Bureau at the same price. In the case of Bureau sales, the price is inclusive of the cost of postage per ordinary mail. Orders should be addressed to: The Director-General, Forestry and Timber Bureau, Canberra, A.C.T., and should be accompanied by remittances made payable to the Receiver of Public Monies, Department of the Interior, Canberra.

Teak Marketing Survey in Burma

A STUDY of the market situation for teak timbers in Burma has been completed by Mr. M. M. Gallant, of the Food and Agriculture Organization of the United Nations (F.A.O.).

Burma will not be able to export more than 60 per cent. of its pre-war volume, but on the other hand world export of teak is at present only 47 per cent. of the pre-war figure, and according to Mr. Gallant this drop is likely to be permanent. High grades of teak timber have a permanent market in Europe, but high grades represent only 30 per cent. of the total production, and the lower grades, which can no longer be readily absorbed by India and Pakistan because of the scarcity of foreign exchange in those countries, will in future have to be disposed of internally, at the expense of other local woods.

Mr. Gallant submitted to the Burmese Government a plan for the future, linking it to market possibilities and milling potential. He also drafted the first written specifications for different grades of sawn timber—previously grading rules existed for only teak logs and squares.

In his survey, Mr. Gallant worked closely with the State Timber Board, an agency of the Burmese Government responsible for the extraction, milling, and export of the major teak resources of the country.

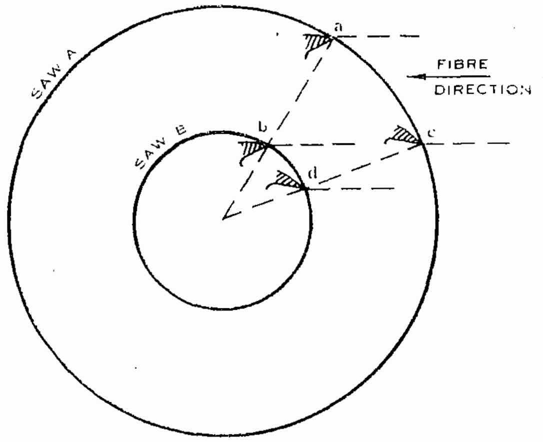
Let's Discuss Sawing

with ***D. S. JONES, Utilization Section***

Relation between Hook Angle and Saw Diameter

The angle made by the tooth front of a ripsaw with the fibre direction of the wood varies as the tooth travels from the top to the bottom of its path. Furthermore, at the top of its path a tooth on a small saw has less effective hook than a tooth on a large saw which is the same height above the table. This fact has led some saw doctors to believe that small-diameter ripsaws should have more hook than larger saws. Indeed, small-diameter saws frequently operate better with larger hooks, and at first sight this would appear to substantiate the above belief. However, a consideration of the diagram below will demonstrate that the improvement gained by using larger hooks on small saws is not due to a change of effective hook angle with saw diameter, but to a different set of factors altogether.

Tooth cutting angles with respect to the fibre direction on saws of different diameter.



Suppose we have two saws, *A* and *B*, of different diameters, and for each saw we consider a tooth cutting near the top of the saw and one near the table. Then we see that:

- Both teeth *a* and *b* make the same angle with the fibre direction even though they are on saws of different diameter.
- Teeth *a* and *b* approach the fibres at a very different angle to teeth *c* and *d*.
- *For the same depth of cut* the teeth of the small saw will have less hook with respect to the fibre direction than the teeth of the larger saw (compare teeth *b* and *c*). Hence, *if both saws are always operated in the same depth of cut* it would be advantageous to increase the hook of the smaller saw.

However, it is not usual for small saws to cut consistently the same depths as large saws, and, therefore, as far as effective hook angle is concerned, there is no reason for applying larger hooks to smaller saws.

Why then do small saws so often respond better with large hook angles? Large hook angles always give easier cutting and feeding than small hooks, but they sometimes give rougher sawn surfaces. When large hooks are applied to small circular saws the advantages of easier cutting and feeding are obtained, but the rougher sawing is, to a certain degree, offset by the better stability of the smaller blade. This is probably the reason for hook angles up to about 35° being sometimes advantageous on small saws when similar hooks are unsatisfactory on large saws.

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Sawing Those Difficult Timbers

By D. S. JONES, Utilization Section

RESEARCH work recently conducted using a sawmill as a field laboratory has revealed that improvements are possible in the sawing of some difficult Australian hardwoods. Studies were conducted on a No. 1 bench in a sawmill on the north coast of New South Wales using 44 in., 54-tooth saws with standard diamond-pointed teeth. The bench was powered by a 75 h.p. motor, the rollers being independently driven by a 3 h.p. variable-speed electric drive. A good many of the hardwoods common to the north coast of New South Wales were sawn during the tests, which involved studying saw stability, saw durability, and power consumption at two saw speeds: 10,000 ft/min and 7000 ft/min. The slower saw speed proved advantageous in all the timbers sawn, but the species which gave the best results was brush box (*Tristania conferta* R. Br.). This is an especially difficult timber to saw.

When cutting brush box, saws frequently become very unstable, and sawyers spend a considerable proportion of their time adjusting the packings in order to stand the saws up. At 10,000 ft/min the saws under test behaved quite well in all species except brush box, indicating that they were well sharpened and tensioned for those species. But in brush box excessive instability persisted. It is estimated that nearly 50 per cent. of the sawyer's available sawing time was lost due to this cause when brush box was being sawn. Also, the dimensional accuracy of the sawn products was very poor. At the slower saw speed, however, the saws became remarkably stable in brush box. As a result, the gain in useful sawing time was considerable, and the dimensional accuracy of the sawn products was markedly improved. There was a less spectacular but significant improvement in all the milder species sawn.

It should be noted that these tests were conducted with saws tensioned for a rim speed of 10,000 ft/min and that the improvement in stability when sawing brush box, and the good results in other species, were obtained by running those saws at 7000 ft/min. Until there is evidence to the contrary, it might be advisable to continue tensioning saws for 10,000 ft/min even when slower speeds are adopted. The additional benefits described below are not obtained by retaining a speed of 10,000 ft/min and tensioning for, say, 15,000 ft/min.

The second improvement brought about by the slower saw speed was in the life of the saws between sharpening. When sawing brush box the average period between saw changes increased from 75 min to 106 min, which represents a 42 per cent. improvement. Hence, the burden on the saw doctor was eased and less of the sawyer's time was lost in changing saws. This aspect of slower saw speeds is especially important when abrasive species have to be sawn, and it is well to remember that when premature blunting is a problem a slower saw speed is usually the best remedy.

It should be noted that improved durability depends upon a slower *spindle* speed. Slower *rim* speeds, as are obtained when saw diameter is reduced owing to wear, will have no effect on saw life.

Now let us consider the power consumption. For substantially the same feed speeds the average power consumed over all depths of cut in brush box decreased from 66 h.p. to 53 h.p. when the saw speed was reduced. This represents a 20 per cent. decrease, and means that there was, in effect, approximately 20 per cent. more power available for sawing. Difficult cuts could therefore be handled more quickly and easily, and feed speeds could be faster.

But how was electricity consumption affected? For the sake of convenience in the tests, electricity consumption was measured in terms of kilowatt-hours (kWh) per 100 sq. ft of sawn surface (defined as length of cut by depth). Due to the decrease in saw speed this quantity decreased from 1·32 to 1·18 kWh/100 sq. ft, which represented an overall decrease of 11 per cent. in the power bill for the No. 1 bench when brush box was sawn.

In conclusion it should be stressed that in these tests roller speeds were not reduced when the saw speed was reduced. This is unnecessary and could result in a production loss.

The results of the sawmill study briefly described above demonstrate that in the case of brush box a slower saw speed considerably reduced sawing difficulties. An improvement was also noted with the milder species. Hence, the very least that can be said is that, if a timber proves difficult to saw at the commonly used rim speed of 10,000 ft/min, one of the most effective cures is probably to reduce the saw speed to about 7000 ft/min.

Some Pitfalls in Sealing, Staining, and Finishing Wood

MOST commercial wood stains and finishes are supplied with instructions regarding their general use and application. These usually refer to the type of thinner to be used, together with instructions for preparing the surface; in some cases it is emphasized that the substance should be applied only to untreated wood.

In general, satisfactory results are obtained by following the manufacturer's instructions but difficulties may be encountered in certain cases. For example, oxalic acid is commonly used for removing iron stain from around nail holes (see Newsletter No. 211) or as a mild bleaching agent. Any surplus oxalic acid should be removed by washing but it is essential that sufficient remains to prevent colour reversion. Some wood stains are sensitive to acid, and wood so treated is liable to show quite marked changes in colour. The effect is more likely to occur during damp weather.

Similar colour changes may occur when certain wood stains are used in conjunction with some of the new-type synthetic resin plastic coatings. In most cases the resin is mixed with a catalyst just prior to application, the function of the catalyst being to accelerate the hardening and setting of the finish. Acidic substances are frequently used as catalysts and if the coating is applied over an acid-sensitive stain drastic colour changes might occur.

There are no simple solutions to these problems. If the wood has been treated with acid to remove stains it may be possible to neutralize the acid with a dilute alkali such as borax; such treatments may result in some colour reversion of the original stain. When using synthetic resin coatings advice should always be obtained from the manufacturer regarding suitable stains. In all cases where such information is not available, or where it is known or suspected that the wood has been given some preliminary treatment, the safest course is to try the stains and coating materials on a small section. If no adverse effects have been noticed after several hours the rest of the area may be completed.

<< Content

Print this page

Alpine Ash

Sawing alpine ash.

ALPINE ASH is the standard trade common name for the timber of the tree known botanically as *Eucalyptus gigantea* Hook. f. It is sometimes known as woollybutt or red mountain ash in Victoria, and as white-top stringybark or gum-top stringybark in Tasmania. It is one of the "ash" eucalypts and in the group commonly sold as Victorian hardwood or Tasmanian oak.

Distribution

The species has a relatively wide range of occurrence in south-eastern Australia. It is found in most parts of the eastern half of Tasmania at elevations of 2000 to 3000 ft; in the central highlands of Victoria at elevations of 3000 to 4000 ft; and at high elevations in the south-eastern highlands of New South Wales and the highlands of the Australian Capital Territory. On the lower elevations of its range it associates with mountain ash (*E. regnans*), but generally it grows in pure stands.

Habit

The tree is one of the giant eucalypts, attaining heights of up to 200 ft. On favourable sites its diameter at breast height may measure 5 ft. The bark on the lower part of the trunk is thick and woolly—somewhat resembling a stringybark. About half way up the stem this gives way to a bark which is clean, smooth, and light bluish-grey in colour.

Timber

The timber is a very pale brown colour, usually showing a definite pinkish tint. It is open in texture, generally straight-grained, sometimes with wavy grain giving rise to a fiddleback figure. Growth rings are often prominent; the late wood being darker than the early wood. Pores are often larger and more numerous in the early wood than in the late wood, so that this timber is probably the most "ring porous" of the eucalypts.

Alpine ash is one of the lightest eucalypts, its density at 12 per cent. moisture content before reconditioning being 41 lb/cu. ft, and after reconditioning 40 lb/cu. ft. Its green density is approximately 65 lb/cu. ft. In drying from the green condition to 12 per cent. moisture content, backsawn boards shrink 8 per cent. (tangential shrinkage), and quartersawn boards 4½ per cent. (radial shrinkage), these being reduced to 6½ per cent. and 3½ per cent. respectively after reconditioning.

Seasoning

The locality in which alpine ash is grown appears to affect very appreciably the results obtained during seasoning. Whereas Tasmanian stock is somewhat refractory, that from New South Wales is much more rapidly and easily dried free from degrade.

Tasmanian alpine ash tends to check fairly freely, and somewhat more readily than mountain ash. It is practically impossible to kiln-season backsawn stock even reasonably well, except in thin case-stock sizes; however, satisfactory results in thicknesses up to 2 in. can be obtained from quartersawn stock. The timber does not generally warp much in drying. Appreciable collapse occurs, but is removable by a reconditioning treatment. Kiln-drying green 1 in. Tasmanian material requires about 3 weeks, but from economic considerations is not recommended. Stock partly air-dried to a moisture content of about 30 per cent. may be kiln-dried in about 5 days. Case material

$\frac{1}{4}$ in. thick can be kiln-dried satisfactorily from the green condition in about 24 hr, and $\frac{3}{4}$ in. stock in about 36 hr.

Quartersawn New South Wales alpine ash can be kiln-dried from the green, free from checks, fairly readily in thicknesses up to 2 in. Much less collapse occurs than in the southern timber. Kiln-drying of green 1 in. stock requires about 2 weeks, and stock partly air-dried to a moisture content of 30 per cent. requires 3–4 days.

The seasoning properties of Victorian alpine ash lie about midway between those of Tasmania and New South Wales.

Mechanical Properties

Alpine ash is a moderately hard, strong, and fairly tough timber, being in strength group C. It is a fair to good bending timber at radii from 3 to 6 in. At 12 per cent. moisture content kiln-dried and reconditioned material has an average modulus of rupture of 16,000 lb/sq. in., the same as mountain ash. Its modulus of elasticity (in bending) is $2{\cdot}13 \times 10^6$ lb/sq. in., while that of mountain ash is $2{\cdot}38 \times 10^6$ lb/sq. in. Compression strength parallel to the grain averages 8690 lb/sq. in. and that for mountain ash is 9180 lb/sq. in. The modulus of rupture and compression strength figures given for alpine ash are mean values of material from New South Wales, Victoria, and Tasmania, while the modulus of elasticity embraces only timber from Victoria and Tasmania.

General

This timber turns crisply and cleanly, and takes an excellent finish, no trouble being experienced with hard and soft bands. It holds nails and screws well, but is inclined to split at the end when nailed. It glues satisfactorily. The species may be peeled readily after appropriate heating treatments, but rotary-cut veneer requires special kiln-drying conditions. Veneer sliced at a large angle to the growth rings dries well.

The sapwood of alpine ash is rarely attacked by the powder post (*Lyctus*) borer.

Uses

Alpine ash is an excellent utility timber for use above ground. Its light colour and ease of staining renders it specially popular, since it may be brought to any desirable shade. It makes high-class flooring, mouldings, weatherboards, panelling, and all finish lines. It is particularly suitable for furniture and cabinet work, office and household fittings, and joinery. In dwelling construction it is widely used for framing in joists, studs, plates, and rafters, and for interior trim.

This timber has many special uses, such as for oars, handles, skis, baseball bats, and cricket stumps. It is one of the most suitable eucalypts for motor body construction, and is in some demand by coachbuilders and wheelwrights for light shafts and spokes, and by agricultural implement makers. In the cooperage industry it makes satisfactory wine and tallow casks. Case makers use it in considerable quantities for cases for fresh fruit and canned goods, cleats for butter boxes, and for bottle crates and miscellaneous packaging. Alpine ash is also pulped for making paper and hardboard.

Availability

The timber is comparatively plentiful in south-eastern Australia. Stocks are held by most Victorian and Tasmanian timber merchants, and by firms in the Riverina district of New South Wales. It is available in narrow, medium, and wide boards, in joinery and furniture sizes, and in a full range of scantling sizes. Long lengths can be obtained if required.

Additional information regarding this species may be obtained from the forest authorities in Tasmania, Victoria, and New South Wales, or from the Chief, Division of Forest Products, C.S.I.R.O., 69–77 Yarra Bank Road, South Melbourne.

DONATIONS

THE following donations were received by the Division during February:

Timber Industries Pty. Ltd., Oberon, N.S.W.	£50 0 0
Bagot's Mills Pty. Ltd., Rhodes, N.S.W.	£10 0 0
Fenton Timber Products Pty. Ltd., Launceston, Tas. ..	£50 0 0

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1958##241

NUMBER 241 MELBOURNE MAY 1958

Use of Wood in Water-cooling Towers

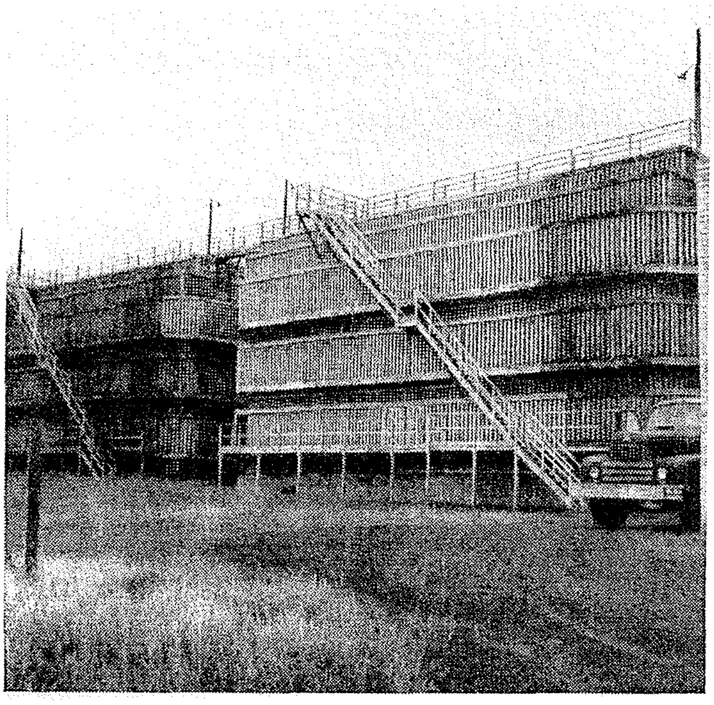
By M. W. PAGE, Utilization Section, and E. W. B. DA COSTA, Preservation Section

THE USE of wood in water-cooling towers has increased greatly in importance in recent years. Owing mainly to Australia's rapid industrial development, much of which has taken place in areas where water supply for industrial purposes is relatively limited, many water-cooling towers have been built to enable the water necessary for cooling such items as condensers and large diesel power units to be cooled and recirculated. In some instances where such water is not recirculated, it must be cooled before being discharged back into streams to make sure that there is no interference with the natural river life.

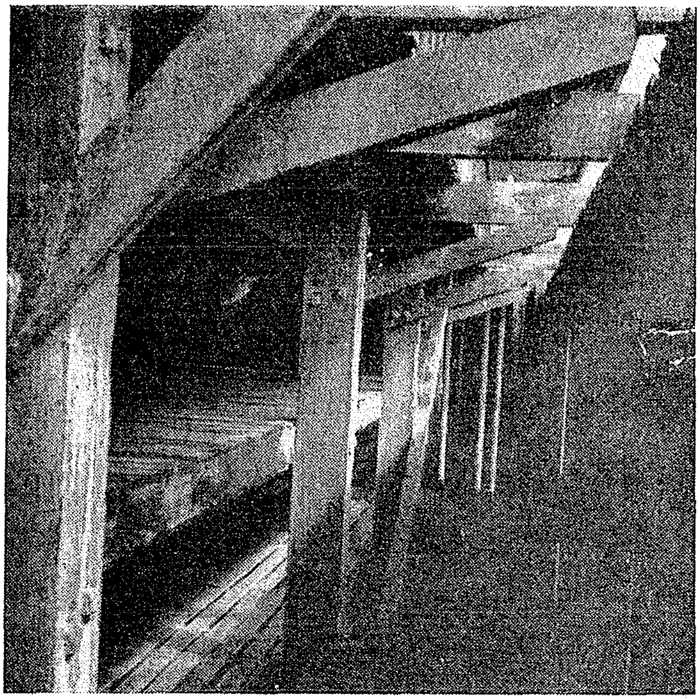
Cooling is achieved partly by transfer of heat from the water to the air, but mostly by evaporation of some of the water. To accomplish both, efficient air–water contact is necessary, and this is obtained by allowing the water to cascade down through a carefully designed tower containing fill or packing (consisting of layers of spaced horizontal members) designed to break up the flow and distribute it uniformly, and to provide an extensive surface from which evaporation can take place. Concrete, steel, fibre glass, and fibro cement have all been either suggested or tried for fill construction, but wood is still the favoured material because of its cheapness, its strength/weight ratio, and the ease with which it can be cut to the desired shape. A large, high-efficiency tower capable of cooling about 3 million gal of water per hour through a 15°F temperature drop may contain up to 300,000 super ft of carefully selected timber, a high proportion of this quantity being used in the fill in relatively small sections.

During the past 10–15 years there has been considerable discussion about which timbers are suitable for use in cooling towers, especially for the filling in modern towers of high efficiency. It has been found that in many towers the high rate of evaporation may lead to a concentration of salts in the circulating water (particularly if the intake water is hard) and to highly alkaline conditions. This may cause direct chemical attack on, and weakening of, the wooden filling and may also, by the leaching-out of toxic extractives or by chemical alteration of the cell wall substance, render the wood particularly liable to attack by "soft rot" fungi. These fungi are more nearly related to common moulds than to the usual wood destroyers and are capable of operating under very wet conditions where the latter fungi are not usually a problem. Of course, in any part of the tower which is not continually wetted, or in an intermittently used tower, the usual wood destroyers can be a high hazard.

Early towers built in Australia were almost always "atmospheric" or natural draught



Natural draught cooling tower.



Fill of a natural draught cooling tower.

types which had to be located in exposed positions where the wind could blow horizontally between the successive layers of filling. On still days the only air movement in the tower was that due to convection currents caused by the warm water entering the top of the tower, and under these conditions cooling efficiency was low and consequently large towers were required. On windy days, on the other hand, air movement could be so rapid that a high proportion of the falling water would be swept away as spray, and where make-up water was expensive, this was a distinct disadvantage.

The filling in these atmospheric towers consisted usually of successive layers of fairly large boards (3 in. by $\frac{1}{2}$ in. to 6 in. by 1 in.) laid as rather open floors with about 1 in. space between each board. Frequently the boards in each alternate layer were laid at right angles, and if this was not done the spaces between the boards were staggered in alternate layers. Douglas fir, jarrah, and cypress pine were often used, and unless the tower was only intermittently operated conditions were usually too wet for decay to be a serious problem. Also because of the relatively large cross section of the boards, soft rot, which is typically a surface deterioration, did not cause any serious weakening. In any case soft rot rarely appears to be prevalent in this type of tower, perhaps because the high spray losses prevent undue concentration of the circulating water with consequent chemical attack favouring the development of soft rot. When operated intermittently, or when prevailing winds kept sections of the tower partially dry, these towers were subject to normal decay, particularly in the outer sheathing. Also under these conditions the timber species used needed to have reasonably good dimensional stability.

To overcome the disadvantages of atmospheric towers, high-efficiency induced draught towers were introduced in which the air is drawn up through the filling by large fans. Thus these towers are largely independent of the vagaries of the weather, and the site location is not so critical. Since air flow is always uniformly high, evaporation and hence cooling efficiency are greatly increased; however, a large surface area of fill is still required from which evaporation can take place, but the fill must be so constructed that high resistance to air flow is not developed. This necessitates using sections of much smaller cross-sectional area (about $1\frac{1}{4}$ in. by $\frac{3}{8}$ in., sometimes on edge) and these small sections must, in addition to supporting their own weight when saturated, carry the load imposed on them by a large throughput of falling water.

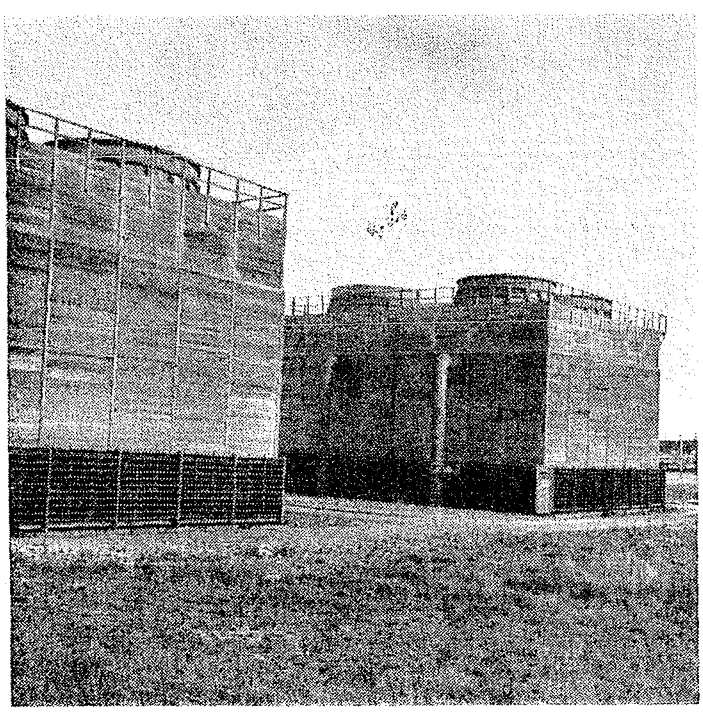
For some considerable time there has been a world-wide preference for Californian redwood (*Sequoia* spp.) for fill, because of its high natural durability, ease of working, good dimensional stability, availability in clear grades, and high strength/weight ratio. It has been found, however, that in many towers conditions favour the development of soft rot attack and that redwood is badly affected, probably because of the rapid leaching-out of toxic extractives under alkaline conditions. It will readily be appreciated that any degradation of these small cross section members constitutes a serious problem.

It thus appears that cooling tower timber is likely to be subjected to fungal attack, whether decay or soft rot, in both atmospheric and induced draught towers, and that unless previous experience with identical towers operated on the same water indicates that no hazard exists, there is a good case for treating timber with a preservative before use. In both the U.S.A. and the U.K. this requirement is recognized, and cooling tower timber is now usually given a heavy treatment with one of the leach-resistant water-borne preservatives.

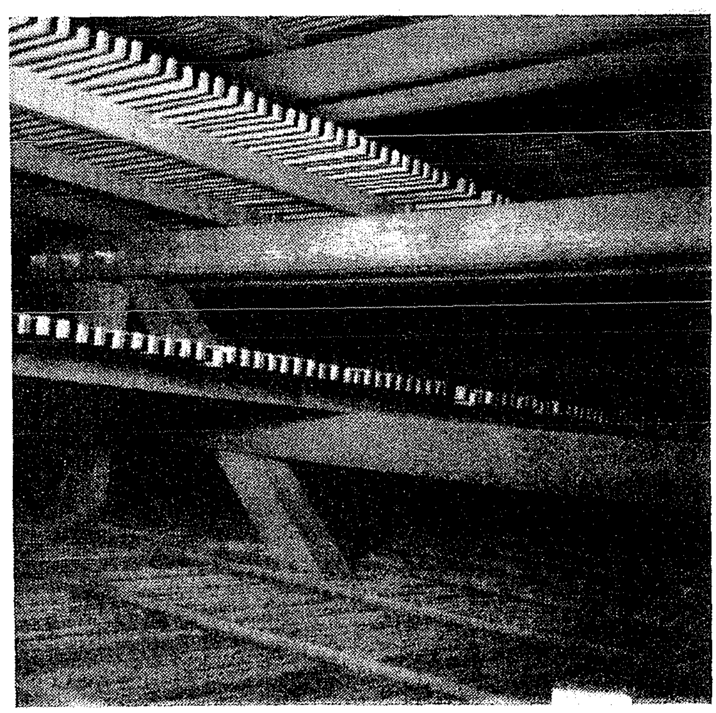
For Australian conditions it appears that as preservative treatment is in most cases desirable, there may be no merit in using costly imported species, particularly those from hard currency areas. Locally grown radiata pine is readily treated with preservatives, easily worked, has satisfactory mechanical properties, and in the small sections and short lengths required for filling slats should be available in a suitable grade. For structural members our native dense durable hardwoods such as tallowwood, ironbark, wandoo, and yellow stringybark are ideal. As these larger members (4 in. by 4 in. and 5 in. by 5 in.) could not be seriously weakened by shallow development of soft rot, their treatment is not warranted. The use of structural members of treated laminated radiata pine is another possibility. Also, where intricate shapes such as fan shrouding or wide widths are required, treated plywood bonded with waterproof glue has advantages over solid timber.

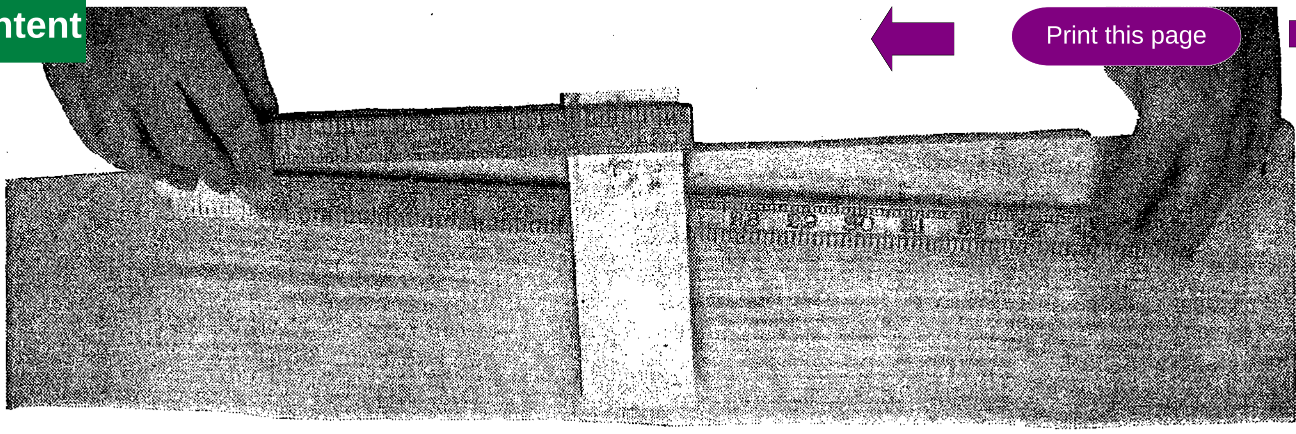
To date very little treated cooling tower timber has been used in Australia, consequently complete information on its behaviour under actual service conditions is lacking. To enable such data to be obtained as rapidly as possible on different timbers and treatments, the Division plans to have manufactured small trays containing both treated and untreated slats which can be placed in operating towers in various parts of Australia and quickly and easily removed for regular inspection. Tower users who would be prepared to cooperate in this programme by allowing trays to be placed in towers under their control are invited to contact the Chief, Division of Forest Products, P.O. Box 18, South Melbourne.

Induced draught cooling tower.



Fill of an induced draught cooling tower.





A SIMPLE DEVICE FOR MEASURING GRAIN SLOPE

SLOPING grain is one of the major defects subject to specific limitations in all grading rules for structural timber. The methods of recognizing the various kinds of sloping grain and the correct way of measuring the grain slope is set out in the Division's Trade Circular No. 48, "Sloping Grain in Timber".

Having determined the direction of the grain by a scratch gauge or some other means, the slope of grain can be quickly measured by a simple device consisting of a carpenter's three-foot folding ruler, a spring clip and a marked gauge. A full size reproduction of the gauge is given on this page.

The device is made up as follows:

(*a*) Cut out the gauge and fold along the broken line. Alternatively the markings can be transferred to a thin piece of metal which is more easily preserved.

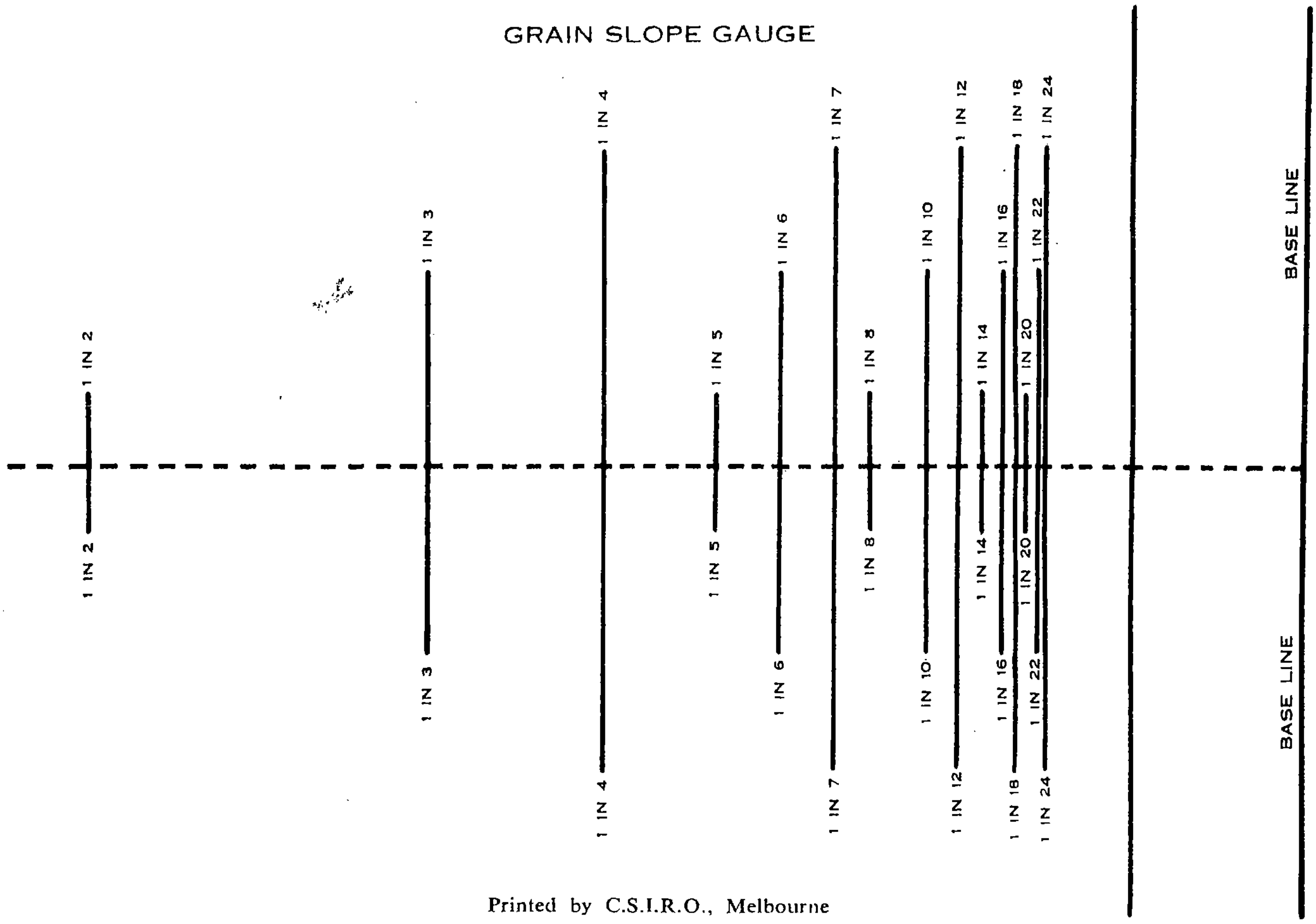
(*b*) Insert the gauge between a fold of the ruler so that the base line is just showing at the ruler's edge, and with the gauge as close to the hinge as possible.

(*c*) Clip the folded ruler so that the gauge won't fall out.

To use, place the ruler so that the under part of the folded portion acts as a register against the piece of wood. If the other half of the ruler is laid along the indicated grain direction, its inner edge will cut the scale at a reading corresponding to the grain slope being measured (see photo). The markings on the back of the gauge allow the device to be used for slopes in either direction.

Note: Either the inner or outer edge of the extended portion of the ruler may be laid parallel to the grain slope but the reading must be taken from the *inner* edge.

GRAIN SLOPE GAUGE



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NUMBER 242 MELBOURNE JUNE 1958

Water-borne Preservatives for Fence Posts—Part I

By F. A. DALE, Wood Preservation Section

SINCE the publication in 1956 of C.S.I.R.O. Leaflet No. 12, "Round Fence Posts: Preservative Oil Treatment", public interest in the use of treated fence posts has increased very greatly. The treatments described in the Leaflet are both simple and effective, and farmers generally have shown much interest in preservative treatment; yet most new fences are still being constructed with the traditional split posts which are often expensive or of doubtful durability.

Apart from the natural reluctance to change on the part of the farmer, one possible reason for this is that creosote in particular is not pleasant to handle and can cost twice as much in remote districts as it does in the city because of high freight and handling costs.

One answer to these objections is the establishment of commercial pressure treatment plants, and a number of these are now treating power and telephone poles in several States. Such plants will be able to treat large numbers of posts with creosote or other preservatives and sell them to the public. These posts would receive full length treatment and would be clean and dry by the time they reached the purchaser.

The other answer is the use of a preservative which can be dissolved in water. The early water-borne preservatives, such as mercuric chloride, copper sulphate, and zinc chloride, were either too poisonous, too corrosive, or too readily leached from the wood to be completely effective. However, a great deal of research abroad has been directed towards the improvement of water-borne preservatives, culminating in the development of "fixed" preservatives which are now generally accepted as giving the same protection as the preservative oils.

These preservatives, which may contain mixtures of copper, chromium, arsenic, and zinc compounds, are usually prepared as dry powders which are readily soluble in water. Once impregnated into the timber they "fix" by chemical reaction, and hence become highly resistant to leaching (or washing out). They are highly effective against decay and insect attack and properly used will protect timber for a very long time.

The preservatives are clean and odourless and if handled with reasonable care are little more dangerous than arsenical sheep dip. Timber treated with the solutions dries readily and can be handled soon after treatment. When fully dried it can be painted and worked like untreated timber. Unlike the oils, water-borne preservatives do not protect the timber against weathering and

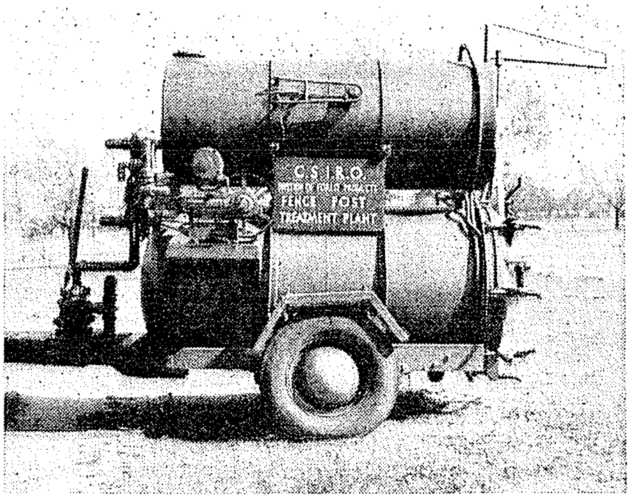


Fig. 1.—*Portable post treatment plant* (50 *lb/sq. in.*).

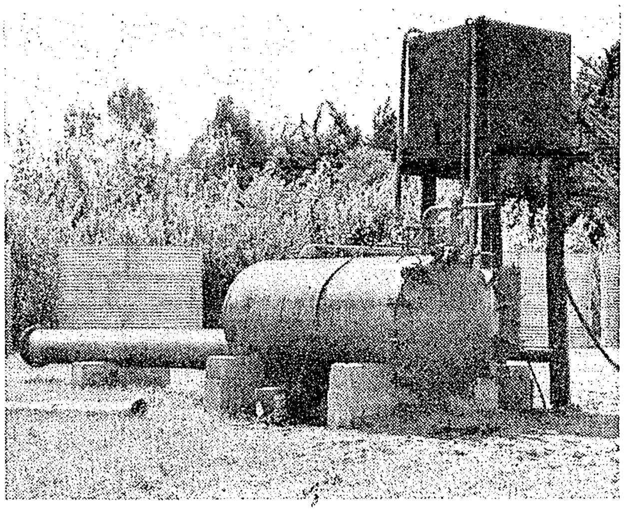


Fig. 3.—*Low pressure plant with extension for poles.*

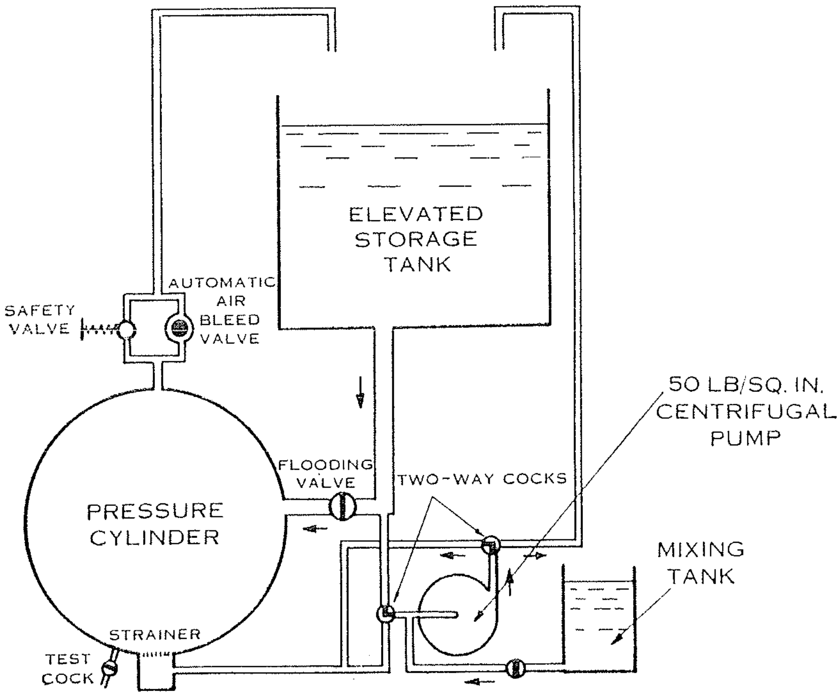
checking, but this is not a serious defect in fence posts.

As with the preservative oils, complete penetration of the sapwood of round timbers must be obtained for satisfactory protection.

Of the three treatments for dry round posts described in Leaflet 12 only the low-pressure soaking method is suitable for use with the "fixed" waterborne preservatives. It has been found desirable, particularly with *Pinus radiata*, to raise the minimum working pressure to 50 lb/sq. in. This does not require any major alteration to the design of the plant but for simplicity a small pump is used instead of an elevated tank as a means of applying pressure. With a working pressure of 50 lb/sq. in., satisfactory treatments can usually be made in 1–2 hours, so that quite a small cylinder will treat a large number of posts each day.

Low pressure treatment plants using waterborne preservatives are either operating or under construction at King Island, Tas.; Meadows, S.A.; Caramut, Vic.; and Port Kembla, N.S.W. The Division's portable plant, from which they derive, has been converted to a 50 lb/sq. in. plant by adding four more bolts to the door and fitting a piston pump driven by an electric motor. The con-

Fig. 2.—*Simple low pressure timber treatment plant.*



verted plant, shown in Figure 1, has treated some thousands of fence posts since conversion. This plant would cost about £350, or about £500 if fitted with a tubular extension to take strainers and gate posts up to 8 ft long, and an engine-driven pump. The more expensive plant would have the additional advantage that it could also serve as a portable fire-fighting outfit. The simplest type of low pressure plant would be arranged as in Figure 2. This stationary plant would be very easy to operate and could be set up for less than £300.

With the smallest of these plants (3 ft diameter by 6–8 ft long), one man can treat up to 200 round posts in an 8-hour day. With an output of this order the plant would very soon pay for itself in areas where durable split posts are expensive or unobtainable. A saving of at least £5 per 100 posts could reasonably be expected by treating small round posts. At 200 posts per day the outlay on a small plant would be recovered in 6 weeks at the rate of £50 per week!

A very sensible addition to a small pressure plant is shown in Figure 3. Here a tubular extension, 18 in. in diameter, has been provided at the back of the cylinder to accommodate one or two small poles. Treated poles are often needed on farms for power and telephone connections or for barns and machinery sheds. Such an extension, which can be bolted to the cylinder when required, greatly increases the plant's value on a large property.

Pressure treatment is undoubtedly the most effective means of treating round posts; it ensures full penetration of the sapwood in a short time and enables the most economical treatment to be obtained by varying the concentration of the solution. The preservative loading required varies with the type of preservative and the timber to be treated. With the copper, chromium, and arsenic compounds a loading of 0·75 lb of dry salt per cubic foot of total volume is generally specified for softwood posts or 1·0–1·25 lb per cubic foot of sapwood for hardwoods.

For those farmers who cannot afford a pressure plant or who are too far from commercial pressure treating plants to buy their products, there is a simple method of treating green posts, known as the sap replacement method, which has considerable promise. Details of this process with its advantages and limitations will be given in the next issue of this Newsletter.

Further information on commercial pressure plants now operating and suppliers of waterborne preservatives can be obtained by writing to the Chief, Division of Forest Products, C.S.I.R.O., P.O. Box 18, South Melbourne, S.C.5.

WITHDRAWAL RESISTANCE OF GROOVED NAILS

By J. J. MACK, Timber Mechanics Section

AN ARTICLE in Newsletter No. 215 described a number of special types of nails which have been developed in the United States of America, where it is claimed that these nails have a greatly improved withdrawal resistance compared with plain shank nails.

Nails with specially rolled annular or spiral grooves after the style described in the previous article are now being made in Melbourne, and tests are being carried out at this Division to investigate their efficiency in withdrawal resistance. Although these tests are incomplete, some information is available which may be of interest to nail users.

Four types of nails are being examined, their withdrawal resistance being compared with the withdrawal resistance of plain shank nails of the same gauge and composition of wire from which they were manufactured:

(1) 2 in. / 13 S.W.G. Monel metal nail with annular groove;

(2) $1\frac{1}{2}$ in. / 9 S.W.G. low carbon steel nail with helical groove;

(3) $2\frac{1}{4}$ in. / $8\frac{1}{2}$ S.W.G. low carbon steel nail with helical groove;

(4) $2\frac{1}{4}$ in. / 5 S.W.G. aluminium roofing nail with helical groove.

Withdrawal Resistance (%)

Nail (See Text)	Initially Green Timber			Initially Dry Timber	
	Immediately	After 4 Months	After 8 Months	Immediately	After 4 Months
(1) Plain	100	26	23	100	72
Grooved	140	170	160	200	180
(2) Plain	100	32	35	100	75
Grooved	100	180	190	130	150
(3) Plain	100	31	42	100	91
Grooved	110	170	180	160	210
(4) Plain	100	50	39	100	71
Grooved	130	220	210	150	180

Some nails are being driven into green and others into dry radiata pine. Some are being pulled immediately and others at various periods after driving. For the delayed tests on green timber, it is being allowed to dry after the nails are driven.

The table on this page gives the results of tests carried out to date. Results have been expressed as percentages of the immediate withdrawal resistance of the plain nail in timber at the initial moisture content.

For use in radiata pine it is clear from these results that grooved nails of the types tested are definitely superior in withdrawal resistance to plain nails for all normal conditions of use. It will be noted that their immediate withdrawal resistance in both green and dry timber, and also that after a delay period, was greater than that of plain nails. An interesting feature is that their withdrawal resistance actually increased a short time after driving, while that of plain nails fell quite considerably. This was particularly noticeable with green pine, when the withdrawal resistance of the rolled nails after 4 months was up to seven times that of the plain nails.

It was mentioned in Newsletter No. 230 that "popping" of nails used for fixing hardboard was being investigated. These tests are incomplete, but results so far obtained indicate that the drying of green wood or the fluctuations of the moisture content of dry timber into which the nails are driven can cause a gradual outwards movement of the nail. Annularly grooved nails tested in comparisons with ordinary plain hardboard nails were not affected as much as the latter. It is therefore suggested that timber, or at least that portion of wood penetrated by the nail, should be as dry as natural conditions allow before hardboard wall surfacing is fixed. It is indicated also that some benefit is gained by using grooved nails.

DONATIONS

THE following donations were received by the Division during March and April:

Timber Merchants' Association of South Australia	£100 0 0
Sydney and Suburban Timber Merchants' Association	£100 0 0
Timber Development Association of Australia (N.S.W. Branch)	£50 0 0
Bright Pine Mills, Vic.	£100 0 0

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NUMBER 243 MELBOURNE JULY 1958

Water-borne Preservatives for Fence Posts

PART II. THE SAP-REPLACEMENT METHOD

By F. A. DALE and E. A. BOWERS, Wood Preservation Section

PRESSURE treatment using methods similar to those described in last month's Newsletter is generally considered to be the most reliable way of treating round fence posts with water-borne preservatives. However, many people cannot afford pressure treating equipment. Others could not use the equipment economically because their annual fence post requirements could be treated in a few days, and the plant would then be idle for the rest of the year.

Many farmers require only a hundred or so posts each year for replacement purposes or for small lengths of new fencing, and need a simple method of treating these posts with minimum effort and expense. Treatment by "sap replacement" is a cheap and effective way of converting freshly cut sapling timber into durable fence posts.

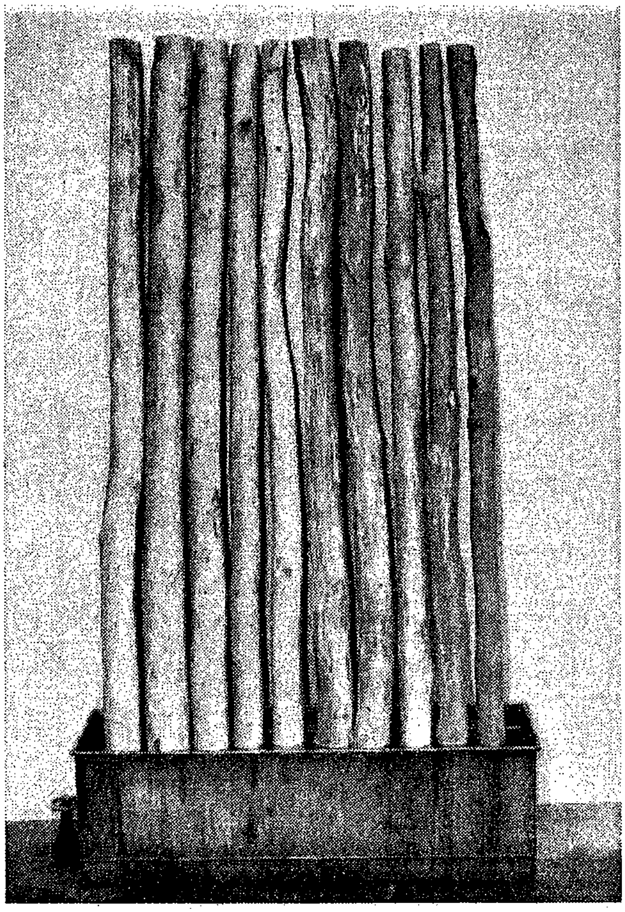
Sap replacement takes place when a freshly cut and barked piece of round timber is stood up with one end in water. As the sap evaporates from the exposed length of the post or pole, the water is drawn up through the sapwood to replace it. Water solutions of preservative salts can be drawn up in the same way, but preservative oils cannot be used satisfactorily. As with other methods of treating round fence posts, the object of sap replacement is to penetrate the sapwood completely with a highly permanent preservative and so form a band of durable wood protecting the untreated heartwood.

The Division of Wood Technology of the New South Wales Forestry Commission was the first to recommend this method in Australia for fence post treatment, using copperized chromated zinc chloride as the preservative. While this is a reasonably good salt it is not in the same class as the highly "fixed" (or leach-resistant) preservatives such as the copper-chrome-arsenic types which are now becoming available in Australia.

The Division of Forest Products has tested the sap-replacement method using these newer preservatives on a number of eucalypt timbers with most encouraging results. The essential steps in the process are given below.

Timber

The sap-replacement treatment can be applied only to freshly cut, round, barked timbers, and cannot be applied to dry posts or to sawn timber. Any green eucalypt timber can be treated, provided that it has at least ½ in. of sapwood, but timbers that split badly while drying should be avoided. Other hardwoods such as tea-tree, wattle, or scrubwoods may be treatable but have not been tested by this Division. Tests are in progress using round posts of radiata pine,



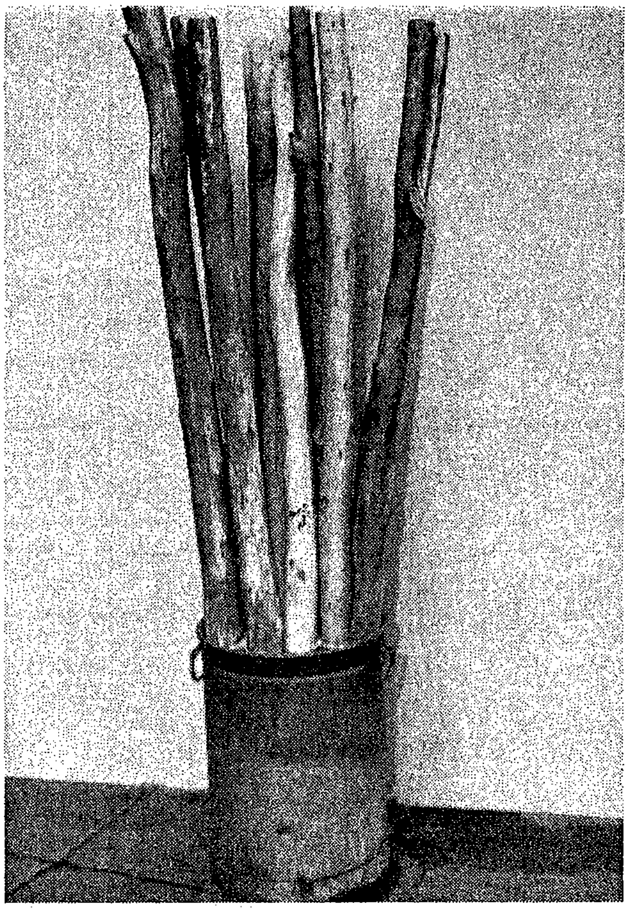


Fig. 4.—Typical containers for sap replacement.

but until these are completed pine timbers cannot be recommended for this treatment.

For economy of preservative, fence posts should be as small as possible. A diameter of 3–5 in. under bark is adequate for ordinary posts, while a 6–8 in. diameter is sufficient for gate and corner posts provided these are sunk at least 3 ft in the ground. Hop, barn, and telephone poles can also be treated, and because the treatment maintains the full strength of the sapwood, smaller diameters can be used.

Posts and poles should only be cut when the bark can be readily removed. Even small patches of inner bark will retard evaporation and replacement of sap, and may cause patchy treatment. A spade or the back of an axe should be used when barking to avoid cutting the sapwood, as this will interrupt the upward flow of preservative. Knots should be kept above the ground line as they may allow decay or termites into the untreated heartwood.

If posts are to be sharpened for driving, the points should be blunt as extra solution must be used to keep the cut sapwood submerged until treatment is finished. Posts should not be pre-bored for wire before treating, and apart from boring should not be cut in any way once treatment has been given.

Preservative

Preservative salts of the copper-chrome-arsenic type are usually available as a dry powder or a wet mix which dissolves readily in water with a little stirring.

These preservatives are usually supplied in 4 or 5 cwt drums,* but it is anticipated that at least one supplier will market his product in 56 lb containers. For convenience, the table of quantities required for treatment is therefore based on the use of 14 lb of dry salt (i.e. one-quarter of 56 lb) dissolved in 40 gal water, giving a 3½ per cent. solution.

* Names of suppliers can be obtained by writing to the Chief, Division of Forest Products, C.S.I.R.O., P.O. Box 18, South Melbourne, S.C.5.

Containers

Practically any shallow watertight container can be used, provided there is ample air circulation around each post. Suitable containers are shown in Figure 4 but a 40-gallon drum cut lengthwise or transversely could also be used.

Safety

Although arsenical preservatives are poisonous, they are quite safe to handle and use if the normal precautions taken with all arsenicals are strictly observed. These are as follows:

- Keep the salts completely out of reach of children and animals.
- Cover the treating containers securely to prevent stock or other animals from drinking the solution.
- Avoid inhaling dust from the salts when weighing out or mixing.
- Wash hands before smoking or eating.

As the solutions are sufficiently acid to damage clothing, splashes should be washed out immediately. Waterproof gloves may be used to prevent the solution staining the hands.

Where to Treat

If there is danger of rain, treatment is best carried out under cover, where ample ventilation can be obtained. An open shed or barn is ideal. In dry weather, posts can be treated outdoors but a temporary cover should be available in case of rain.

When to Treat

Treatment can be done at any time of the year, but cold, wet weather will retard evaporation and hence slow down the treatment. In hot dry weather treatment is much more rapid but at this time of year posts may be difficult to bark.

How to Treat

For most eucalypts a preservative solution of 3–3½ per cent. strength is required to obtain the desired loading of 1 lb dry salt/cu. ft of sapwood.

Table 1 shows the minimum amount of 3½ per cent. solution required to treat 10 posts of the sizes and sapwood thicknesses most likely to be used in fencing, as well as the maximum number of posts that can be treated with 40 gallons of the same solution.

Quantities of solution required for poles can also be obtained from Table 1 by multiplying the amount required for a post of the same diameter by the ratio *pole length/post length*. For example, an 18 ft pole would require three times the amount needed for a 6 ft post. Top treatment by inverting the pole is just as essential as in the case of a post, particularly in such timbers as messmate stringybark (*E. obliqua*) and spotted gum

TABLE 1

Number of 6 ft Posts Which can be Treated with 14 lb of Preservative Salt in 40 Gallons of Water

Preservative loading: 1 lb dry salt/cu. ft of sapwood

Average Post Diameter* (in.)	Normal Sapwood (up to ¾ in.)		Thick Sapwood (up to 1¼ in.)	
	No. of Posts	Gallons of Solution per 10 Posts	No. of Posts	Gallons of Solution per 10 Posts
2	114	3½	107	3¾
3	63	6½	49	8¼
4	44	9	31	13
5	34	11¾	23	17½
6	27	14¾	18	22¼
7	23	17½	15	27
8	20	20	13	31

* Diameter of barked post at mid length.

(*E. maculata*), which have sapwood susceptible to Lyctus borer attack.

Enough posts for one treatment should be cut, barked, and placed butt down in the container. Posts should preferably be of the one species and of the same size.

If the butt of each post is sitting on the bottom of the container, the required amount of preservative solution should then be added. If the butts are not on the bottom or if they are pointed, extra solution to submerge all cut sapwood must be used before the required amount is added.

The posts should remain in the solution until at least three-quarters of the required amount has been absorbed. They should then be turned end for end and the tops immersed until the remainder of the solution has been absorbed. Treatment may take from a few days to a fortnight, depending on the timber and the weather.

Checking the Treatment

One or two posts from each of the first few treatments should be allowed to dry for a day or so and then cross-cut 6 in. above the ground line. Treated sapwood should have a uniform faint green colour. If untreated patches of sapwood are found close to the surface they will limit the life of the posts, and if this occurs in more than a few posts treatment should be discontinued until further advice has been obtained from this Division.

After Treatment

Posts can be used immediately after treatment or if desired can be stacked to dry out. In this latter case a faint white deposit may gradually develop on the surface of the post due to the fact that in some copper-chrome-arsenic formulations, potassium sulphate is produced as a by-product when the preservatives fix in the wood. If there is any fear that this deposit may contain traces of arsenic it can be readily washed off.

If top splitting occurs during drying it can be arrested with a wire tie. The tops of important posts such as gate or corner posts can be given extra protection by using a galvanized iron cap to keep water out of the heartwood.

Expected Life

Round posts properly treated by the sap replacement method should have a life of 20–30 years under average conditions. They are resistant to termites and to decay, and because the sapwood remains hard and smooth, are less likely to catch alight in a grass fire than untreated posts.

Timbers for Clothes Pegs

When manufacturers think of uses for offcuts or other reject timber, one of their first ideas, it seems, is the production of clothes pegs. Timbers to be suitable for pegs, however, must satisfy exacting conditions. They should be strong and elastic, although light in weight, have a close even texture, and be light coloured.

Staining of wet clothes would rule out a timber altogether if it were not possible to remove the stain-producing components. These are commonly resin, gum, and tannin. Timber containing resin canals or gum veins should be rejected, but as tannins are water soluble they can be removed by washing the pegs in hot water after machining is completed. Bleaching is also sometimes necessary.

There are a considerable number of Australian timbers which satisfy the above conditions, but those more readily available are white birch, sassafras, radiata pine, hoop pine, and the ash group eucalypts.

PERSONAL

Mr. Stanley A. Clarke, Chief of the Division, returned to Australia at the end of last month after six months overseas. Mr. Clarke spent some time with the U.K. Department of Scientific and Industrial Research in an advisory capacity on pulpwood problems, attended the Fourth F.A.O. Conference on Wood Technology in Madrid from April 22 to May 2, and visited various laboratories in France and Belgium. He returned to Australia via New Zealand.

DONATIONS

The following donation was received by the Division during May:

N.Z. Forest Products Ltd. £125 0 0

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Forest Products Newsletter

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1958##244

NUMBER 244 MELBOURNE AUGUST 1958

How Strong are Wooden Fence Posts?

By J. D. BOYD, Officer-in-Charge, Timber Mechanics Section

THE QUESTION is sometimes argued as to whether concrete posts are stronger and more durable than wooden posts. As the Division has become particularly interested in the use of preservative-treated round fence posts, and as the rural community also is showing considerable interest in this development, a few notes on recent comparative tests of posts of concrete, timber, and steel may be of some interest.

The strength tests of the concrete and wooden posts were made at the request of a large farming organization with progressive ideas on fencing, and they supplied the posts. These included a good-quality 6 by 4 in. (tapering to 4 by 4 in.) vibrated reinforced-concrete post; a pre-stressed concrete post, triangular in shape, with 3¼ in. wide main faces and ¾ in. bevel corners; two round wooden posts approximately 5 in. in diameter which had been treated with preservative; and a sawn wooden post of 8 in. width across the curved side and 3 in. maximum depth, being one-third of a round post. A standard-type Y-section steel post also was tested. All posts were tested in an identical manner, with a simulated ground support and loading applied at 2 ft 8 in. above the nominal ground-line.

The vibrated reinforced-concrete post failed at 450 lb. The pre-stressed concrete post had not completely failed when the test was discontinued at 875 lb, but failure was so far advanced that ultimate failure was estimated at 900 lb maximum load. The round wooden posts failed at maximum loads of 5300 lb for the swamp gum specimen, and 5700 lb for long-leaved box. The grey box sawn post, tested on its flat (the weaker direction), failed at 2650 lb. The maximum load at failure of the steel post was 200 lb or 240 lb, according to the loading direction.

With such a limited number of specimens tested, it would be unwise to put very much weight on the figures which have been quoted above. There is evidence that concrete posts made by some manufacturers are much weaker than the post tested. Also the strengths of round and sawn timber posts vary between species and even within species. However, these comparative tests clearly indicate the very considerable strength advantages which can result from the use of wooden posts, and especially "rounds".

It has been suggested that concrete posts are more durable than wood. It is clear from observation of concrete posts in use, however, that moist air (and ground water) penetrate through pervious sections of the concrete and cause rust to develop. The internal pressure of the rust soon causes spalling-off of the concrete around the reinforcement, and ultimate failure can then occur at a very much lower load than that quoted here for the sound good-quality concrete post.

It will be realized also that concrete posts are heavy to handle, and they tend to cause severe wear of the fencing wire.

Steel posts are susceptible to rust, and even without being corroded they bend under low loads. In soft ground they can be pushed over very easily. Galvanized fencing wire used with them may corrode rapidly by electrolysis at the post.

On the other hand, preservative-treated timber posts can be shown to have a very long life. Experience throughout the world with millions of round posts treated with reliable preservatives shows a life of 20 to 30 years or more, irrespective of the timber used. The Division has carried out tests in Australia ranging over localities of severe decay and termite hazard in Western Australia, Victoria, and New South Wales, for periods up to 27 years. Even after this long period a great majority of these posts treated with creosote oil are still in good condition, and an average life of at least 30 years is now assured using this treatment. In many cases a considerably longer life can be expected. Untreated round posts of several of the timbers used, set in the test lines for comparison, lasted only from 3 to 6 years. It will be noted also that wooden posts treated with creosote do not increase the corrosion or wear of the fencing wires.

It is not proposed to compare in detail the costs of the alternatives discussed; costs will vary considerably in different localities. However, it should be realized that the preservative treatment of round posts is relatively simple and the cost small, and where suitable timber is freely available treated round wooden posts will generally be cheaper than any other type offering.

Thus it is seen that wooden posts have a considerable strength advantage over posts of other materials, so that round timbers as small as 2 or 3 in. in diameter may be satisfactory for many fences. Further, a properly (and simply) preservative-treated round post, even of one of the least naturally durable timbers, is exceptionally durable in the ground under severe conditions. As small round timbers suitable for treatment are generally freely available and inexpensive, can any farmer, or other user of posts, afford to disregard the decided advantages of preservative-treated round wooden posts?

BOOK REVIEW

Timber Engineering Design Handbook

A NEW HANDBOOK written specifically for the use of Australian engineers and architects concerned with the design, fabrication, and erection of timber structures has now been published. The *Timber Engineering Design Handbook* by Pearson, Kloot, and Boyd, three senior officers of the Timber Mechanics Laboratory, Division of Forest Products, incorporates the results of 30 years' intensive research and experience in timber technology.

All the factors contributing to the most efficient and economic use of wood are considered, including its fundamental structure, seasoning, and preservation. Methods of design and construction which will produce soundly engineered structures are suggested.

The Handbook is based on the latest research, and it provides authoritative information not previously available for Australian timbers and conditions. Chapters are devoted to the design of beams, columns, joints, and trusses. Among subjects receiving special attention in other chapters are: the design of glued laminated structures; plywood in built-up beams and stressed-skin construction; the prevention of deterioration in timber structures; and procedures for the proof testing of timber structures.

The Handbook has been published by C.S.I.R.O. in association with Melbourne University Press and is available from leading booksellers throughout Australia for 30*s*. plus postage. If any difficulty is encountered in obtaining copies, inquiries should be addressed directly to: Melbourne University Press, 369 Lonsdale Street, Melbourne, C.1., Victoria.

Keeping the Roof over Your Head

By H. KLOOT, Timber Mechanics Section

WHEN a violent storm dislodges tiles or sheet roofing, the occupier is probably correct in blaming the elements. However, if his roof is damaged by a storm of only moderate intensity, he might well suspect poor building practice. Most large commercial buildings are designed to withstand the forces due to the worst expected winds, but seldom is consideration given to these forces in the design and construction of homes and other small buildings. Recent press reports of roof damage in wind storms of only moderate intensity indicate inadequate construction, and this in turn suggests a lack of knowledge on the part of some builders of the effects of wind loads on roofs. *The important point to remember is that a roof is seldom blown down—it is sucked off.*

The wind velocity over a roof of a building depends on the height of the building and the degree of protection afforded by other buildings, trees, and the natural configuration of the ground. The force on the roof due to the wind is dependent on its velocity, the amount of air leakage in the building (they are never airtight), and the pitch of the roof. Even on one face of a pitched roof the wind forces vary, and parts of the roof may be subject to quite high-intensity forces from relatively moderate winds.

On the windward side of a pitched roof with a slope steeper than 1 in 3, there is an overall downward pressure which, even in a gale, the roof as a whole can carry without distress. If, however, the pitch is less than 1 in 3, there may be an upward or suction force on the windward side of the roof; the lower the pitch the greater the suction. On the leeward side, irrespective of the roof's slope, there is a suction which, combined with the pressure built up inside the building as the result of air leakage, tends literally to "raise the roof". For a wind velocity of 22½ m.p.h., the upward force over all the leeward side of the roof (or over the whole of a flat roof) is equivalent to 1 lb/sq. ft. At 45 m.p.h. the force represents 4 lb/sq. ft., and at 63 m.p.h., 8 lb/sq. ft.

Opposing this uplift is the weight of the roof itself, and the fixing of the roof to the walls. Tiled roofs vary in weight from 12 to 18 lb/sq. ft., according to the type of tile, and so even if they were not properly tied down it is obvious that it would need a gust of wind of considerable velocity to lift them.

Roofs covered with sheet materials, such as iron, aluminium, or fibro-cement, are quite a different matter. Including the weight of the roofing timbers, these may weigh as much as 8 or 9 lb/sq. ft. when ceiling joists are tied to the rafters, or as little as about 4 lb/sq. ft. Thus the weight of the roof may not always be sufficient to counterbalance the uplift of the wind. The remainder of the force required to hold such roofs against the lifting force must therefore come from the fixing of the rafters to the wall plates and ridging. If the rafters, and ceiling joists if any, are adequately nailed to each other and to the wall plates, and the wall plates are well fixed to the studs, there should not be much danger of the roof being lifted. Too often, in practice, the nailing of rafters and joists to the wall plate is thought of purely in terms of locating these members in their right positions. Poorly nailed joints are not only useless in a high wind but can fail in winds of quite moderate intensity. This is because each time the wind force exceeds the weight of the roof, some movement will occur in the inadequately nailed joints. Over a period this straining can result in loosening of the nails to such an extent that they may offer little or no resistance to a wind which normally would not be considered severe enough to cause damage.

Skew nailing of the rafters and ceiling joists to the wall plate can be quite effective. The nails should be driven to a solid head contact, penetrate well into the plate, preferably for more than 1 in., and should not be so close to the edges as to cause splitting.

Important as it is to tie the rafters to the wall plate, it is equally important to effectively tie the wall plates to the studs. Here it should be noted that nails driven into end grain exert virtually no resistance to withdrawal.

A simple means of effectively holding a roof down is to tie each rafter to the nearest wall stud by a loop of metal strap. If each end of the strap, which must be tightened as much as possible, is held to the sides of the studs with two or three 1-in. clouts, this will provide all the fixing necessary to withstand winds up to 90 m.p.h. In gable roofs, effective toe nailing of the other ends of rafters to the ridge will ensure that the whole roof is secured as a unit. Metal framing anchors specially designed to take the place of strapping and toe nailing may be purchased in Australia. These were originally designed for the earthquake and hurricane areas of America and have been used there with considerable success.

So far this discussion has been limited to the wind effects on the roof as a whole. It will be readily appreciated that the need to hold down effectively each sheet of roofing material (or individual tiles) is even more important. The force required to hold the roof covering down is greater per unit area than that required to hold the roof and supporting members as a whole, because the individual sheets are not assisted by the weight of the rafters, purlins, and battens. In addition, the upward force on the roof is not uniform, and in certain areas, such as overhanging eaves, the suction may be considerably greater and the uplift forces larger than those mentioned above. It is therefore essential that the nailing of the sheets in place should be adequate and not regarded as a matter simply of holding them in place to keep out the rain.

It is not practicable, in a short article such as this, to go into the details of the proper nailing to be used to ensure adequate roof construction.* So much depends on the type of roofing material, the roof pitch, the span of the rafters, and the species of timber used. The location of the building is also important: whether it is in a closely built-up suburb or in open country, whether in Tasmania or North Queensland. As a matter of routine these factors are always taken into account in the design of large buildings, and it is hoped that this brief discussion will draw the attention of architects and builders to the need for giving careful attention to this aspect of design in smaller buildings such as houses, which after all represent a tremendous capital investment.

*Of considerable interest in this respect, is the information given in "Traditional Roof Framing for Tiled Roofs", N.S.B. No. 44, available at a cost of 9*d.* from the Building Research Liaison Service, Department of Works, Yarra Street, Hawthorn, E.2., Vic.

PERSONAL

MR. W. M. MCKENZIE, Utilization Section, has accepted an appointment at the School of Natural Resources, University of Michigan, where he will undertake fundamental research into the wood-cutting process. It is expected that he will be away for one or possibly two years. He plans to leave Melbourne early in August.

MR. D. E. BLAND, Wood Chemistry Section, left Melbourne during July for Vienna, where he will present a paper at the Symposium on the Biochemistry of Wood, which is being held as part of the Fourth International Congress of Biochemistry. Mr. Bland will spend about three months studying the work on wood chemistry at the University of Vienna and the Austrian Wood Research Institute, and another month visiting other forest products laboratories in Europe. His trip is being partly financed by a grant from the Rockefeller Foundation.

DONATIONS

THE following donations were received by the Division during June:

Consolidated Zinc Pty. Ltd.	£200 0 0
A. A. Swallow Pty. Ltd.	£100 0 0

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1958##245

NUMBER 245 MELBOURNE SEPTEMBER 1958

Reducing End Splitting in Logs and Poles

THE USE OF END COATINGS

By R. FINIGHAN, Seasoning Section

REQUESTS are frequently received for advice on how to control end splitting and cracking in logs and poles. This end degrade may result from such causes as: poor felling techniques causing excessive shock loadings in the tree during the actual operation of felling; the release or unbalancing of growth stresses (previously in equilibrium in the tree) while felling or cross-cutting; or the production of a stressed condition due to drying of the log or pole ends. In addition, splits (known as shakes) sometimes develop in the living tree and become apparent on cross-cutting.

With lines of wood failure established by any of the above causes, further exposure to normal atmospheric drying conditions usually results in these splits opening further and extending, thus increasing log damage.

While care in felling, rapid conversion, and conversion into lengths as long as possible can help in reducing log loss due to end splitting, probably the most effective control treatment that can at present be recommended is end coating. This is of greatest value if it is applied immediately following felling or cross-cutting, even though this may mean some inconvenience.

Various end-coating preparations have been used by sawmillers, but as little systematic work has been done in comparing the usefulness and economy of different types of products, manufacturers of material which might be suitable for this purpose were invited to submit samples of their products to the Division for comparative tests. The majority of these were by-products of the petroleum refining industry, but some wax emulsion preparations were also tested.

In addition to the ability to reduce degrade, a good end coat should:

- Be easy to apply with brush, paddle, or spray.
- Dry out or harden in a few days to reduce danger or discomfort to sawyers or others handling the coated logs.
- Not contain highly inflammable solvents.
- Be reasonably clean to handle, and not stain hands or clothing.
- Be resistant to sun and rain.
- Be effective with one coating and economical to use.

To determine the merits of the materials submitted, 40 logs were end coated and stacked in a block pile. Photographs of the ends were taken every month, and comparisons made between coated and uncoated matched ends.

The logs used in these tests were cut from mountain ash trees growing in the Broadford district of Victoria, and were supplied

<< Content

Print this page

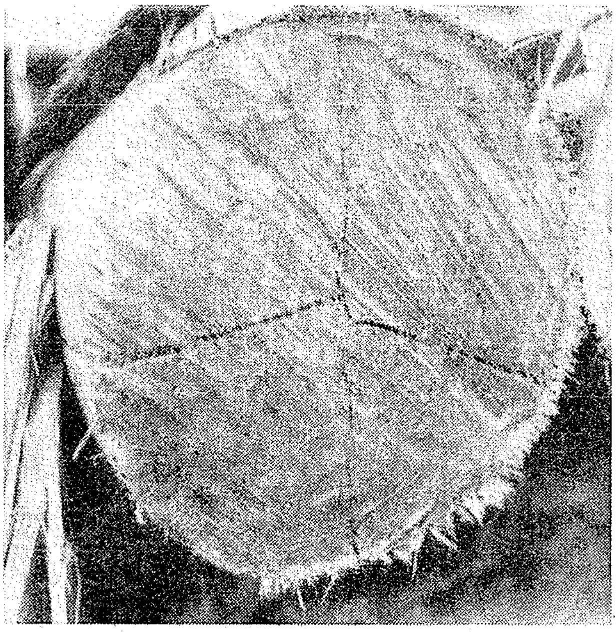
Test logs used in log degrade prevention studies.

by courtesy of the Victorian Forests Commission. Each tree was cut in 32 ft lengths and transported to a storage yard near Melbourne, arriving about two days after felling. On arrival at the yard one end of each log, selected at random, was coated with a test preparation. After a week each log was cross-cut into 16 ft lengths and one of the two new ends so formed was immediately coated with the same preparation as that on one of the original ends. The matching end was left uncoated as a control. Each coating was used on four log ends.

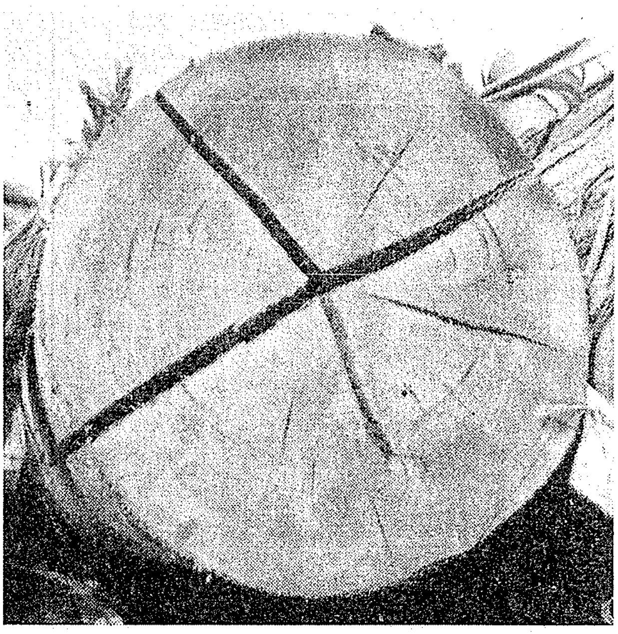
A wide variation in the effectiveness of the coatings tested was observed, and no difficulty was experienced in selecting the coatings which best fitted the requirements. Some preparations which were not very satisfactory when used as one coat have since been shown to be effective if two coats are applied but, in general, the added labour and material costs put these among the less attractive preparations.

The most suitable products tested were the heavy petroleum grease and wax mixtures applied by paddle or brush. Certain of these

Coated log end after 6 months' exposure.



Uncoated matched end after 6 months' exposure.



gave excellent protection against end degrade with one-coat application, and hardened after a short while to give a surface which could be handled without trouble.* One of these products is available dissolved in mineral turpentine or power kerosene, and can be readily sprayed.

Despite the suitability of the grease and wax mixtures and their general lack of greasiness under normal outdoor storage conditions, they are not recommended for applications where a load is to be placed directly on the coated face, e.g. mining timbers. Under such conditions of heavy load and possible high temperatures the coated faces could become sufficiently slippery to present a hazard to those handling this material. For these purposes a bituminous-type coating may be more suitable.*

Other preparations which showed promise were a paraffin wax emulsion and some microcrystalline wax emulsions. These types do not appear to give satisfactory protection to very green timber as they become diluted by sap after application, resulting in poor retention of the coating.

The results suggest that, while the ideal procedure is to coat the log immediately on felling, if this is not practicable there is still much to be gained by coating on arrival at the storage yard or log dump if the delay in transit is short. The significance of a delay will, of course, be affected by the growth stresses residual in the logs and by the amount of drying which takes place between felling and coating.

* Names of manufacturers will be supplied on request to the Chief, Division of Forest Products, C.S.I.R.O., P.O. Box 18, South Melbourne.

Low Pitch Roof Trusses

By R. G. PEARSON, Timber Mechanics Section

TO MEET the current architectural demand for low pitched roofs in houses and also to provide the utmost freedom in internal planning, new types of roof trusses have been developed in recent years. Trusses have a number of advantages for house construction. They allow the building to be quickly roofed, so that subsequent work can proceed under cover, and flooring can be laid over the entire area without the tedious and time-consuming cutting to fit individual rooms which is necessary with conventional construction. Further, most partitions need not be load-bearing and so they can be placed where required to suit architectural instead of structural considerations and can be rearranged easily at a subsequent date to satisfy changes in occupation.

A low pitch truss involves some difficulty in making satisfactory heel joints; however, this has been overcome in the trusses illustrated in Figures 1 and 2. These trusses were tested by the Division of Forest Products for builders who had been using them in their housing projects.

The triangular-shaped truss or box beam shown under test in Figure 1 had a span of 25 ft with an eaves overhang of 18 in. It was designed for a spacing of 3 ft and to carry sheet roofing. The flanges of the light truss are of hardwood, only 3 by 1 in. in section, and have $\frac{3}{16}$ in. hardboard glued and nailed to each side. Several lengths of 5 by 1 in. hardwood were butt-jointed and glued to the underside of the truss to support ceiling panels. The truss proved very stiff and strong under test, its deflection under a load of 100 lb/ft being only $\frac{5}{8}$ in. It did not

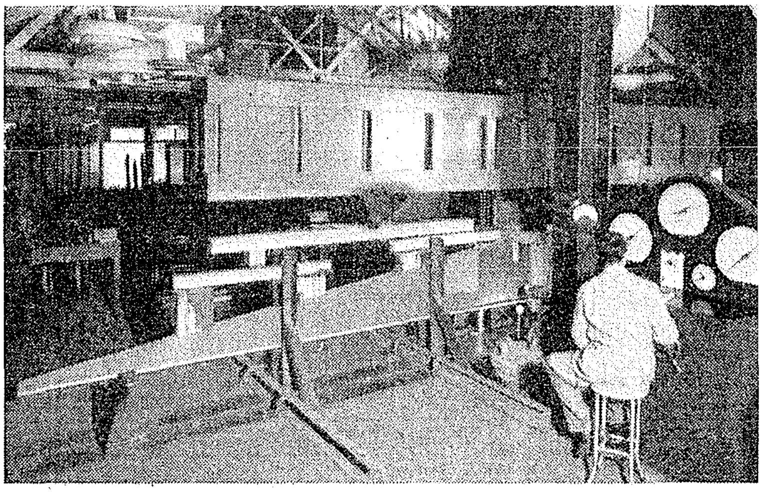


Fig. 1.—Glued box-section roof truss under test, the load being applied by a testing machine through a heavy I-beam with plywood web.

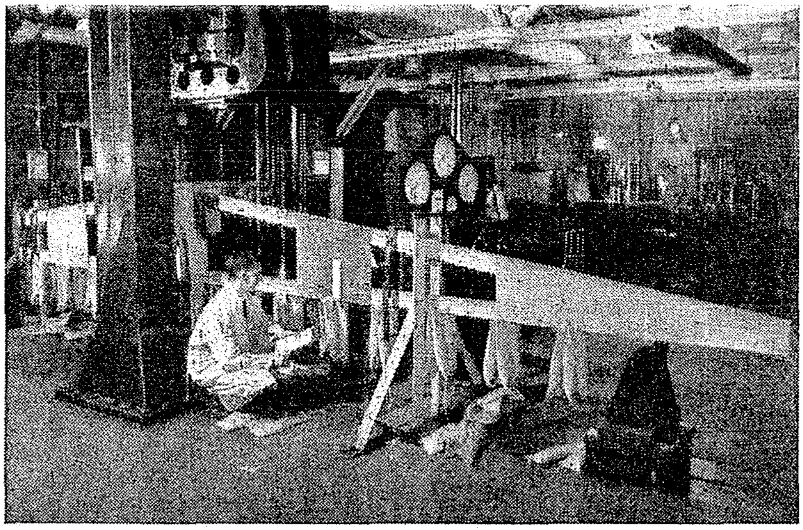


Fig. 2.—Open web nailed roof truss being loaded by bags containing steel shot.

fail until the load reached 237 lb/ft, and so had an adequate reserve of strength.

In the truss shown in Figure 2, the flanges were 4 by $1\frac{1}{2}$ in. building scantling and had a discontinuous web of $\frac{1}{4}$ in. thick hardboard nailed to them on one side only. A test load of 90 lb/ft showed the truss to be of similar stiffness to the one in Figure 1. The test was not carried through to failure, but instead the truss was set up under a long duration load to determine whether it would creep, i.e. continue to deflect under dead load with time. If its behaviour under long duration loading proves satisfactory, this type of truss should fill an important need in house construction, for it is simple and cheap to make. Trusses of similar type, but with plywood instead of hardboard for the webs, have been in use in the United States for some time. They have proved very satisfactory and have been approved by major home finance authorities.

CONCRETE FORMWORK DESIGN

THE COST of formwork is a substantial part of the total cost of a concrete structure. Accordingly building contractors give much attention to making their formwork as economical as possible.

Practical details of formwork design and construction are presented in standard text-books. These refer, however, to overseas timbers, and because the working stresses and design tables provided are not applicable to Australian species, builders have had to modify them as best they could in the light of their own experience.

To fill this gap in essential design knowledge, the Division of Forest Products has derived working stresses for Australian timbers used in concrete formwork. Tables and charts based on these working stresses have been prepared to show the maximum permissible sizes, spans, and spacings of timber and plywood sheathing, studs, wales, toms, and ties. Plywood sheathing has received particular attention, and full design information is now available for the wide range of different types and thicknesses of plywood obtainable in Australia.

All this information has recently been published by the Australian Plywood Board in a brochure—"Plywood for Concrete Formwork". Copies of the brochure are obtainable gratis from the Australian Plywood Board, 129 Creek Street, Brisbane, the Timber Development Association in each State, and the Division of Forest Products.

DONATION

THE following donation was received by the Division during July:

D. Hardy & Sons, Glebe, N.S.W. £100 0 0

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Decay in Wooden Flooring

PART I. CAUSES OF DECAY

By E. W. B. DA COSTA, Preservation Section

DECAY or "dry rot" of wooden floors is a common form of deterioration in buildings and often necessitates extensive repairs and replacements (see Fig. 1), yet all this expense and inconvenience could be avoided simply and cheaply if the underlying causes of this type of decay were more generally understood.

Moisture Content of Wood

Decay in flooring may be due to any one of a number of fungi, the spores of which are commonly present in the air, but the incidence of decay is restricted by the fact that it can develop only in wood with moisture contents above 25 per cent., which rarely occur in building timbers. It is not sufficient for the wood to be in contact with humid or even saturated air: it must actually become damp and remain damp for some time. Specific cases of decay in flooring can be explained, therefore, by determining how the wood came to be wet, and can be controlled by ensuring that it does not become wet in future.

Wetting of Timber by Seepage

Flooring and sub-floor timbers may be wetted by seepage of rain or soil water through brick or concrete walls or piers, owing to the absence or breakdown of damp-courses or to their being short-circuited by the banking up of soil against the wall or by mortar droppings in cavity walls. In other cases decay may follow small unobserved plumbing leakages or the continual spilling of water on bathroom and laundry floors, especially where it can seep under the edges of linoleum or other coverings. These causes, however, are rare and affect only localized areas; most cases of decay are caused by condensation of water on the flooring from moist air in the sub-floor space, and it is vitally important that the factors affecting this process be fully understood.

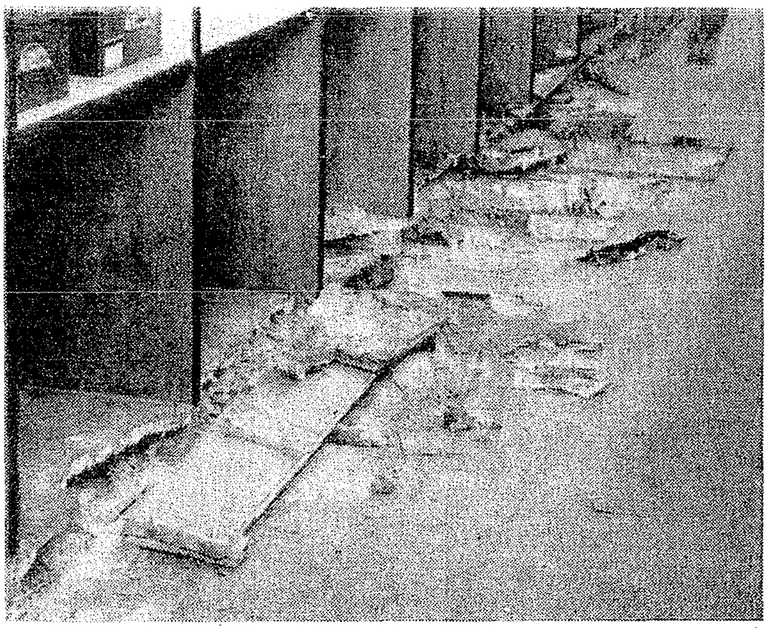
Sub-floor Condensation

Condensation on flooring (and hence most decay in floors) is due to the fact that, for much of the year, temperatures within the soil are higher than the prevailing mean air temperatures. Water vapour from the warm moist soil below a building enters the sub-floor space (passing readily through any dry surface layers of soil present) and diffuses up into the flooring which, because of its contact with the cold air above it, is colder than the soil or the sub-floor air. This may lead to condensation in or on the flooring (see Fig. 2), which will continue as long as the conditions remain unaltered. (Since water vapour will diffuse through concrete — even waterproofed concrete — such condensation can occur in wooden floors laid over a concrete slab, as well as in suspended floors.) This condensation takes place chiefly in early winter, when air temperatures are well below soil temperatures, but may occur at any time of the year if weather conditions are suitable.

Where sub-floor ventilation is adequate, water vapour from the soil is usually swept out before it can build up sufficiently for condensation to occur, and even if condensation does occur over a short period, the wood can dry out again before any damage is done; decay is usually, therefore, associated with inadequate sub-floor ventilation. Even where ventilation apparently conforms to the recommended provision of 4 sq.in. of free air space per lineal foot of external wall and double this amount for any internal sub-floor walls, it may still prove inadequate owing to: (1) the movement of air through the ventilators being impeded by sub-floor timbers across them, by mortar droppings, or by garden plantings; or (2) the unsuitable placing of ventilators leaving dead air pockets in corners or niches around chimneys or solid-fill floors. Low sub-floor clearances or large distances between external walls make it difficult to obtain adequate ventilation, whilst condensation is more likely to occur on wet sites and in humid localities.

Where the upper surface of the floor is bare or covered with carpet only, water can evaporate into the dry air within the building faster than it condenses in the flooring, so that no long-term moistening of the wood occurs. Where, however, the floor is covered with linoleum or rubber or with vinyl, cork or asphalt tiles, no evaporation can occur from the upper surface and water accumulates in the wood below the impervious covering, making conditions favourable to decay. (It is often noticed that where part of a floor has been left uncovered the decay stops sharply at the margin of the linoleum).

Fig. 1.—Severe decay in flooring of shop.



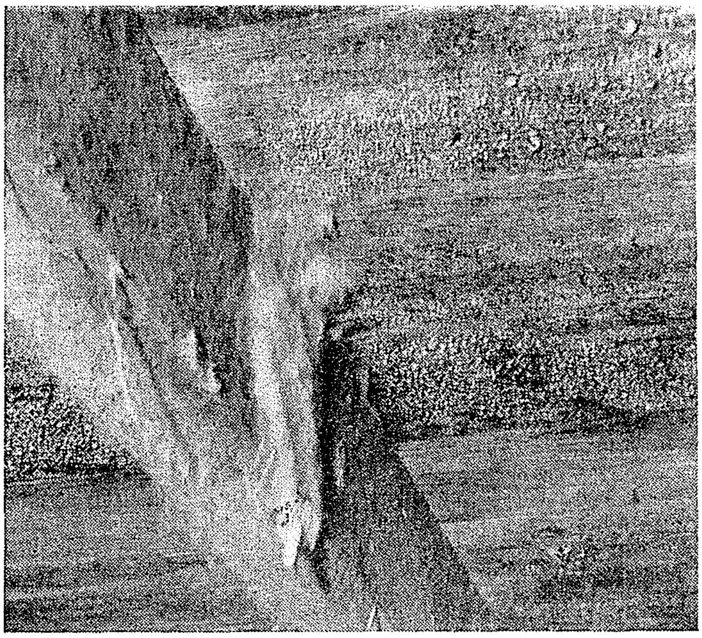


Fig. 2.—Heavy condensation and fungal growth on linoleum-covered flooring.

Other Factors

Although the occurrence of decay in flooring is primarily due to the presence of moisture, the actual rate of deterioration is influenced by many other factors. Decay is favoured by temperatures of 80–90° F and hence progresses more rapidly in tropical and subtropical areas. Its rate of development also depends on the durability of the wood concerned — it is more serious in baltic pine and radiata pine floors than those of eucalypt hardwood, although it may eventually affect even the most durable timber, including cypress pine. Wooden debris left on the ground under a building may also increase the decay hazard, as it provides a constant source of infection for any flooring nearby.

(Part II — Preventative and Remedial Measures — will be published in the next issue of the Newsletter.)

Switch off to Save Money

By D. S. JONES, Utilization Section

THE twin circular saw log breaking down rig is a heavy machine, and whether it is cutting or idling it consumes a considerable amount of energy. If energy has to be paid for, as is the case in sawmills connected with external electrical supply, the sawmiller will benefit when the consumption is reduced. Most sawmillers have at some time or another wondered if it is more economical to leave the saw running between cuts or to switch off, and generally they appear to believe that the energy required to restart the machine would exceed the amount of electricity consumed during idling. Top saws, of course, are usually stopped when not required, and this article accordingly deals with the bottom saws of twin circular rigs.

Data obtained in a recent sawmill study show that considerable savings can be obtained on electrically driven machines by switching off the motor rather than allowing it to idle. On the particular machine studied the bottom saw was powered by a 100 h.p. motor, and for most of the time a 63 in. diameter saw was in use. During the tests a recording wattmeter was connected to the input leads of the motor to record automatically and continuously its true power input. The wattmeter revealed that about 10.5 h.p. (= 8 kW) was drawn by the motor when idling. Between starting and the time of reaching operating speed the motor drew 0.25 kWh of electrical energy. An equivalent amount of electrical energy would have been expended by idling the machine for only about 2 min. Hence, for all idling periods longer than 2 min, electricity would be saved if the motor were stopped and only restarted immediately before sawing again commenced.

A time analysis made of the operation of the machine allows relative costs to be calculated. During a 160 hr working month the saw was shown to cut for only 11 hr and to idle for the remaining 149 hr. The average power drawn during sawing was 80 h.p. (= 59.7 kW) and hence the quantity of electrical energy consumed in 1 month by sawing would be 657 kWh. For the purposes of these calculations it is reasonable to cost the electricity at a unit rate of 4*d.* per kWh, and thus electricity for sawing would cost about £11 per month. The amount of energy consumed doing no useful work during the 149 hr of idling would be 1190 kWh, which would cost £20, nearly twice as much as for sawing. The total monthly cost of electricity for running the bottom saw on this machine would thus be about £31, the major portion of which would be incurred by wastefully idling the saw between cuts. If, by switching off as often as possible, the idling costs were cut, say, by two-thirds down to about £7, the total cost of running the bottom saw would be reduced to about £18 per month. Based on the charge of 4*d.* per unit, a typical monthly power charge for the sawmill under discussion would be about £130, so simply by reducing the idling costs of the breaking down rig the electricity cost for the whole mill would be reduced by about 10 per cent.

Time studies in other sawmills have shown that twin circular machines frequently idle for a greater proportion of their time than the machine from which the above figures were obtained, and therefore greater savings can be expected in many mills.

The start and stop control must be installed in a convenient location so that little extra effort is required by the operator in switching on and off, and a press-button remote control is accordingly desirable. The existing switching equipment in many mills does not meet these requirements. However, when old mills are installing new equipment, or when new mills are being constructed, the advantages of conveniently located press-button control equipment should be considered. The extra cost of such equipment would soon be recovered.

The squirrel-cage induction motors usually used in sawmills do not suffer any ill effects from frequent stopping and starting. The contactors used in the starting equipment will deteriorate more rapidly, but these are cheap and easily replaced. It is probable that belt wear is proportional to the amount of energy delivered to the saw, and if it is, belt wear will be reduced at the same rate as electricity costs are reduced when switching off is practised.

Fundamentally, of course, the best solution to the problem is to reduce the lengthy periods for which the breaking down saw does no useful work. This can be done by improving the log-handling equipment and by improving the balance of work between the breaking down machine and following machines. However, while present sawmilling practices remain, significant savings can be made in electricity costs by switching off the saw motor immediately a period of idling is foreseen.

Guest Workers from Abroad

OVER the next 18 months three distinguished overseas scientists will work in the Section of Wood and Fibre Structure. The first of these visitors is Dr. Walter Liese, of the Department of Forest Botany in the University of Freiburg. Dr. Liese is well known for his electron microscopic studies of the fine structure of pits in wood fibres, and the relation of pit structure to problems of penetration of preservatives into wood. During his stay in the Section, from September 3 until the end of this year, Dr. Liese will investigate, among other problems, the fine structure of bamboo and other grass fibres.

Dr. Liese's visit will be followed by that of Dr. H. Harada, of the Government Forest Experiment Station, Tokyo, from January to June 1959. Dr. Harada, is also distinguished for his electron microscopic studies of plant cells and will work on the fine structure of hardwood fibres and the physical organization of cellulose.

From July 1959 until May 1960 Dr. Vernon I. Cheadle, Chairman of the Department of Botany in the University of California at Davis, will be investigating the microscopic and submicroscopic structure of the tissue elements of phloem. During his stay in this Laboratory Dr. Cheadle will make several excursions to various parts of Australia to collect specimens.

Visitors from New South Wales See Division's Work

EARLY in September the Division welcomed 20 members of the New South Wales Branch of the Timber Development Association on a 2-day visit. Mr. A. Kevin Smith, President, and Mr. Don Barnes, Director, headed the party. Mr. J. Hauser, Director of the recently re-formed Victorian T.D.A. also joined in the visit.

The first day was spent inspecting the laboratories and normal research projects of the Division. During the tour, considerable interest was shown by T.D.A. members in the wide variety of structural units which have been designed by the Timber Mechanics Section for incorporation in the rebuilding of the Division's sawmill. These included trusses, heavy-duty beams, and flooring panels.

The second day was mainly spent in lectures and exchange of ideas, and the lively discussions which ensued showed the keen interest taken in the Division's work. It is hoped that this visit will be the forerunner of further visits by this and other interstate organizations.

PERSONAL

MR. C. SIBLEY ELLIOT, Assistant Chief of the Division, left Australia at the end of July to take up an F.A.O. appointment for three months on a Technical Assistance Mission to the Government of Argentina.

DONATIONS

THE following donations were received by the Division during August:

Timber Engineering Co. Pty. Ltd.	£100 0 0
Westralian Plywoods Pty. Ltd. ..	£150 0 0

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1958##247

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Decay in Wooden Flooring

PART II. PREVENTIVE AND REMEDIAL MEASURES

By E. W. B. DA COSTA, Preservation Section

Adequate Sub-floor Ventilation

Most decay is due to condensation from moist sub-floor air and control depends primarily on providing sufficient sub-floor ventilation to obtain a continual mass movement of air beneath every part of the floor. For general building construction in Australia, provision of 20 sq. in. of free air space in each 5 ft of external wall and 40 sq. in. in each 5 ft of sub-floor internal wall is recommended. This requirement is satisfied by woven wire or stamped metal vents at 5 ft centres in the external walls and the removal of two bricks every 5 ft in internal walls, but other measures may be adopted provided measurement of the free air space shows that it is adequate. (Many old buildings with much less than this amount of ventilation have remained free of decay and some building codes allow smaller amounts, but the high incidence of sub-floor decay shows that past standards have not been high enough to prevent decay in all buildings.) Buildings on wet sites, in humid localities, or in tropical climates, and buildings with very large distances between external walls may require higher standards of ventilation.

Ventilators must be placed, constructed, and maintained to avoid any restriction on the flow of air through them. Air movement under a building depends on the small difference in air pressure between the windward and leeward sides of the building and on the forward momentum of the air blowing against the building. For maximum air movement, air must be able to move into and through the sub-floor space in a straight line. Vents in the inner and outer leaves of a cavity wall should therefore be directly opposite one another, and sub-floor timbers should not be placed across vents, if it can be avoided. Vents should not be covered with fine screen wire, which hinders air movement and often becomes completely blocked by dust or debris, and care should be taken to see that they are not blocked by mortar droppings. Decay is often caused by vents being partly blocked by dense garden plantings or even by soil or concrete paths being built up against them.

Vents should be so placed as to avoid any dead air pockets in corners and niches around chimneys and solid-fill floors of bathrooms and laundries. Where solid-fill floor areas or built-up terraces outside a building make it difficult to provide normal ventilators along one wall, adequate ventilation can often be obtained by using more vents in other walls, but, if this is doubtful, ventilating pipes of 6 in. diameter should be laid through the fill.

Shops and office buildings are particularly liable to decay and present many difficulties with sub-floor ventilation. They are usually

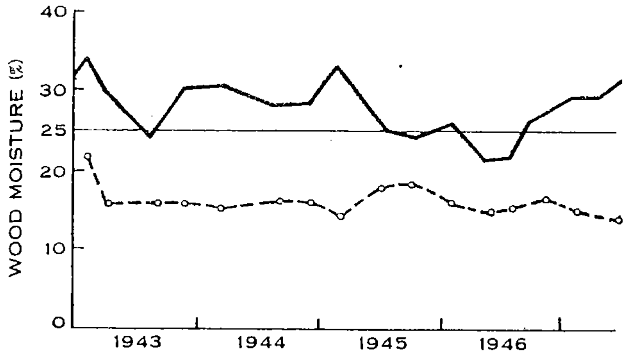


Fig. 3.—Effect of soil cover on moisture content of sub-floor timbers. Broken line — house with soil cover; solid line — comparable house without soil cover. (Data from U.S. Department of Agriculture.)

constructed in terraces in highly built-up areas so that there is no ventilation at the sides; the ground clearance is kept very low to obviate steps where customers enter; the floor area is relatively large; and the need for a decorative floor treatment with high resistance to foot traffic leads to general use of impervious floor coverings such as linoleum, rubber, or tiles. For these buildings, the first step is to obtain as much natural air movement beneath the floor as possible by abundant ventilation for the entire length of two opposite sides of the floor area, and by removing any obstructions beneath the floor (including soil if necessary) to give an almost uninterrupted 8–12 in. space beneath the lowest sub-floor timbers. Where sub-floor vents cannot be provided on opposite sides of the floor area, floor vents along the side opposite that ventilated are of some value, but a much more effective measure is the use of vertical flues in the corners furthest removed from the ventilated side. These should be 8–12 in. in diameter and should be taken up to above roof level and fitted with a suitable extraction cowl. Mechanical ventilation of sub-floor space is sometimes suggested but is prohibitively expensive. Even where the intake of an existing air-conditioning plant can be from beneath the floor, the volume of air moved is usually inadequate and the location of intake ducts unsatisfactory.

Where wooden floors are laid on fillets or joists on top of concrete slabs, and are then covered with impervious coverings, ventilation holes should be provided into all sub-floor cavities. Where an adequate moisture vapour barrier has been installed beneath the concrete, only a small amount of ventilation may prevent decay, but where no vapour barrier is present, the decay hazard may be very high and the use of highly durable or preservative impregnated timber is essential.

Soil Cover

In many cases, especially with old shops and warehouses, sub-floor ventilation may be of doubtful adequacy even after everything practicable has been done to improve it: in such cases, the "soil cover" method should be used. Since the ventilation cannot be further increased, the amount of water vapour entering the sub-floor space must be reduced to a level with which the ventilation can cope. This is readily done by covering all or most of the soil surface with an impervious material which will prevent water vapour leaving the soil. This technique is in common use in the United States, where many years of use and testing have shown it to be highly effective (see Fig. 3), but is not sufficiently well known in Australia. The material most frequently used in America is heavyweight roll roofing, i.e. asphalted felt, but any moisture-impervious material, such as linoleum, rubber, plastic film, or metal foil, will serve, provided it is not subject to decay. It is desirable to cover all of the soil surface (with 2 in. overlap) and to extend the covering up any moist brick walls for the maximum protection where ventilation is entirely absent. However, for the vast majority of buildings, the great reduction in water vapour concentration brought about by covering 80–90 per cent. of the soil area will be sufficient protection against decay, even where ventilation is much below normal requirements. Such partial coverage can easily be obtained even in existing buildings with very low clearance, as the material can be pushed into place with rakes or poles. Reduction of moisture content in wooden floors by soil cover or improved ventilation will often prevent distortion of floorboards or failure of adhesives for floor coverings as well as decay.

Use of Decay-resistant Timber

Where the decay hazard is high and adquate sub-floor ventilation difficult to provide, and especially in large floors with low clearance and impervious floor coverings, it is desirable to use a more durable timber for construction and replacement. Hardwood flooring even of the less durable species is less susceptible to decay than baltic or radiata pine, but will decay under severe conditions. Tallowwood, wandoo, red gum, etc. have high resistance both to decay and to wear. If the floor is to be covered, high resistance to wear is not usually required, and in this case radiata pine impregnated with a suitable water-borne preservative may be used. Most modern preservatives are highly effective not only against decay but also against termites and borers, and in many localities this is an important additional safeguard.

Other Measures

Adequate sub-floor clearance makes the provision of sub-floor ventilation much easier — the minimum clearance under bearers should be 9–12 in. in most areas and 18 in. in wet sites or in tropical climates. In wet sites, provision of agricultural drains around the building may greatly reduce decay hazard. Use of carpets, or of uncovered sealed and polished flooring, in place of impervious floor coverings, will help to remove any decay hazard.

Timber Rigid Frames for Prefabricated Building

R. G. PEARSON and R. N. BOURNON, Timber Mechanics Section

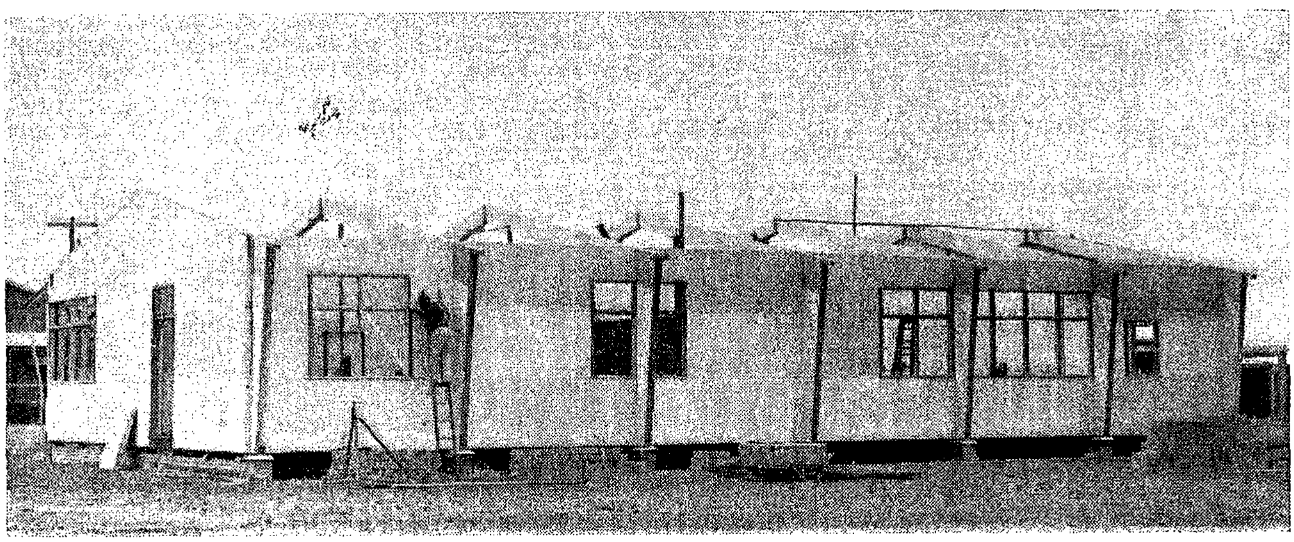
THE high hopes held not long ago that prefabrication would prove economical and become a major force in the building industry have not been sustained by experience. Nevertheless, in many areas of Australia, materials and skilled labour are not readily available for building construction, and prefabrication of a building at some more suitable centre and its transport to the site becomes practicable and economical.

Recently, a canteen 72 by 40 ft was prefabricated in Melbourne and transported by road to Woomera for erection. The structure was novel in several respects, particularly in the extensive use of hardboard structurally. Rigid frames were chosen by the architects to give a spacious internal appearance. They were of box section with $\frac{1}{4}$ in. thick tempered hardboard webs glued to the flanges of 6 by 2 in. seasoned hardwood. Karri plywood $\frac{1}{2}$ in. thick was used at the knee instead of hardboard to transmit the high shear stresses at this point. In fabrication, the webs were held in place and gluing pressure applied by pneumatically driven staples spaced about 3 in. apart.

For ease of transport, a field joint was made at the knee, the wall leg and the roof member being made separately and then fastened together at the site with coach screws.

Walls were partly full-length windows and partly built up from prefabricated panels 12 by 4 ft in size. The wall panels were of stressed-skin construction and comprised

Rear view of canteen at Woomera during erection, showing the rigid frames and wall panels.



¼ in. hardboard glued and stapled to a timber frame of 4 by 1 in. seasoned hardwood.

The roof covering of corrugated galvanized iron was fastened directly to prefabricated ceiling panels which spanned between the principals. These panels, which were painted before erection, comprised hardboard sprung between the longitudinal timber side members to present a concave undersurface and form a fluted ceiling. Foil insulation was incorporated in the panels.

The flooring was ½ in. thick karri plywood sheets, 8 by 4 ft, laid over precut, dressed, seasoned hardwood joists and Douglas fir bearers.

A prime advantage of prefabrication is speediness of on-site erection and this was well demonstrated with this canteen. All seven pairs of rigid frames plus 80 per cent. of the side walls were erected in one day with five men and one crane. The roof also was quickly erected, half of it being completed in one day.

The architects for the canteen were Alsop and Duncan, Hawthorn, Victoria, and the builders Messrs. Davies and Jones, Box Hill, Victoria. The Division of Forest Products was responsible for the structural design and testing of the rigid frames and for the design of the wall and ceiling panels.

PROPERTIES OF AUSTRALIAN TIMBERS

White Mahogany

WHITE MAHOGANY is the standard trade common name for the timbers known botanically as *Eucalyptus triantha* Link. (syn. *E. acmenioides*) and *E. carnea*. In Queensland it is commonly called yellow stringybark.

Habit and Distribution

White mahogany is a large tree which under good conditions reaches 120 ft in height and 12–14 ft in girth. At times the larger trees are hollow. The bark is thick, fibrous, stringy, and persistent except for the extreme branches. It occurs occasionally throughout the coastal forests between Sydney and Rockhampton, generally associated with tallowwood and blackbutt. Further north it diminishes in size but is found in association with white stringybark around Mackay, Ayr, Ingham, and Cairns.

Timber

The timber varies from yellowish to brown in colour. The grain is usually interlocked, although sometimes fiddleback is found, and the texture is very close and even. It is hard, heavy, stiff, strong, and tough and has a reputation for fire resistance. It weighs between 51 and 67 lb/cu.ft air dry (average 59 lb/cu.ft) and has been placed in strength group B. The narrow sapwood is not susceptible to Lyctus borer attack. White mahogany saws and machines easily and is regarded as one of the best of the eucalypts to work. It is one of the most durable of all Australian timbers, resisting both decay and termites well.

Seasoning

The timber dries slowly with little tendency to check or split. Shrinkage from green to air dry of 3 per cent. radially and 5·5 per cent. tangentially is lower than most eucalypts.

Uses

White mahogany is a high-class structural timber. It is used for poles, pit props, sleepers, wagon and carriage building, fence posts, bridge framing and decking, and in house building for stumps, general framing, and exposed flooring.

Availability

The total supply is considerable, the timber being available in the round, hewn, or sawn. Approximately 10 million super feet (sawn) are produced annually.

DONATIONS

THE following donations were received by the Division during September:

G. J. Klitze, Hobart	£15	0	0
N.Z. Forest Products Ltd. ..	£250	0	0
Vermont Timber Mills ..	£10	10	0
Local Timber Ltd., Myrtleford	£50	0	0

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A Pendulum Dynamometer for Sawing Research

By W. M. McKENZIE, Utilization Section

PRACTICAL TESTS of new ideas in sawing and saw design are essential, but the development of these ideas using an industrial machine is very expensive. When an ordinary saw is under test its teeth must be carefully profiled, sharpened, and set many times, and small variations between teeth are practically impossible to eliminate. Large quantities of wood must be sawn to cover different species, cope with the great variability of wood within species, and eliminate the effect of many sawing variables that cannot be closely controlled under such conditions.

In addition, the factors that may vary in a sawing operation are very numerous, totalling about 28. Fortunately not all need be investigated, but even so, the study of the factors whose influence is not well known would require millions of cuts. Fortunately, as about 13 of these factors are related to the features of the individual teeth, or to the wood, it is possible that much work and wood might be saved by studying the action of a single tooth cutting in a small specimen of wood. This is especially convenient if it can be done at a low speed, instead of the high speeds at which many saws run. There are factors which are affected by the speed at which a tooth acts, but in most cases it is not difficult to allow for these effects.

Such considerations led to the use of the pendulum type of dynamometer, which measures the energy used when a single tooth cuts through a small specimen of wood. It is constructed so that a tooth can be attached to a rigid type of pendulum, released from a given point, and swung through a small wood specimen. The energy absorbed from the pendulum is obtained from the angle between the position after a free swing and that after a cutting swing, indicated on the circular scale on the front of the machine. From this information the tangential force during cutting can be calculated. Such machines in laboratories in Sweden, France, and U.S.A. have already provided valuable information.

The new machine at the Division of Forest Products, which has special provision for measuring the radial force also, is illustrated in Figure 1. Its frame, of box construction in ¼-in. steel plate, is mounted on a concrete base. The pendulum, 44 in. long, swings on frictionless bearings and has a steel tube shaft forked at the lower end to take a revolving turret head (see Fig. 2). The head has six sockets around its periphery for holding saw teeth, so that a sequence of up to six different types of teeth, or three pairs, can be mounted, and any tooth can be quickly brought into play. Each tooth can be accurately adjusted by screws as to angle and height relative to others, using its magnified shadow cast by a projector. The

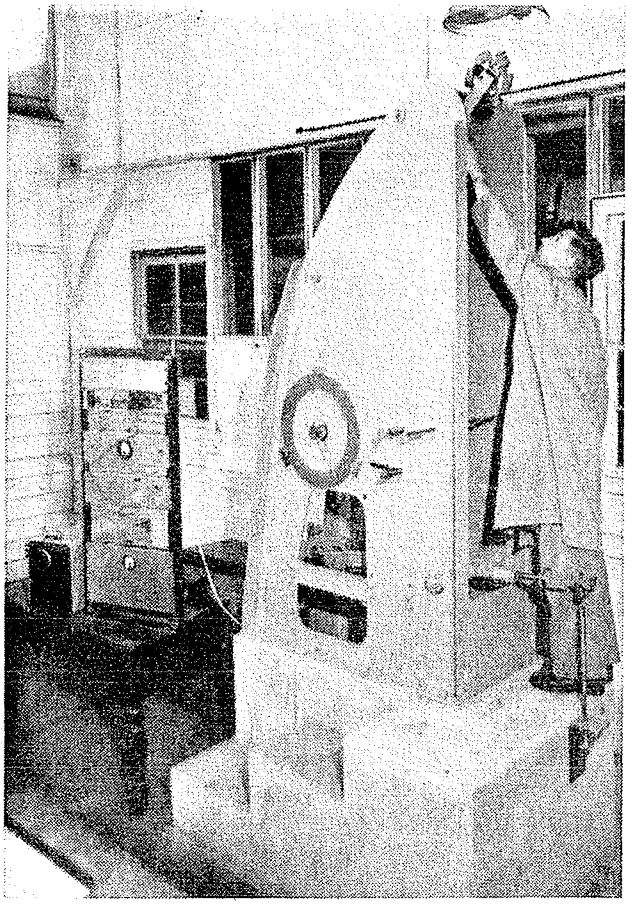

Fig. 1.—*The pendulum dynamometer.*

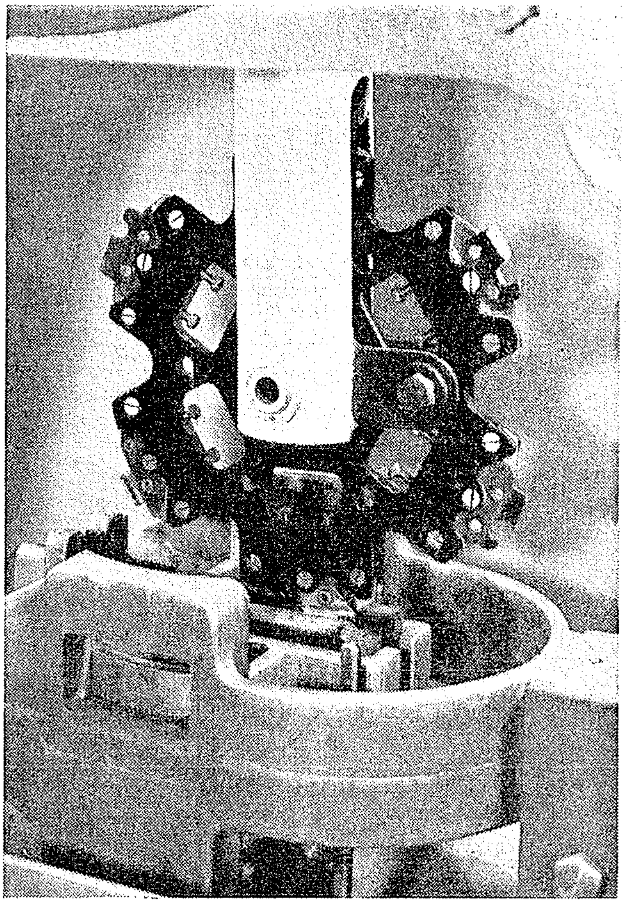

Fig. 2.—*View of turret head and suspension unit.*

pendulum is normally dropped from a position 45° above the horizontal, the drop height of 6 ft 3 in. giving a tooth speed at the cut of 1200 ft/min.

In the study of tooth action, forces in directions other than tangential are also of interest. In particular the force in the radial direction (referred to a circular saw or pendulum) affects the power required to feed the saw, and causes deflections of the tooth. Therefore in designing the Division's pendulum, provision was made for registering the radial force. The specimen is held in a specimen holder by two pins through accurately bored holes. The specimen holder is clamped in a U-shaped fork as shown in

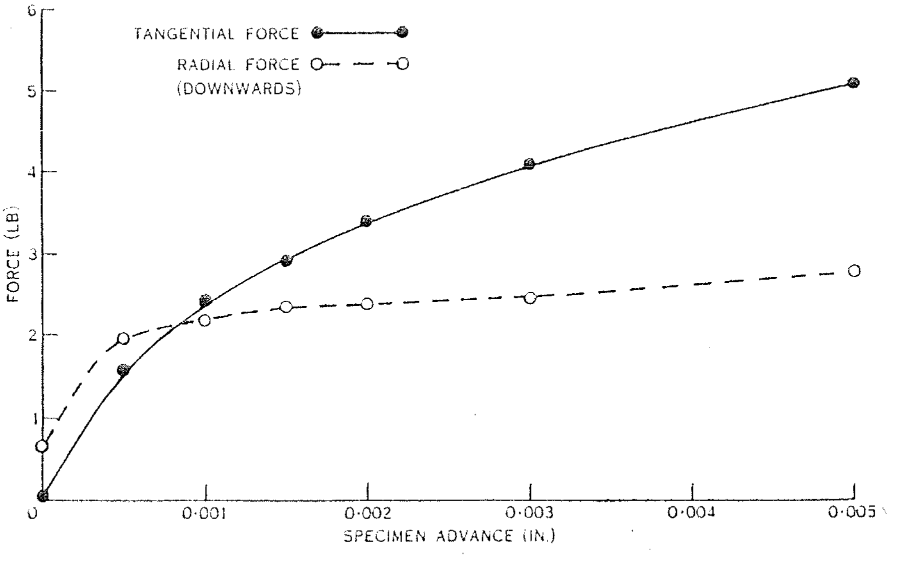

Fig. 3.—*Variation of tangential and radial forces on a gouge-type chain saw tooth with increasing specimen advance.*

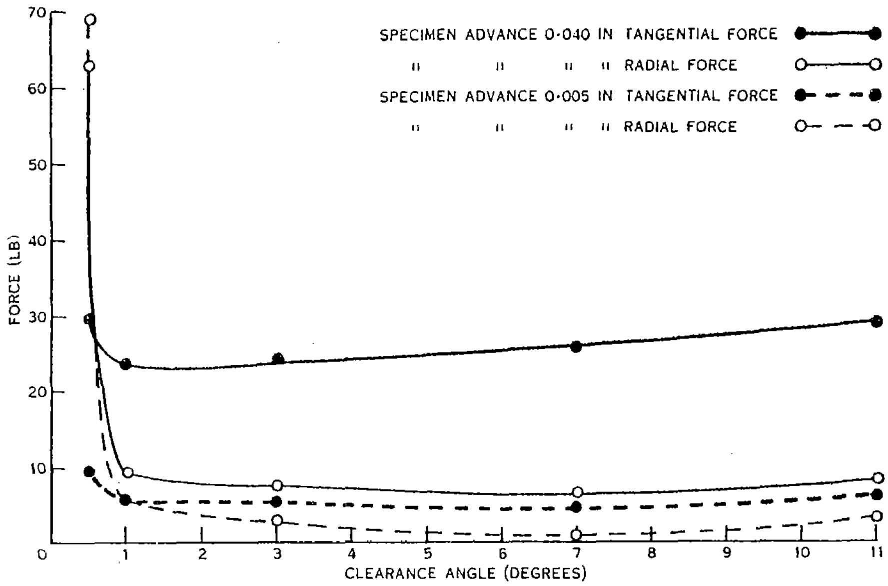

Fig. 4.—The effect of clearance angle on tangential and radial forces on a gouge-type chain saw tooth.

Figure 2. A horizontal arm restrains the fork from moving in the direction of swing arc, and the bottom of the fork is attached to one plate of a condenser. This plate rests on a rubber pad, which is compressed to varying degrees by the radial force of the tooth acting on the wood. The resulting variations in the capacitance of the condenser are amplified and displayed as a wave on a cathode ray oscillograph, and may be recorded using a special camera. The amplitude of the wave is calibrated by placing known weights on the specimen holder, thus allowing the force in the radial direction to be calculated.

Some results obtained from the machine are shown in Figure 3. This shows how the tangential and radial forces varied as the specimen advance was increased from 0 to 5 thousandths of an inch. Figure 4 shows the variation in these forces at very small clearance angles. Both these figures reveal that the radial force may vary in a different manner from the tangential force, at least under some cutting conditions.

Since one of the advantages of this type of testing machine is that many types of teeth can be attached to it, it is expected that it will be extremely useful in investigating a wide range of wood-cutting operations.

Penetration of Liquids into Radiata Pine

By G. W. DAVIES, Wood and Fibre Structure Section

IN THE PAST extensive studies have been made of those features of wood structure which govern the penetration of liquids, particularly preservatives. In softwoods, such as radiata pine, it has been established that there are channels connecting adjacent wood fibres, most of which are present in the radial walls of the fibres. Through these channels, or bordered pits, as they are called, liquids usually pass from fibre to fibre.

These bordered pits, which were recognized almost 300 years ago by Leeuwenhoek, have a remarkably complex structure. Thus, if we imagine two adjacent wood fibres—*A* and *B*—as resembling two parallel cylinders joined by a cementing material (lignin), and we cut a thin section through a pit in the plane parallel to the bark, then our section would appear as in Figure 1(*a*).

If an examination is made of woods difficult to penetrate, one often finds that there has been a slight change in pit structure. The pit membrane can move to one side, and the thickened central region—the torus—blocks the pit aperture as shown in Figure 1(*b*). Such a pit is said to be aspirated, and this is often the reason for many of the observed differences in penetrability of softwoods by preservatives.

Recently some samples of radiata pine were examined in this laboratory which were readily penetrated by creosote oil, but not

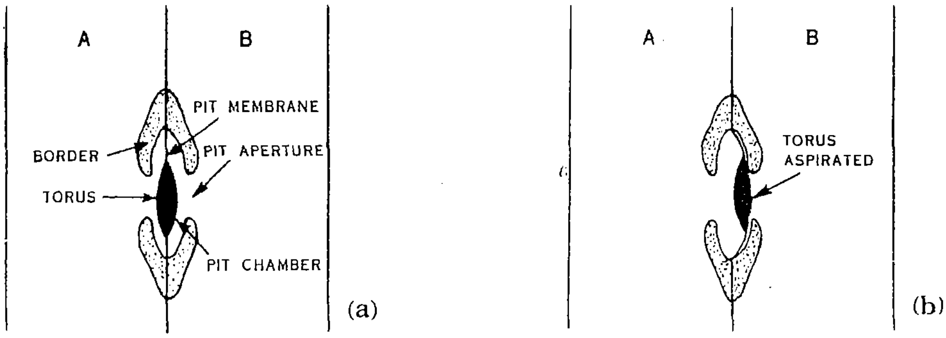

Fig. 1.—Section through two adjacent wood fibres, showing (a) torus in normal position and (b) torus aspirated.

by aqueous preservatives. Microscopic examination showed little pit aspiration—indicating that some other factor prevented penetration. The fact that an oily preservative could penetrate led to the idea that within the fibres there might be some material of a fatty or waxy nature which would permit the entrance of (i.e. be wetted by) oily liquids but not water or aqueous solutions.

To test this idea further it was necessary to examine the effects of various treatments on the rate of penetration of water into the wood. To do this a "sinkage time" test was employed. In this test small standard-size blocks of wood are placed in a vessel under vacuum for a fixed time to remove air from the wood. At the end of this period water is allowed to run into the evacuated flask and the time for the blocks to sink in the water is measured. This time is called the sinkage time.

For the original wood the sinkage time was greater than 72 hours. If, however, the wood was extracted with alcohol and ether which remove fatty and waxy substances, the blocks sank immediately. Severe oven drying of the blocks before extraction increased the sinkage time, but similar drying after extraction was without effect.

These observations clearly indicated the presence of fatty or waxy materials impeding the penetration of water into the wood, and further, that this material tended to be fixed in the wood by severe drying. To obtain further information the wood was examined microscopically, after staining with dyes known to stain fatty substances.

In fresh wood stained with Sudan IV (a fat stain) the presence of globules of fat was shown, particularly in the ray cells. After drying, this fat was found not in globules, but in sheets along the inner surface of the cell walls. Sudan Black, another fat stain, gave similar results, and showed a preponderance of fatty material in the pit chambers. After the wood had been extracted in alcohol and ether, the fatty material was found to have been removed.

It seems, therefore, that the failure of water to penetrate dried wood is related to the fact that fatty substances spread out during drying, thus possibly sealing up the pits and repelling water. After extraction, when the fatty material has gone, the blocks sink because there is no water-repelling layer present. Hence, the problem of penetration of aqueous preservatives is not always due to pit aspiration, but to the condition of the cell contents, particularly fatty substances, at the time of penetration, and to the amount of drying which the wood has undergone.

DONATIONS

The following donations were received by the Division during October:

Kalangadoo Timbers Ltd., S.A.	£50 0 0
Walter & Morris Ltd., Port Adelaide, S.A.	£50 0 0
Queensland Timber Stabilization Board	£100 0 0
Hardy's Joinery Pty. Ltd., Wagga	£50 1 6
Duncan's Holdings Ltd., Sydney	£52 10 0

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