CSIRO

Forest Products Newsletter

DIVISION OF FOREST PRODUCTS, CSIRO, P.O. BOX 310, SOUTH MELBOURNE, S.C.5, VICTORIA

REGISTERED IN AUSTRALIA FOR TRANSMISSION BY POST AS A PERIODICAL

NUMBER 304 JANUARY—FEBRUARY 1964

1964##304

Water Sprays Prevent Losses in Softwood Log Dumps

By R. Finighan and R. M. Liversidge, Seasoning Section

BECAUSE OF the increasing significance of plantation softwoods to the Australian wood-using economy, the problem of preventing degrade in log storage dumps is assuming considerable importance. Blue stain and barrel checking can often cause serious material and monetary losses and various methods of minimizing these have been advocated. Overseas reports suggest that the spraying of unbarked logs with an anti-stain solution may be of value, while, on the other hand, at least one Australian company has approached the problem by removing the bark before spraying with the anti-stain solution. The possibility of using water spray protection has also been considered.

To compare the effectiveness of these various methods, an experiment was commenced in the Melbourne area during December 1962, with Victorian-grown *Pinus radiata*. To ensure that the logs arrived in fresh condition, all ends were thickly coated with a heavy petroleum grease immediately on felling. On arrival at the test site this coating was removed by docking 3 in. from the ends of each log. Four test piles were constructed with 10 ft long logs in diameters ranging from 8 to 14 in. Half of the logs in each pile were barked and the remainder left unbarked.

The following treatments and storage conditions were examined:

Pile 1.—Logs dipped for 30 sec in an anti-stain solution consisting of 2% sodium pentachlorphenate plus 2½% borax in water and stored without water sprays.

*Pile 2**.—Logs dipped in anti-stain solution as in (1) but stored under continuous re-circulating water sprays.

*Pile 3**.—No anti-stain dip treatment, but logs stored under continuous recirculating water sprays.

Pile 4.—No anti-stain dip treatment, and logs stored without water sprays, i.e. a control pile.

Figure 1 shows the type of spray installation used on Piles 2 and 3.

After exposure periods of 3½ and 5½ months, typical barked and unbarked logs were withdrawn from each pile for inspection, and an evaluation of the remaining logs was made after 7½ months' storage.

All test logs were docked at points 3 in. and 12 in. from each end and were examined for blue stain. At the same time the incidence and severity of any barrel checking was noted. The remaining portion of each log, viz. approximately 8 ft, was ripped down the centre to examine the longitudinal spread of the fungal attack. Wherever blue stain was observed on the docked ends, it was also present throughout the entire length of the

* To ensure that the logs in Pile 3 were not affected by any fungicide which may have been washed from the logs in Pile 2, separate spraying systems were used.

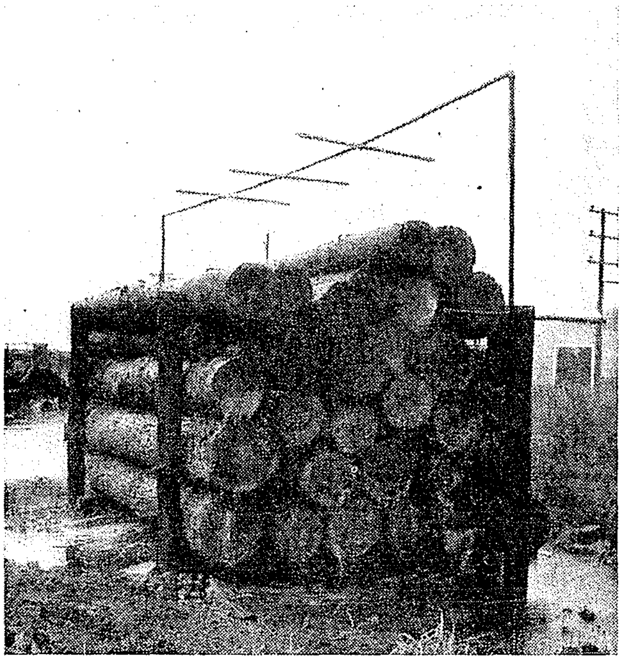

Fig. 1.—Pile 3 (undipped logs) under the continuous recirculating water sprays.

log. In one or two cases it appeared that the fungus gained entry through knot clusters on the barrel of the log and spread from this point for some distance along the length, although it was not obvious on the docked ends. To enable the various treatments to be compared, the extent of any blue stain present was expressed as a percentage of the cross-sectional area.

Typical sections from the test logs are shown in Figure 2. Table 1 shows the effects of various treatments in the incidence of blue stain and checking.

It is clear that the water sprays, in themselves, provided complete protection against blue stain and checking for both barked and unbarked logs. No advantage was gained by giving the water sprayed logs a preliminary dip in the anti-stain solution.

All logs in the piles held without water sprays showed bluestain infection. The preliminary dip appeared to reduce the severity of the blue stain in the barked logs but had no effect on the unbarked logs. The unbarked logs remained free of drying degrade but severe checks developed in all logs without bark.

To examine the effect of a delay between felling and piling a small number of unbarked logs was held for periods of 1 and 2 weeks

Table 1: The Effect of Storage Conditions and a Preliminary Dip in Anti-Stain Solution* on the Incidence of Blue Stain and Drying Degrade in *Pinus radiata* logs

	Logs Stored under Water Sprays		Logs Stored without Water Sprays	
	Dip	No Dip	Dip	No Dip
Bark on				
Blue stain	Nil	Nil	Slight to severe (all logs infected —av. 55%)	Slight to severe (all logs infected —av. 63%)
Checking	Nil	Nil	Nil	Nil
Bark off				
Blue stain	Nil	Nil	V. slight to moderate (all logs infected —av. 16%)	Slight to severe (all logs infected —av. 60%)
Checking	Nil	Nil	Severe	Severe

* Thirty sec dip in solution of 2% sodium pentachlorphenate plus $2\frac{1}{2}$% borax, in water.

before being placed, undipped, under the water sprays. These logs were examined with the other test logs after the $7\frac{1}{2}$ months' storage period and were found to be free of blue stain and checking. It is almost certain that blue stain spores would have gained access to the logs during the holding period and since the weather conditions were favourable to the development of the fungi it seems likely that the water sprays were effective in preventing any further spread. However, under certain conditions the blue stain could develop more rapidly than was the case in the above experiment and to avoid any risk it is recommended that the logs be placed under water sprays as soon as possible after felling.

Although this experiment, and the hardwood study previously reported (cf. Newsletter No. 298, July 1963), were on a comparatively small scale, the results show that a properly designed and operated spray system giving a complete water cover is extremely effective in preventing degrade in both hardwood and softwood logs.

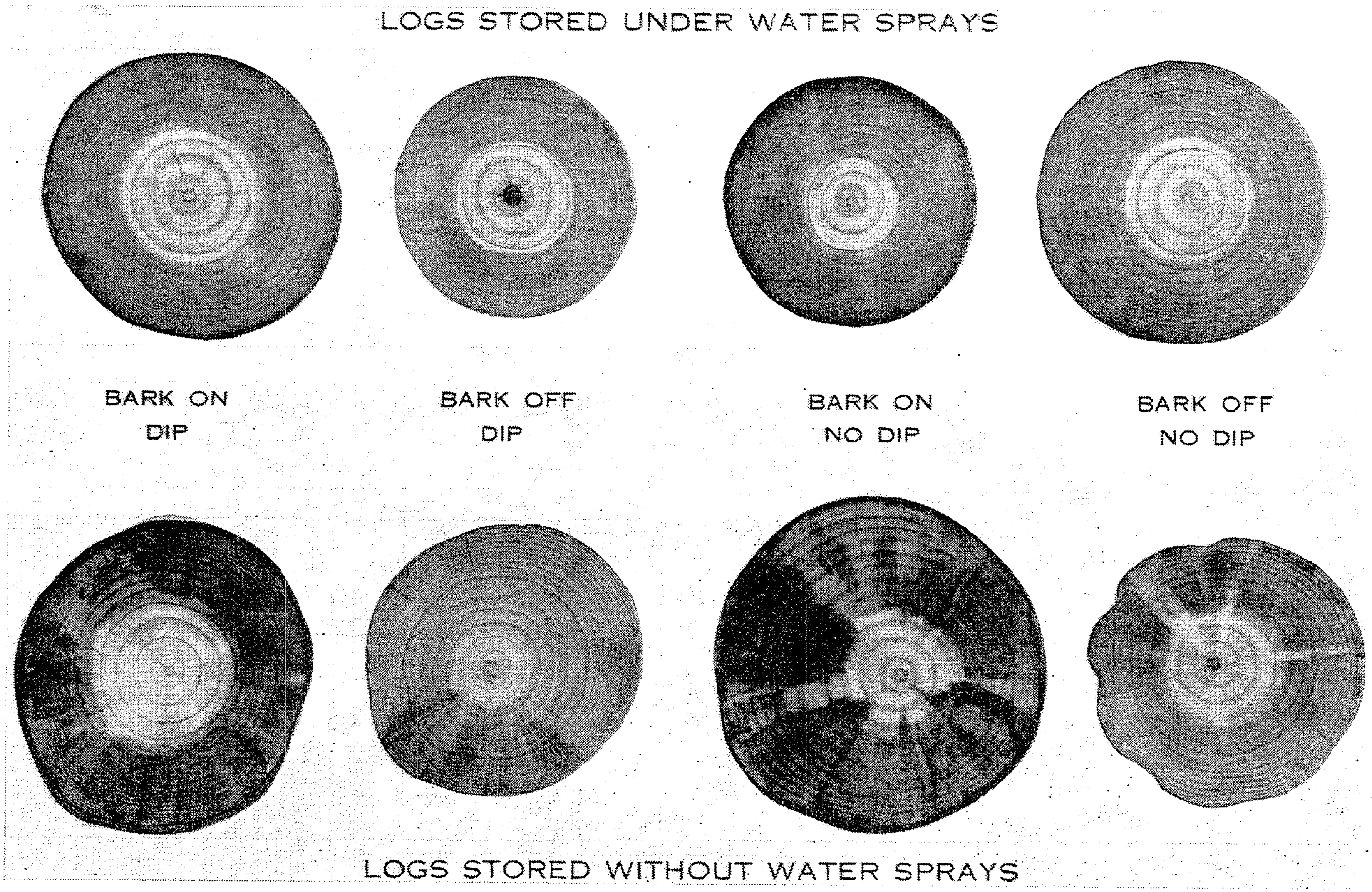

Fig. 2.—Typical log ends from the four test piles. Upper group shows that the water sprays were completely effective in preventing both the blue stain and checking which occurred in the logs stored without water sprays.

Comparing the Strengths of Timbers

By H. Kloot, Timber Mechanics Section

Publications, such as the Division's Technological Paper No. 25, in which are tabulated various mechanical properties of a large number of Australian timbers, are intended primarily to enable comparisons to be made between one timber and another.*

Generally, however, there is little merit in comparing in detail one timber with another unless such a comparison is related to some practical problem. For instance, to say that grey ironbark in the dry condition is two and a half times as dense, has three times the bending strength, three times the stiffness, and six times the toughness of Queensland kauri suggests that the latter is vastly inferior to grey ironbark. And so it is, if we are considering a use where strength alone is important. But this comparison means very little unless these two timbers are being considered as possible pole timbers, or for laboratory benches or for some other specific use. Usually the only purpose served by making a detailed comparison between two species is to determine whether one species can or cannot be used as a complete substitute for the other. For example, figures published for the mechanical properties of white stringybark indicate that this timber is so similar in its properties to yellow stringybark that the two species are virtually interchangeable for all practical purposes.

Usually the purpose for which a timber is required or likely to be required is known and comparisons of its properties with some other timber or timbers are made on a much more restricted basis. For example, marri (*E. calophylla*) has indications of being a suitable timber for general structural purposes such as house-frames, trusses, poles, sleepers, and the like, and it is logical to make comparisons between its properties and those of karri, jarrah, and other common structural timbers. Apart from physical and other characteristics, such as durability, that must be considered, an estimate of the suitability of marri for the purposes mentioned would be based on a comparison of the mechanical properties of modulus of rupture, to which most importance would be attached, modulus of elasticity, maximum crushing strength, and maximum shear strength. Some attention might be paid to some of the other properties but none would be considered as important as the four properties mentioned.

If, on the other hand, the suitability of marri for axe and hammer handles was in question—and it would appear that this species could be very suitable for the purpose—the impact properties of toughness or Izod are of prime importance when making comparisons with other axe handle timbers.

There are occasions when the hardness values of timbers are the only indication of relative merit, as for instance when resistance to indentation or resistance to abrasion are of importance.

A direct comparison between the properties of timbers can sometimes be misleading or at least can fail to give the full story unless backed by some elementary engineering knowledge. For instance, it will be found that the lighter timbers are generally weaker than the heavy ones, but it is probably not generally realized that weight for weight the lighter timbers are more efficient. To illustrate this let us take a rather exaggerated sample of comparison between ironbark and King William pine, both in the dry condition. Ironbark has a modulus of rupture of 27,000 lb/sq in and a modulus of elasticity of 3½ million lb/sq in. King William pine has a modulus of rupture of 10,000 lb/sq in and a modulus of elasticity of 1 million lb/sq in. If we require a 10 by 3 in. ironbark beam to carry a certain load over a given span, a 16½ by 3 in. beam of King William pine will also do the job as far as strength is concerned. If we are concerned with stiffness, then a 15 by 3 in. King William pine beam will do as well as a 10 by 3 in. ironbark beam. The point of this comparison lies in the fact that ironbark weighs 70 lb/cu ft whilst King William pine weighs only 24 lb/cu ft. Thus the ironbark beam in either case will be approximately twice as heavy as the pine beam.

* The property values given in such publications are not immediately usable for engineering design purposes unless modified as discussed in the Timber Engineering Design Handbook.

As mentioned, this comparison is rather an exaggerated one, so let us consider another example much closer to practice.

Ironbark, as a naturally durable timber, has been in common use for many years for poles. Hoop pine, a softwood, is not naturally durable but with modern methods of preservation can be treated to give it a service life, as a pole, equivalent to that of ironbark. In the green condition ironbark has a modulus of rupture of 17,300 lb/sq in, two and a half times that of hoop pine. An 8 in. diameter pole of ironbark would, on a strength basis, require to be replaced by an 11 in. diameter hoop pine pole. If the 1 in. thick sapwood of the ironbark pole is not treated, the comparison would be between a 10 in. ironbark and an 11 in. hoop pine pole. For transport purposes, the hoop pine would weigh perhaps 36 lb/cu ft, including the weight of the preservative, whilst the ironbark would weigh 75 lb/cu ft.

From these examples, it is hoped that the point has been made that a timber should not necessarily be discounted for structural purposes simply because it is relatively light and weak. Even balsa, one of the lightest and weakest timbers known, was used as a structural component in the famous war-time Mosquito bombers.

Imported Douglas fir was at one time the major framing and structural timber used in Australia and even today it is still used for this purpose in large quantities, particularly in New South Wales. It is natural, therefore, that Douglas fir should be one timber with which our local timbers are compared to decide their suitability for structural use at least as far as strength is concerned. Strange though it may seem, it does not yet appear to be universally realized, even among those used to handling timber, that there is almost no Australian hardwood commonly used for building purposes which is not the equal of or superior to Douglas fir. Certainly there are times when Douglas fir is preferred to our hardwoods for some particular purpose but this is never because Douglas fir is superior to hardwood on a strength basis. In point of fact, building regulations in various States allow the vast majority of hardwoods to be used in sizes smaller than those specified for Douglas fir. The main advantages of Douglas fir are that it is available in longer lengths and larger sizes, shrinks somewhat less, and is somewhat easier to nail than the hardwoods.

It must be made clear that the comparison just made is on the basis of either defect-free timber or with the hardwood having precisely the same defects as the Douglas fir. As hardwoods are generally freer from defects than Douglas fir, the comparison is even more in favour of the local timbers.

D.F.P. PUBLICATION ABSTRACTS

Editor's Note

Under this heading we will publish, from time to time, summaries of papers by officers of the Division which have appeared in trade or technical journals. In most cases reprints of the original articles are available, but only in strictly limited quantities, so it is intended to indicate under each item the type of profession, business, or trade from which requests for single copies only will be accepted. Those who have access to the journal containing the original article are asked not to apply for reprints. Australian and overseas research laboratories may apply, as usual, for any reprints they require.

Australian Research on Load Bearing Properties of Timber as a Basis of Grading by J. D. Boyd (Officer-in-Charge, Timber Mechanics Section), *Australian Timber Journal*, Vol. 29, No. 5, D.F.P. Reprint 547. Availability—limited to timber industry.

This paper was presented at the All Australia Timber Congress in 1963, and in introducing it, Mr. Boyd pointed to the necessity for the timber industry to study the needs of the potential buyer of timber and to market a product designed to meet those needs.

Timber may be graded to meet the needs of any one of a large number of end uses, but where it is destined for structural use, strength is a prime consideration and the related grading rules are framed to place limits on the nature, size, and location of defects that might affect the strength of the timber.

Grading rules designed to separate timber into parcels according to its load bearing properties are widely applied throughout the world. These are based on standard mechanical strength properties of clear timber, as determined by various research laboratories, including this Division. The strength for clear timber is then modified according to the defects in the commercial qualities. The effect of defects has been found to be somewhat different in our hardwoods from that in the American softwoods used generally as a basis of grading rules in the past. This was confirmed by research on jarrah scantling.

An extensive study was undertaken to check the feasibility of estimating the strength of radiata pine through the application of grading rules. Unfortunately, only a small proportion of the timber so graded could be designated as suitable for structural use. However, the result was quite unsatisfactory as strength tests showed that a large proportion of the rejected material had in fact a load bearing capacity above the minimum for the particular structural grade. These rules were therefore shown to be unsuited practically to the grading of this timber.

The study also indicated that generally a direct relationship between strength and stiffness exists. This is contrary to the principle previously accepted and used in structural design calculations.

This relationship indicated that a system of mechanical grading was feasible, and could provide the answer to the problem of assessing the load bearing capacity of fast grown exotic softwoods, and possibly also regrowth native timbers.

Several types of mechanical graders have been developed in America, but these are barely out of the experimental stage. An experimental machine has been built by the Division, but many difficulties must be overcome before a cheap reliable machine is available to industry.

Potentially, machine grading has many advantages over visual grading, not the least of which are better timber utilization and the guarantee of strength reliability. The latter point cannot help but promote the interests of timber in engineering construction.

Load bearing capacity as a basis for grading also applies to flooring, plywood, hardboard, and round timbers. In any timber structure, some or all of these are used as components of the structure, and the designer should be able to have equal confidence in their load bearing capacity as for the sawn timber.

The Fungus Herbarium

By N. E. M. Walters, Preservation Section

A COLLECTION of dried or preserved plant material is known as a "herbarium" and the dried collections are called "exsiccata". Questions often asked are: "Why do you keep a herbarium? Has it any real use?" This brief article concerned with the collection of fungi kept in this Division is intended to show the scope and importance of a large herbarium, and of this one in particular.

The first advantage of a collection is clear to anyone who wants to learn the names of the more obvious plants in his area: it is simply an easy way of recording the characteristic features of a plant. If for instance you know two different mint bushes but can't easily remember which is which, a small pressed sample of each with its name is as good a reminder as you can have. Now add their locality and collection date and assemble with them all the collections of these plants ever preserved and you have more valuable information: their geographical range, the type of situation they prefer (such as altitude, soil, climate, and shelter), their variability, and flowering season. If a plant belongs to the subkingdom of the fungi it will nearly always be found on or near another plant, usually a green one, and a comprehensive collection noting the "host" plant too, will reveal the host range, type of damage if any, and speed of attack.

As a fungus collection grows to include more and more species it soon transpires that some are restricted to one host plant (e.g. myrtle beech) and are therefore restricted to the localities of their host, while others will grow on several kinds of plants or even on any plant material at all. In the last case the fungus is often found everywhere, even perhaps in extremes of climate.

Another fact quickly emerges, that a given fungus will always produce a similar rot in all its different hosts. Further, its near relatives will often produce the same rot too. Hence, it is finally possible to say of some groups with more or less certainty that all the species produce a certain type of rot and that if a different kind of rot appears a careful examination will show that it was wrongly identified in the first place. Other groups however may possess species with a variety of different decay types. This suggests that the original bases on which the group was defined were faulty and that in years to come someone will be able to split the group into its "natural" classifications, i.e., based on true relationship. An example of this is the genus *Merulius* which contains the dry rot fungus. Some species produce a white rot, some a brown. Now it has become clear that we have really two or more unrelated genera lumped together because of accidental similarity in one respect, formerly believed important but evidently not so.

And so we learn that some characteristics are unimportant in founding a natural system of classification, while others give a true lead to relationship. Why take trouble to find the true relationships between fungi? Apart from the urge to investigate the unknown, whether clearly profitable or not, the natural relationships between plants allow fair predictions on the behaviour of any new species found. Further, a sound understanding of a group (possible only when all its more "disguised" relatives have been shown to be such), is necessary before accurate research can be conducted into such questions as their possible culture or extermination, their biochemical products (e.g. penicillin), how they affect their host plants and how this effect can be encouraged, modified, or completely halted.

The most important function of a fungus herbarium now stands revealed: it is the scientist's true text-book on the identity of the organisms that collectively make up "Nature". What text-book could record so exactly all microscopic characters in such a way that fresh information on the plants could be determined by further research a century after the specimens were first preserved? Indeed, to the scientist the herbarium is the ultimate text-book to which he always must refer in the last resort. If he has an adequate record of collection data, including the appearance of the fungus when fresh, and an adequate library containing information from the other herbaria of the world, he can confidently name a new species as such. The material he uses to base his description will henceforth be known as the "type" collection and will be used for comparison by other herbaria finding the species. The type specimen is, in fact, the standard description itself and its preserved characters overrule any errors its original describer may have made.

Similarly, type material elsewhere must be compared if a little-known species comes to light and has to be identified with confidence. No research on plants can be regarded as of the highest quality if the identity of the plants used is uncertain.

Comparison with overseas type collections has, unfortunately, been necessary for most of our common species too through an unfortunate but little-known facet of Australia's early history. In colonial days fungi were collected in large numbers both by private and professional collectors and sent back to Europe for identification and to stock European herbaria. Among these early collectors are such well-known pioneer names as Robert Browne, Cunningham, and Baron von Mueller. The recipients in England, France, Germany, and elsewhere named them and of course retained the invaluable type collections so that names like the Rev. M. J. Berkeley and M. C. Cooke appear frequently as the authorities for our fungus names. This means that by about 1890 nearly all our common fungi had been described and their type collections lost for ever to Australia. Although McAlpine at Burnley then turned the tide, he was too late. It has left the continent with a very small collection of its own type material and that scattered through a number of State or university herbaria, notably the National Herbarium in Melbourne. To prevent further losses it is of vital importance to Australia that herbaria here are built up to world standard in each botanical section by obtaining duplicate material (collected from the type localities) that has been carefully compared with the types in Europe and thus authoritatively named. Until this has has been done we are not in a position to say certainly that a given specimen is a new species and it too may be sent away for accurate comparison in larger herbaria.

The Forest Products herbarium of fungi is now a valuable collection, even though it is mainly restricted to groups of fungi found attacking dead wood. (There are very few herbaria in the world that have no limits on their scope at all.) It contains a number of type collections and in its 5000 collections are included all the commoner species as well as many rare ones. There are about 500 named species within about 150 genera. Of course there are hundreds of collections still unnamed, awaiting critical examination.

Nearly all the specimens in the collection are dried and stored in boxes with naphthalene flakes. Only a negligible fraction are pressed or pickled. The records include a card system recording collection data and subsequent observations (e.g. under the microscope). There is also an invaluable cross-reference card system which will permit a searcher to find all the fungi of a given locality, all those of a given host, or all those found on a given structure (e.g. a boat), and so on. This provides a series of built-in text-books with an infinite range of titles, such as "Fungi Occurring on Arsenic Treated Timber", "Fungi of the Southern Coastal Areas", or "White Rotting Fungi of Radiata Pine".

A vital accessory to the Herbarium of a research body such as this is a collection of living cultures, obtained as often as possible from named specimens in the herbarium. These cultures are necessary to test the natural durabilities of timbers or the effectiveness of timber preservatives.

They also add information on fungus growth requirements and so permit the elimination of decay at its source. As a culture can only be identified from its fungus fruit body, the culture collection and herbarium are mutually dependent for full effectiveness.

The last requirement to make the herbarium an effective tool is to ensure that overseas authorities know of its existence and contents. By using it they can confirm identifications and can often supply missing specimens. They can also work over specimens within their own special studies to bring them to a high state of authority. This is the reason for our recent Herbarium catalogue. So the Division will continue in the future to act as a link between the man who is troubled with a decay problem, the man who likes to collect fungi in the field, and the world's mycological authorities.

DONATIONS

THE following recent donations are gratefully acknowledged:

South Australian Hardwoods Ltd., St. Peters, S.A.	£25	0	0
Bond & Rundle Ltd., Rotorua, New Zealand	£5	0	0
Tasmanian Timber Association	£500	0	0
Perfectus Airscrew Co., Newport, Vic.	£15	15	0
V.I.A., Airport West., Vic.	£52	10	0

Cooperation in Research

Since 1932, the Division has been permitted by the Victorian Country Roads Board to use as a test site an area adjacent to the Hume Highway between Benalla and Glenrowan, in north-eastern Victoria.

Initially, the site was only for field tests of pole stubs, both treated and untreated, but since 1945 various other tests have been carried out, including some on small stakes received from overseas.

During 1963, the Country Roads Board completed a major realignment of the Highway in the vicinity of the test plot which is now fully exposed to view from the road. Because of this, and because a recent inspection revealed that a substantial number of stakes from one of the small specimen tests had been removed, it was decided to fence the site.

Immediately this was made known, Mr. Alan Bailey of Bailey Bros., Glenrowan, offered to donate all posts and rails required for the fence. These were supplied in *Pinus radiata* "tanalised" in Bailey Bros.' own fence post treating plant. The Cyclone Co. of Australia offered to donate and fix "Standard 6 in. × 28 in. Ringlok Sheep and Lamb Fence" around the site, when the posts had been set up.

The Country Roads Board agreed to clear a fence line around the site, and the State Electricity Commission of Victoria arranged to drive the posts, using equipment borrowed from the Divisional Engineer of the Post-master-General's Department. Subsequently, the Country Roads Board cleared a firebreak around the plot which the Winton Rural Fire Brigade burned off without damage to any of the specimens.

We are taking this opportunity of offering our thanks for the varied help and cooperation we have received from so many organizations in this project.

Printed by CSIRO, Melbourne

CSIRO

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REGISTERED IN AUSTRALIA FOR TRANSMISSION BY POST AS A PERIODICAL

NUMBER 305 MARCH 1964

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Eliminate Those Squeaks

By W. D. Woodhead, Utilization Section

DURING THE summer months some householders are concerned about creaks and the appearance of cracks in wooden strip floors. These annoying features are more apparent at this time of year because loss of moisture during the hot weather results in some shrinkage of the timber. Creaking frequently disappears when more humid conditions return at the end of the summer, and during winter gaps in flooring close up to some extent.

The following notes outline some of the methods which can be employed to eliminate creaking; a later article will discuss methods of filling gaps.

Creaking may be caused by movement in the subfloor members, movement between the joists and floor boards, or by the rubbing of adjacent boards. If the cause is movement in the subfloor caused by sinking of stumps, or gaps between joists and bearers, the provision of strengthening members or packing pieces in the spaces may solve the problem. Similarly, if shrinkage of a joist has resulted in a gap between the boards and joist, a packing strip will eliminate movement. In these instances examination should be made to ascertain whether the movement is associated with any major structural defects. In old floors it is not uncommon to find that nails have pulled out a small amount, leaving a narrow gap between the board and joist; renailing of the boards affected will provide the remedy.

Squeaking caused by rubbing of the tongue and groove of adjacent boards between the joists is not uncommon. Apart from being the result of broken boards or missing nails it is sometimes the result of the timber having been machined at too high a moisture content, when subsequent drying causes the dimensions of the profile to change; alternatively, poor milling may have resulted in a faulty profile. Pressure applied when the boards are cramped and nailed during laying prevents movement, but slight subsequent shrinkage may reduce the pressure to a degree which is just sufficient to cause slight movement and creaking. Complete breakage of a portion of the tongue may also cause movement to develop.

Skew nailing adjacent boards through the tongue and groove between the joists is found to be effective in preventing relative movement (Fig. 1). A $1\frac{1}{2}$ in. No. 14 gauge nail is suitable for most flooring of $\frac{3}{4}$ or $\frac{13}{16}$ in. thickness. Predrilling of the boards, especially with the harder timbers, facilitates the nailing.

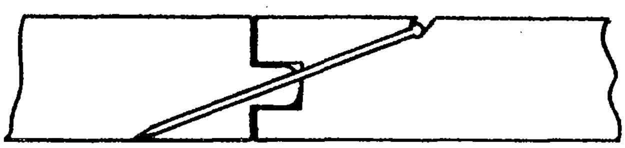


Fig. 1.—Skew nail through the tongue and groove of adjacent boards.

Where wooden floors are to be covered, nailing may be done from the upper surface. Providing the heads are punched well in and the holes filled, the nails do not detract greatly from the appearance of a polished floor. However, appearance is important and it may be desired to nail from the underside, providing sufficient space is available for working.

Another method, rather more expensive, may be preferable for floors in which there is greater movement in the profile. This involves screwing a 1 by 1 in. batten across the underside of the boards midway between the joists, as shown in Figure 2. One or two screws per board may be used, depending on their width and the amount of movement present.

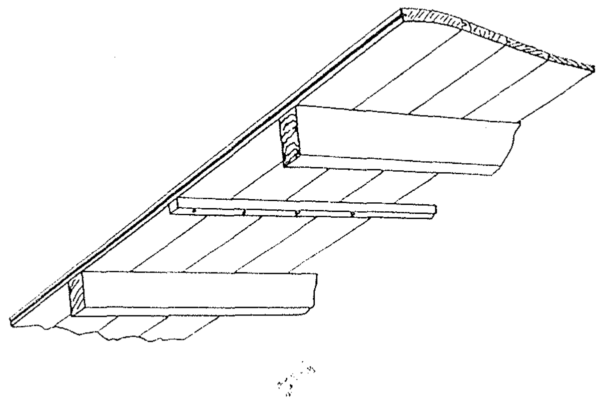
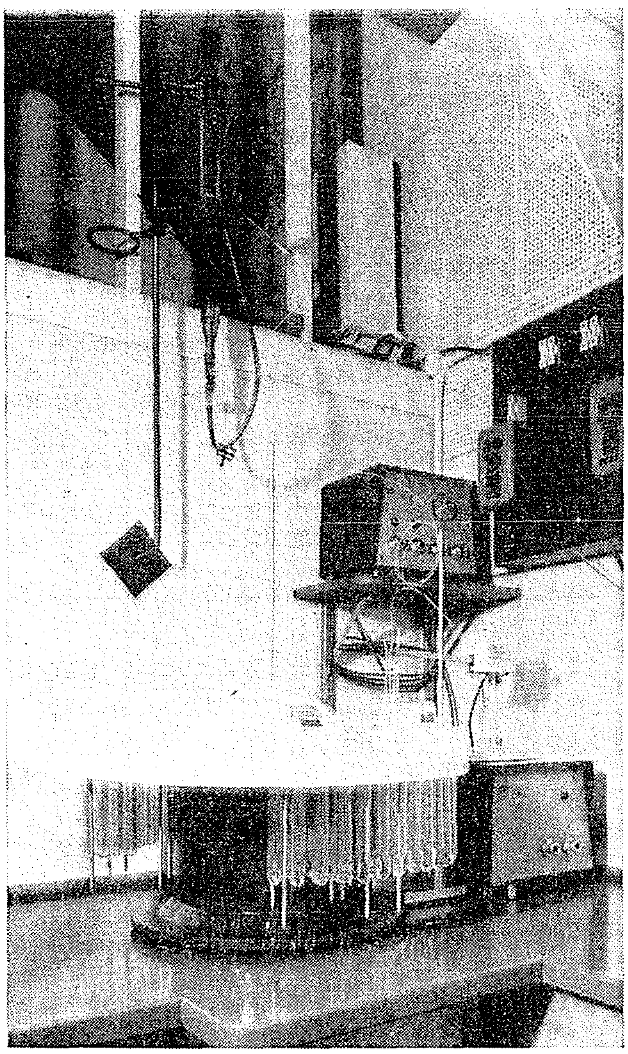


Fig. 2.—1 in. by 1 in. batten screwed to underside of boards midway between joists.

Wood Extractives



ALTHOUGH MANY of the properties of wood are determined by characteristics of the cell wall, the contents of the cell do at times have a marked influence on utilization and properties.

Many timbers, such as jarrah (*Eucalyptus marginata*) and red iron bark (*Eucalyptus sideroxylon*, contain unusually large amounts of cell contents which block the cell cavities. These contents, or extractives, are largely responsible for the resistance to decay of these timbers. Other members of the genus *Eucalyptus*, as well as the two species referred to, often have a high acidity, and in addition, contain components which react strongly with iron. This, of course, is troublesome in many aspects of utilization and, therefore, care must be taken to avoid development of strong tannin stains.

The great durability of wandoo (*Eucalyptus redunca*) probably results from the presence of components in small amounts in these cell contents. In various species, both hardwoods and softwoods, small amounts of components in the cell contents are responsible for deterioration of paints and varnish films, different types of stains, some of the difficulties associated with the use of adhesives, corrosion of metal fasteners, dermatitis, and sometimes major problems in the pulping industry.

In order to isolate these substances in quantities sufficiently large for chemical examination, it is necessary to make use of equipment such as that shown in the illustration. This fraction collector can be adjusted in a number of ways and can be left to operate unattended for long periods. The various fractions are examined to assist in the determination of the chemical composition of the components responsible for the troubles referred to earlier, and a knowledge of this composition will, it is hoped, indicate whether it is possible to control their synthesis in the living tree.

D.F.P. PUBLICATION ABSTRACTS

Seasoning Research in Australia and its Application to Industry, by G. W. Wright (Officer-in-Charge, Timber Seasoning Section), *Australian Timber Journal*, Vol. 29, No. 5, D.F.P. Reprint 548. Availability—industry, technical school instructors.

IN THIS PAPER, also presented at the All Australia Timber Congress in Adelaide in 1963, the objectives of timber seasoning research are stated and an indication is given of the progress that has already been made in Australia in this field.

The current major seasoning projects being carried out at the Division are covered in some detail. These are as follows:

Predrying.—An economic substitute for air drying in areas where this is slow or where space considerations are important. The predryer is a large-capacity, low-cost drying chamber with forced air circulation and low temperature heating. Predryers have resulted in faster throughput of timber and current work is aimed at improvements in both techniques and equipment.

Presteaming.—It has been found that a steaming treatment of green timber can materially speed up the process of drying of some species. A considerable amount of investigation has been necessary to determine the optimum conditions for the treatment, the economics of the process, and its effect on timber properties.

Air Seasoning.—Surveys have shown that air drying practices in Australia are often grossly inadequate, and this is having a serious effect on the overall economics of timber drying. Current research is aimed at providing a better technical basis for the process, and hence improving both the economics and the product.

Equilibrium Moisture Content Survey.—The main object of this work is to enable the probable equilibrium moisture content reached by seasoned wood anywhere in Australia to be predicted from a knowledge of meteorological data for the area concerned. This is an important need of industry in order to avoid problems due to shrinkage and swelling, especially where timber or items manufactured from timber are used in a climate very different from that where they were originally dried or manufactured.

Dimensional Stability.—In order to prevent, as far as possible, trouble due to the movement of wood with changes in moisture content or from drying stresses, various methods of dimensionally stabilizing wood are under investigation. These include surface coatings, chemical agents, and materials which penetrate the wood. The ideal solution would be a material which could be used to treat green timber to prevent shrinkage on drying. The economic advantages of such a process are obvious.

Collapse.—Although the reconditioning process has eliminated a great deal of the trouble due to collapse, it is clear that an enormous amount of timber is still being wasted owing to incomplete recovery. Further work on this problem is aimed at improving the process, or controlling (or even preventing) collapse by other means.

Drying of Pole Timbers.—This is of particular importance in view of the desirability of increasing the number of suitable pole species, and the necessity for keeping prepreservative treatment costs to a minimum. Other projects include the development of seasoning plant, equipment and materials, special methods of drying, quality control, and the prevention of degrade in green and dry storage.

Future Seasoning Research.—The paper concludes with references to the changing pattern of forest utilization in Australia, the extent to which developing changes in the availability of timber and processing methods have introduced research problems of a broad regional nature, and directions in which future seasoning research should move.

Quality Control of Timber and Structural Units by J. D. Boyd (Officer-in-Charge, Timber Mechanics Section), *Australian Timber Journal*, Vol. 29, No. 7, D.F.P. Reprint No. 556. Availability—structural timber fabricators, design engineers.

THIS PAPER highlights the fact that, if the timber engineering industry is to consolidate its early successful growth, greater attention must be paid to the quality of structural units and their components.

This applies not only to the main item, the timber, but also to the material and manufacture of gussets and webs, to gluing where applicable, and to the general standard of manufacture of the whole unit.

In the case of timber quality, the importance of grading for strength is emphasized. This can differ materially from grading for appearance, and the so-called merchantable grades cannot generally be regarded as safe for engineering uses.

The quality of gussets and webs of plywood, hardboard, or similar materials must also be carefully controlled to ensure satisfactory service of the complete unit. The incorrect grade of plywood, or incorrect use of hardboard can seriously affect the performance of the structural unit.

Metal gussets or connectors can have a wide field of satisfactory application, but should be checked carefully for suitability of metal thickness, tooth or prong shape, spacing of punched nails, etc.

Gluing as a method of joining timbers is more difficult to control, and very strict specification and supervision are necessary to ensure a satisfactory joint.

Control of quality in manufacture is the final, but probably most important, aspect discussed and various examples of poor practice are cited to indicate the care which must be exercised at this stage.

An indication of developments in regard to mechanical grading is given and the paper concludes with an indication of the desirability for manufacturers to provide a "product service" to ensure proper use of structural units.

Towards Stiffer Saw Teeth by D. S. Jones (Utilization Section), *Australian Timber Journal*, Vol. 29, No. 8, D.F.P. Reprint 555. Availability.—saw manufacturers, sawmillers, and saw doctors.

DETERMINATION of the best tooth profile is often a problem in the sawmilling industry, and several factors have to be considered in arriving at a solution.

One factor not usually considered, but which has been shown by recent investigations to be important, is tooth stiffness. Unfortunately, provision of adequate stiffness often conflicts with other requirements such as greater hook angle and gullet depth, and also the use of thinner saws.

Details of some experimental work and results are given and, in conclusion, the point is made that the studies have established the principle to be employed when improving tooth stiffness is to reinforce the front of the tooth where stress is a maximum, rather than the back. A tooth profile of high stiffness and low stress is suggested, but it would need to be supported by sawing studies before a firm recommendation for its use could be made. Further work is proceeding on this project.

Wear Resistant Tips for Saw Teeth by D. S. Jones (Utilization Section), *Australian Timber Journal*, Vol. 29, No. 8, D. F. P. Reprint 544. Availability—sawmillers, saw manufacturers, saw doctors, and wood processers.

BLUNTING OF SAWS is a serious problem when sawing certain species of high density or containing silica. This is particularly evident in North Queensland where several such species form quite a high percentage of the timber sawn. Certain sheet materials such as hardboard, particle board, and plywood also tend to dull saws rapidly.

Continuing interest is therefore shown in the use of wear resistant tips composed of such materials as tungsten carbide, hard alloys, chromium layers, and high speed steel inserts. Other techniques are also being developed to overcome the problem.

This article summarizes the essential facts concerning the most commonly used wear resistant materials, and it could be of considerable assistance to sawmillers handling species that cause blunting problems.

Printed by CSIRO, Melbourne

CSIRO
Forest Products Newsletter
DIVISION OF FOREST PRODUCTS, CSIRO, P.O. BOX 310, SOUTH MELBOURNE, S.C.5, VICTORIA
REGISTERED IN AUSTRALIA FOR TRANSMISSION BY POST AS A PERIODICAL

NUMBER 306 APRIL 1964

1964##306

The Knife Testing of Plywood with a Small Pneumatic Chisel

By P. J. Moglia, Plywood and Gluing Section

IN THE TESTING of plywood with the standard knife, as described in the Australian Standard Specifications A.S. 0.6 and A.S. 0.59, certain criticisms of the method are immediately apparent to the operator. One is the necessity of providing a stop on a bench sturdy enough to withstand the force needed to perform the test; another is the difficulty of providing for the testing of large sheets which may require a special bench. The effort needed to pierce the face veneers in hard species or thick-faced assemblies rapidly leads to operator fatigue and tends to reduce the amount of testing in industry to a miminum

Certain mechanical aids aimed at reducing the effort involved in testing have been developed but, while these are of value, they are limited in the range of horizontal travel and in the angle of tilt of the knife. Also, they are not readily adaptable to very thick assemblies unless a height adjustment is incorporated, they cover only a small area of a panel, and suffer badly by virtue of their fixed location.

An instrument has been developed in this laboratory which has none of these shortcomings. It is a small pneumatic hammer with a modified chisel which is light and is easily held and guided with one hand. The hammering action can be started and stopped at will by means of the thumb lever incorporated and the range of portability is restricted only by the length of the air line. In our installation this line is a length of nylon pressure hose of negligible weight and only $\frac{1}{4}$ in. outside diameter.

The instrument is much easier to use than the standard knife and, since no force is required, it eliminates operator fatigue. It needs no bench or bench stop for the specimen. Testing over different areas of a panel is much easier and, if desired, the tool can be directed to the edge of the glue line. The danger of injury by the knife is greatly reduced, and it is possible to hold a test specimen in one hand and perform a test with the tool held in the other.

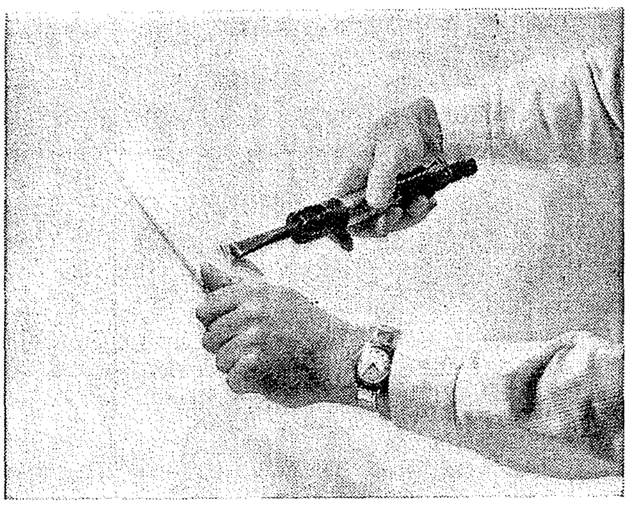
With a little practice an operator has no difficulty in finding the glue line, and when found, the hammering action can be stopped by releasing the thumb trigger and the actual test completed in the usual way with the tool "dead". Judgment of the force needed to prize the glue line open is not impeded.

The tool used in this laboratory is a Broomwade Light Duty Chipping Hammer Type B X 78A*. It is a small pneumatic hammer weighing about 2 lb. It is approx. 8 in. long and can deliver 4500 blows per minute with a supply pressure of 80 lb/in^2 and a free air consumption of 6 cu ft per minute.

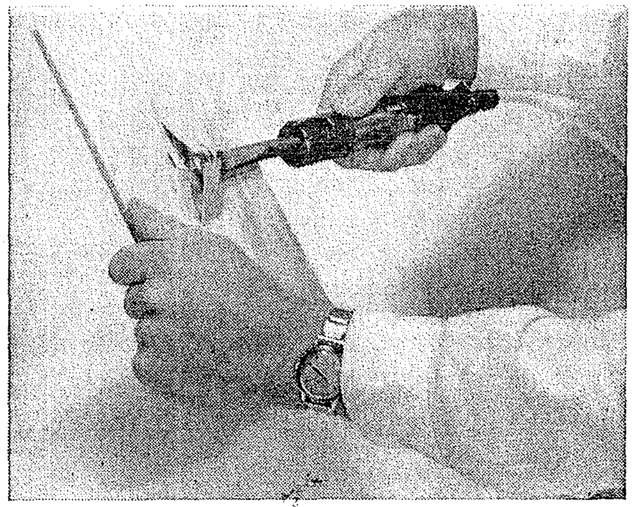
* Other manufacturers of pneumatic equipment may also have light hammers suitable for this work e.g. The Consolidated Pneumatic Tool Co. (Aust.), and Ingersoll-Rand (Aust.) Pty. Ltd.

It can accept a variety of chisels. They are captive and can be indexed to any of six positions. We used the standard ½ in. flat face chisel and modified it to conform to the profile of the standard testing knife; it was then rehardened and tempered and projects 4 in. beyond the body of the tool. To reduce the drag of the air hose, standard ¼ in. nylon flexible pressure tubing, 1000 lb grade, and nylon compression fittings have been used.

Previous publications on the subject of knife testing have stressed the need for the operator to "feel" the glue line and have suggested that a mechanical chisel would not permit this. This is true to a degree but with only a little experience an operator does in fact develop a sense which permits him to find the glue line and follow it.



The hammering action is used to penetrate the outer veneer.



The veneers are levered up with the tool "dead".

The existing Australian Standard Specifications A.S. 0.6 and A.S. 0.59 contain instructions describing the use of the standard testing chisel, but they differ in their direction regarding the degree of importance to be attached to the force needed to separate the veneers. The new Australian Draft Standard (Doc. 602–1961) now being prepared, instructs the operator to assess the test only on appearance and suggests that the value of assessing the ease of finding the glue line or of the force needed to separate the veneers is of little value.

The use of a pneumatic hammer of this type eliminates almost all the effort of knife testing, permits tests to be made on unsupported panels in any position, is less dangerous, and yields test results equally as reliable as those obtained with the hand knife.

The Strength Grouping of Structural Timbers

By H. Kloot, Timber Mechanics Section

THERE ARE some 80 to 100 species of timber commonly used in Australia for structural purposes, and altogether perhaps some 200 to 250 different species find their way into structures of various types from time to time. To obtain sufficient detailed information on such a large variety of species in order to provide working stresses for each individual species would be an enormous, if not completely impracticable task.

To overcome the problem, we have adopted in Australia for the past 25 years a grouping system whereby structural timbers are placed in one of four strength groups, A, B, C, or D, on the basis of their strength properties. Examples of species in these groups are the ironbarks and tallowwood in Strength Group A; karri, blue gum, and salmon gum in Group B; jarrah, W. A. blackbutt, mountain ash, messmate stringybark in

Group C; Douglas fir and cypress pine in Group D, to mention a few of the common timbers. The advantage of this system to the timber trade is of considerable significance. It obviates the need for stocking a wide variety of timbers that might be ordered if particular species were to be specified by the buyer, and this greatly simplifies the marketing of structural timbers.

To the user, the advantages of strength grouping are twofold. Firstly, to decide in which strength group a timber belongs it is not necessary to carry out anything like the amount of testing required to determine working stresses for a particular timber. This means that useful information can be found out about a lot of species in a reasonable time.

The second, more important advantage, is that the architect, engineer, or builder does not have to rely on the ready availability of one particular species. Instead of specifying one species by name, the designer simply specifies that the timber to be used shall be of this or that strength group. It is then open to the builder to obtain any suitable timber of the strength group which is available. Arising from this is the added advantage that a structure built in Victoria of, for instance, messmate stringybark does not have to be completely redesigned if a similar structure is required in Western Australia. It is only necessary to find a readily available Western Australian timber, such as jarrah, of the same strength group as messmate.

For each strength group, a full set of basic working stresses is available so that the designer does not really require an intimate knowledge of the timber that is eventually used to be able to design an economic and satisfactory structure.

When information on the strength properties is sufficiently precise, working stresses can be derived for an individual species. For maximum efficiency the designer would use these, rather than the working stresses for the strength group to which the species belongs.

A table of the strength grouping of the timbers commonly used for structural purposes in Australia may be obtained on request, from the Chief, Division of Forest Products, 69 Yarra Bank Road, South Melbourne.

D.F.P. PUBLICATION ABSTRACTS

Load Distribution in Wooden Floors subjected to Concentrated Loads by N. H. Kloot and K. B. Schuster (Timber Mechanics Section), D. F. P. Technological Paper No. 29. Availability—architects and engineers.

If, before the wooden floor is laid in a house, someone stands on one of the floor joists, all his weight is carried by the one joist. However, once the flooring is laid, the weight of a person standing in the same position as before, i.e. immediately above a joist, is no longer carried only by that joist. In fact, in floors of usual construction, such a joist would only be carrying perhaps 50 to 60% of the weight, the remainder of the load being distributed by the flooring to adjacent joists.

This load distribution effect is fairly well known. For example, tradesmen working above the ceiling frequently take advantage of the principle by using crawl boards laid across the ceiling joists. This is not only convenient as they do not have to step from joist to joist, but also it distributes their weight over several joists and so reduces the possibility of damage to the plaster ceiling beneath.

The results of an investigation of the load distribution under concentrated (point) loads on timber floor systems have recently been reported in this paper. The conclusions reached are that in respect of strength and stiffness, the nailing of the flooring to the joists and the joists to the bearers has little effect and, for the practical purpose of deciding the necessary sizes or thicknesses, both joists and flooring could be considered as simply supported beams.

The paper shows how the load-sharing may be calculated from simple engineering theory with a simple empirical allowance being made for the number of floor boards effective in distributing the load. Although not specifically discussed in the paper a greater degree of certainty and efficiency in the engineering design of timber-framed structures, particularly dwellings in which load-sharing between members is common, should result from the findings of this investigation.

Timber Laboratory Building

IN EARLIER issues of this newsletter (April and September, 1962), mention was made of the new timber building to be constructed for the Division adjacent to its existing buildings in Yarra Bank Road, South Melbourne.

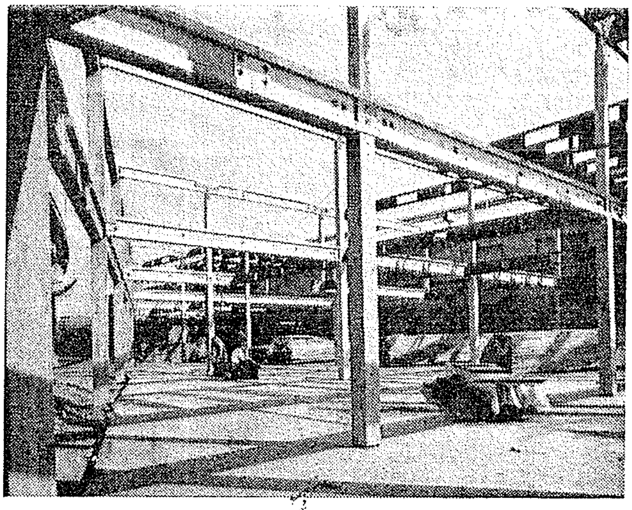
The poor foundation conditions of the site would have required a very expensive foundation system for a conventional building and after considering designs in steel and concrete and timber, a timber structure was chosen because of its special advantages.

Work has now commenced on the building which will house laboratories and offices for three of the Division's research sections.

The building was designed with clear spans of 24 ft between columns. The main framework will be entirely of timber, including columns, main floor beams, and floor joists and flooring. Because of the light weight of this timber structure, it would have been practicable to build five storeys without piling, whereas a concrete building or a combined steel and concrete construction would have required piling for three storeys. Even in this type of two-storey timber building, as at present planned, it is possible to provide some 15,000 sq ft of floor area in a conventional type building.

The main beams which have been fabricated by gluing are in the form of a double I-section 18 in. deep. Flange sections of the beams are seasoned mountain ash and the double webs are of radiata pine plywood in $\frac{1}{2}$- and $\frac{3}{4}$-in. thick sheets, scarf jointed to the full length of the beams. The flooring joists span 24 ft and are made up of green hardwood flanges with discontinuous, hardboard webs; they are extremely lightweight and when braced by the flooring and ceiling they will be quite stiff. Columns are glued–laminated from thin boards of moderate grade to provide the required cross section and quality in seasoned timber, and they will be protected from fire with a sheathing of timber treated with fire-retardant chemicals.

Wooden buildings are sometimes regarded as fire hazards. However, this criticism of structural timber is generally quite unjustified, as the real fire danger with any building arises from the usual combustible contents, and safety in large buildings can be ensured only



New building in course of erection.

through the provision of appropriate fire-fighting equipment, proper design of exits, and use of fire barriers. With these essential factors in mind, it has been possible to design this timber laboratory and office building to give very ample fire protection including a 1-hour fire rating for all the main structural members including the floor and the roof system and the columns.

In addition to their structural potential as described, plywood, wood, and wood-base materials can be exceptionally attractive. For these reasons they will be featured for the partitioning and finishing trim of this building. The whole structure promises to be unique, cheap yet outstandingly functional, highly durable, and attractive.

DONATIONS

THE following donations were received by the Division during February:

Hickson's Timber Impregnation Co. (Aust.) Pty. Ltd., Wood preservative and poles to the value of	£140 0 0
Ray & J. Page Pty. Ltd., Melbourne	£5 0 0
R. M. Pollock, Melbourne ..	£2 0 0
G. K. Wilson, Camden, N. S. W. ..	£1 0 0

Printed by CSIRO, Melbourne

CSIRO

Forest Products Newsletter

DIVISION OF FOREST PRODUCTS, CSIRO, P.O. BOX 310, SOUTH MELBOURNE, S.C.5, VICTORIA

REGISTERED IN AUSTRALIA FOR TRANSMISSION BY POST AS A PERIODICAL

NUMBER 307 MAY 1964

1964##307

The Pressure Preservative Treatment of Green Radiata Pine

By P. Rudman, Preservation Section

THE TREATMENT of air dry radiata pine with a fixed waterborne preservative is now accepted as a means of producing a durable timber that may be used in a variety of situations. The process has been in operation in Australia for seven years and few problems have been encountered. Nevertheless, the present price of preservative-treated timber, particularly dry treated timber, relative to that of naturally durable timbers or to materials competitive with timber discourages its use in some cases. Any reduction in costs associated with treatment, therefore, would help to make preservative-treated radiata pine more competitive. For the convenience of this article, the costs which have to be considered may be divided into four categories:

- Basic cost of green timber
- Cost of initial drying to 20–25% moisture content
- Treatment costs
- Cost of re-drying if necessary.

Of these costs, the first is common to both treated and untreated timber. The second, third, and fourth items will be studied in a little more detail in an attempt to find ways in which savings may be made.

Cost of Initial Drying

This is quite an important item and involves three aspects: the operational cost of drying from green (150–250% m.c.) to a suitable moisture content for pressure treatment (20–25% m.c.), the tying up of capital, and the need for ground space. The distribution of costs depends on whether air drying or kiln drying is practised.

Treatment Costs

Treatment costs may be subdivided conveniently into three parts, the cost of the salt, the cost due to the impregnation techniques employed, and the cost of the plant required. If this discussion is confined to the use of the conventional preservative salts then, because of preservation retention requirements, the salt item is reasonably constant. The cost due to techniques and to plant requirements may be varied to some extent.

Re-drying Costs

Drying of treated timber is not always necessary but, if it is, it represents an extra cost. Waterborne treated timber takes longer to dry than green timber because the cells are usually saturated with water, thereby slowing down the movement of water vapour. Any speeding up in this process, and/or reduction in the handling charges should help to reduce costs considerably.

From a study of the three major cost items mentioned, it was considered that savings could be made if pressure treatment with a preservative of green or semi-green small sized timber could be successfully carried out. Then, if a dry product were required, the treating cylinder could be used in effect as a kiln for a rapid but incomplete drying, and only the final stages carried out in a conventional kiln.

P. radiata sapwood, when green, varies in moisture content from about 150 to 200% and sometimes higher, the heartwood being nearer 40 to 60% m.c. Such green sapwood is usually almost saturated, whereas the heartwood is far from being saturated. To obtain satisfactory retentions of preservative, assuming no penetration problems, the sapwood moisture content would have to be lowered by 50 to 60%, though the heartwood moisture content would be satisfactory without further drying.

An experiment was planned in which it was proposed to take inch-thick green sapwood boards of radiata pine, to remove rapidly some of the moisture of these boards by a steam and vacuum treatment, and then to pressure treat these semi-green boards with a wood preservative. It was also planned to re-subject some of the treated boards to a further steam and vacuum drying cycle followed by transfer to a normal kiln, in order to study the effects of a preliminary rapid drying.

The *P. radiata* sapwood was purposely used green, in this case 150–160% m.c. (In commercial practice green timber would rarely be used and this would be an advantage.) The green *P. radiata* was put through a number of steam-vacuum and preservative treatment schedules, and it was found that a half-hour steaming (230–260°F) of the one-inch sapwood boards (to heat the boards) followed by a half-hour vacuum (to boil off water from the sap) followed by a repeat of this cycle gave an undistorted board of about 90 to 110% moisture content. This fall in moisture content was not uniform across the board, but was greater on the outside than in the core.

These boards were then pressure treated at 200 lb/sq in. with a wood preservative. Again, the best results were not obtained with a single pressure treatment but with a cyclic treatment in which the pressure was released twice for five minutes each time during the one hour pressure treatment schedule. This ensured that adequate mixing of the preservative and sap remaining in the board took place, particularly in the core. Using a 3·2% solution of preservative the average loadings (at the core) in 1-in. sapwood boards was 0·16 lb/cu ft, whereas a cross-sectional loading of 0·4 lb/cu ft was obtained. The heartwood core loading was considerably higher, being approximately 0·6 lb/cu ft.

The satisfactory retention and distribution of preservative obtained and the obvious savings in costs which would apparently ensue from use of a schedule of this type, certainly warrant a closer look at the method under conditions which more closely approach those used in commercial practice.

It is not expected that a commercial plant will be able to use such short schedules, but two treatments daily should be quite possible. Nor is it suggested that 3·2% solutions of preservative be used, this being only to illustrate the principle; actual solution strength would have to be determined in practice by studying the core and cross sectional loadings of the average board, that is a board containing both sapwood and heartwood.

Those boards which were given a further steam and vacuum drying followed by the normal kiln schedule showed no distortion, and the rapid fall in moisture content from saturated to about 50% below saturated also appeared most satisfactory.

There are three disadvantages inherent in the method. Firstly, there is the possibility of greater variation in retention, both within a board and between boards. This may be associated with either uneven distribution of moisture in the green board and/or uneven distribution of moisture after partial drying. This results in an uneven pick-up of preservative and, to ensure that no board falls below the accepted minimum retention, some over-treatment of the majority of boards will be necessary.

Secondly, the capital costs of installing a treatment cylinder are higher than for the conventional cylinder because of the need for a live steam supply and the introduction of steam outlets within the cylinder. Those timber suppliers already having a steam supply are in a more favourable position, of course.

Thirdly, the kick back of sap into the preservative solution may interfere with the chemical composition of the mixture and necessitate more frequent analyses.

Despite these disadvantages, the method holds some promise for decreasing operating costs and the final product could well be quite satisfactory for a variety of uses, such as weatherboards, barge and fascia boards, stops, flooring, plinths, storm sashes, external architraves, concrete formwork, and, with certain reservations, for the smaller sized scantlings.

In conventional pressure treatment of *P. radiata* the heartwood tends to be under-treated, whereas with the present method it tends to be over-treated. This is more desirable from the consumers' point of view.

The Resistance of Timber to Chemical Attack

By W. D. Woodhead, Utilization Section

INDUSTRIAL PROCESSES frequently require the use of timber which is able to withstand attack by corrosive chemicals. Components for which such timbers are used include vats, tanks, and other liquid containers, filter presses, racks, ducts, chutes, and stirring paddles. Timber is also used for structural members in roofs and other places in chemical plants which may be subject to acid vapours.

These service conditions are extremely conducive to the breakdown of most commonly used structural and lining materials. The resistance of wood to a wide range of chemicals, including hot and cold solutions of neutral or acid salts, dilute acids or alkalis, and organic substances, makes it a valuable material in plant construction.

Timbers vary considerably in their resistance to chemical attack, but many have the ability to maintain their strength satisfactorily under the conditions of service mentioned above and are used in preference to cast iron and ordinary steel, which have a very limited service life, especially under acidic conditions.

Softwoods are generally recognized as being more resistant to chemical attack than are hardwoods. However, some hardwoods of high density are found to be satisfactory because their lower natural resistance to chemical attack is compensated by their dense impervious structure. Wood may be used in contact with practically all common solutions at reasonable concentrations and temperatures. Hydrochloric acid up to 5% concentration, sulphuric acid up to 20%, and most dilute organic acids have no appreciable effect on wood at normal temperatures, although extractives may be leached out of some timbers, discolouring the chemicals. Glacial acetic acid attacks wood even at normal temperatures. Higher concentrations and elevated temperatures cause more rapid decomposition and loss of strength.

Timbers are less resistant to alkalis than they are to acids. Low concentrations of the caustic alkalis can be withstood for a limited period at normal temperatures but higher concentrations cause swelling of the wood and loss of strength. Wooden containers are not often used for the storage of alkaline solutions.

Some chemicals, in particular iron and copper salts, cause staining on timber even in minute concentrations. The reduction in strength due to copper and many other chemical stains is negligible but the presence of iron or iron salts can, with time, produce considerable strength loss.

In general, the severity of chemical attack depends on the moisture content as well as the actual chemical in contact; where the timber and chemicals are damp the effective concentration is high and attack can be rapid. Galvanized or non-ferrous metals should be used when moist wood is in contact with metal components. Under dry conditions resistance to attack is very high. Alternate wetting and drying of the timber causes very rapid reduction in strength due to penetration of the chemicals into checks in the wood. In order to minimize subsequent movement and checking, dry timber having a moisture content of from 12–15% should preferably be used. Vats and tanks which will be used to contain liquids at normal temperatures may be constructed of green or partially dried timber but if the liquids are to be heated it is essential to use dry timber. Failure to do this results in evaporation of moisture from the outer surface with associated shrinkage and warping of the timber and subsequent leakage. If partially dried timber is to be used it is advisable to avoid those species which are prone to collapse during drying.

Timber is frequently used in exhaust ducts for flue gases and for structural members over electrolytic tanks. Such gases and vapours may contain sulphurous acid, sulphur dioxide, or chlorine. These are extremely corrosive to metals; they are much less so to timbers.

Surface breakdown of the timber may occur where there is abrasion caused by solids in contact with the wood, by particles held in suspension, or by the rapid agitation of solutions; under these conditions a dense timber is preferable to a light one as the surface is more resistant to abrasion.

Decay is often a source of breakdown and containers for liquids or hygroscopic solids may have a short service life due to this cause rather than to chemical breakdown. The choice of a durable timber can assist in this regard.

Methods of Improving Corrosion Resistance

Most synthetic resins and waxes are resistant to attack by chemicals in common use and can be used in various ways to extend the service life of wooden components.

Surface finishes applied in the form of coatings are of limited value, especially where moisture is present or where the surface is subject to wear. One small fracture in the coat causes rapid breakdown of the bond between the wood and the remainder of the coating, which then flakes off.

Resin-impregnated fibreglass can provide substantial surface protection, especially for wooden vessels containing liquids. Careful application is necessary to obtain a satisfactory bond to the wood which should have a moisture content of not greater than 15%. The surface must be free from all traces of grease and other chemicals and preferably be freshly sanded, before the resin is applied.

Another method applicable to timbers which are permeable to liquids is to impregnate them under pressure with waxes or resins. These relatively inert substances provide a barrier which extends to some depth in the timber and are most effective where surface abrasion is encountered. Cutting, boring, and machining operations are best carried out before treatment so that a continuous sheath of impregnated wood covers the whole surface. Pressures normally used for impregnation are in the region of 200 lb/sq in. and the timber should be dried prior to treatment.

High melting point waxes and synthetic resins which are cured by heat are effective where service at high temperatures is required. Timbers which are suitable for treatment of this type include radiata, hoop, and Baltic pines, coachwood, sassafras, white beech, ramin, light meranti, and other permeable species.

The following table lists, in order of density, some timbers that have been used in an untreated condition in contact with corrosive chemicals.

Timber	Density (lb/cu ft) (12% M.C.)	Durability	Occurrence
Softwoods			
Californian redwood	25	2	Imported
Radiata pine	32	4	S.A., Vic., N.S.W., W.A., Tas.
Hoop Pine	32	4	Qld., N.S.W.
Kauri	34	4	Qld. and imported
Douglas fir (Oregon)	34	4	Imported
Celery-top pine	40	2	Tasmania
Pitch pine	47	2	Imported
Hardwoods			
Jarrah	51	2	W.A.
Blackbutt	54	2	N.S.W., Qld.
Karri	55	3	W.A.
Turpentine	59	1	N.S.W., Qld.
Tallowwood	62	1	N.S.W., Qld.

Printed by CSIRO, Melbourne

CSIRO

Forest Products Newsletter

DIVISION OF FOREST PRODUCTS, CSIRO, P.O. BOX 310, SOUTH MELBOURNE, S.C.5, VICTORIA

REGISTERED IN AUSTRALIA FOR TRANSMISSION BY POST AS A PERIODICAL

NUMBER 308 JUNE 1964

1964##308

Common Borers In Building Timbers

PART V. THE LONGICORN BORERS

By C. D. Howick, Wood Preservation Section

This article deals with the incidence of longicorn borers in building timbers and discusses their comparative importance from the point of view of builders, householders, carpenters, architects, and so on. Although certain species of longicorn occur in sufficient numbers in various parts of the world to be of economic importance, they are essentially a forest pest, since all but a very few species attack only living trees and green timber. Because of this, they can affect the amount of merchantable timber obtained from the tree, but they do not greatly affect the performance of building timbers.

The average householder or builder is often puzzled when a comparatively large ($\frac{1}{4}$ in.–$\frac{3}{8}$ in.) oval hole appears in dry wood or through lining materials, because he is not informed on the habits of these borers.

The information given in this article will enable these people to understand such a situation should it arise.

THE *Cerambycidae* is a family of beetles widely distributed throughout the world, and popularly known as the "longicorns" or "longhorns" because of the length of their antennae (feelers). Although many hundreds of species regularly breed in Australia, only a limited number of species occur in sufficient quantities to be of great importance to timber users. In addition, some species from abroad may be brought into this country in immature stages in imported timber. A large percentage of these are detected at the port of entry by quarantine officers and the timber is fumigated or, where treatment is not worthwhile, it may be destroyed. However, it is possible for some infested timber to escape detection and some overseas species could become established.

Most longicorns are medium- to large-sized beetles (1–2 in. long) and are characterized by the antennae which are generally as long as, or longer than the body. The larvae of practically all longicorns are wood borers. With few exceptions, they infest living trees, freshly felled logs, and green sawn timber, while they are sometimes found in wood already infested with various species of fungus. A number of species of *Cerambycidae* occasionally emerge from structural timbers or furniture, not because the larva develops naturally in dry wood, but because while it developes naturally in green timber, it is also able to develop in dry wood, although the larval period may then be prolonged over some years.

Life History

As is typical of all beetles, the longicorns have four distinct stages, i.e. egg, larva, pupa, and adult. In the warmer months of the year, the female beetle lays her eggs in cracks or fissures in the tree or green timber. In a matter of weeks, these eggs hatch out into small grubs (larvae), which tunnel into the tree, obtaining nourishment as they progress and growing continually, sometimes up to an inch or more in length.

The actual wood boring is done during the larval period, which is usually from 1 to 3 or 4 years in the living tree. In seasoned timber where moisture contents are necessarily lower, and the amount of starch present may be much less than in green wood, larvae obtain less nourishment, and thus the life cycle may be extended greatly. Periods in excess of 20 years have been recorded. At the end of this period the larvae pupate, and subsequently emerge from the wood as mature beetles. They live for only a few weeks and are no longer interested in wood boring. The only damage they cause is to cut a flight hole through the surface of the timber in order to emerge.

Timber Attacked

In Australia, the majority of longicorn attack occurs in green hardwoods. Attack is not confined only to the sapwood as larvae may tunnel deep into the heartwood also.

Conditions for Attack

Although most infestation by longicorns occurs in the green tree or in recently felled timber, the ability of many species to continue developing after the timber dries—and in one or two special cases to re-infest dry timber—is the characteristic of greatest importance to timber users.

Destruction

The structural weakening of framing timbers is unlikely. Most Australian longicorns do not excavate timber extensively and although the galleries are large, they do not "honeycomb" the wood. As it is unusual to find more than one or two larvae in a piece of framing-sized timber, emergence is unlikely to be any more than sparse. The oval emergence hole disfigures the timber, but it can be filled and the surface finish restored. Except for a very few species, longicorns cannot re-infest the dry timber from which they have emerged and thus further damage is improbable. In emerging from studs or other framing timbers, longicorns may cut through lining materials such as plaster or fibre walls. This does not mean that they are attacking the wall, but merely that the lining was impeding their egress.

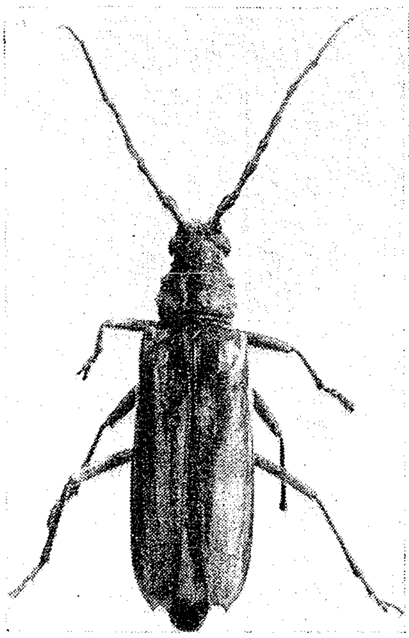


Figure 1

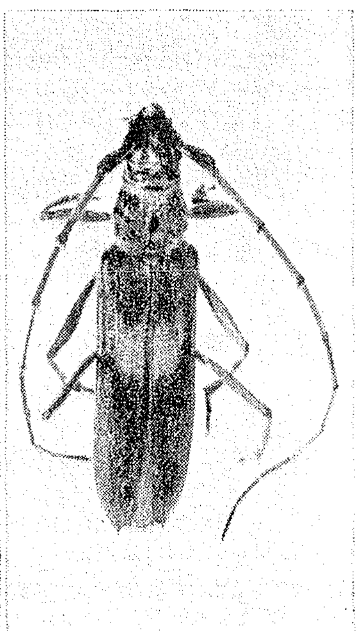


Figure 2

Persistence

Because attack ceases when timber dries, no re-infestation of seasoned timber will occur after emergence. If timber which has been attacked when green is subsequently kiln-dried, no larvae will emerge from it, as the temperatures normally used in kiln-drying schedules are sufficiently high to kill most larvae.

Symptoms

These are isolated scattered oval flight holes $\frac{1}{4}$–$\frac{3}{8}$ in. in diameter, the margins of which are unstained. The galleries are usually across the grain and the "frass" or borer dust is often coarse and stringy.

Treatments

Framing timber of local hardwood which has been attacked by longicorns normally requires no eradicative treatment. This of course is because structural damage is unlikely and re-infestation does not occur.

NOTES ON SPECIES SHOWN IN FIGURES 1—6

Figure 1.—*Pachydissus sericus* Newm. **The Silvery Brown Longicorn**

This borer can cause considerable damage to the trees of several species of wattle (acacia). The beetle is a light chocolate colour and the wing cases have a silvery sheen. Antennae are at least as long as the body which measures up to $1\frac{1}{2}$ in. It has a wide range over Australia.

Figure 2.—*Epithora dorsalis* Macl.

The adult is often seen on flowering shrubs, but it also attacks green hardwoods. The

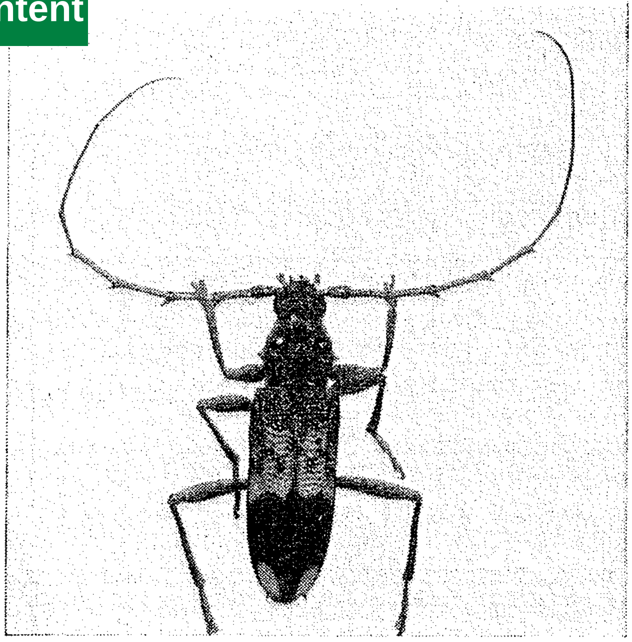
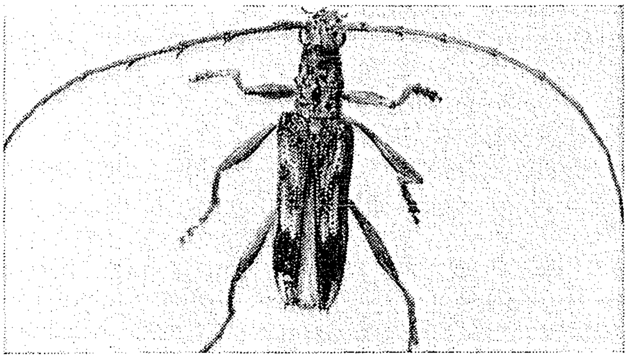


Figure 3 (above)

Figure 4 (below)



beetle has a uniform reddish tint across the centre of the wing covers and a broad patch of dull yellow. It also has a wide range over the continent.

Figure 3.—*Phoracantha semipunctata* Newm. **The Firewood Beetle**

Commonly found in New South Wales and Victoria, this beetle in most parts of Australia attacks a wide range of eucalypts and, as its name implies, is often found emerging from firewood. It has also been introduced into several overseas countries such as New Zealand and South Africa. In Israel, it has become a pest of economic significance on plantations of *Eucalyptus rostrata*. The adult beetle is usually about 1–1¼ in. in length and has a regular pattern of dark brown on its back.

Figure 4.—*Coptocercus rubriceps* Bois. **The Variegated Longicorn**

Found in most Australian states including Tasmania, this species attacks various eucalypt trees, particularly messmate stringybark (*Eucalyptus obliqua*) and peppermint gum (*E. odorata*). The adult beetle is 1–1½ in. long and the wing covers are of a light-brown colour with a variegated pattern of dull yellow or fawn.

Figures 5 and 6 show two species of longicorn which are *not* indigenous to Australia and are *not* established here. However, both species have been found in timber infested overseas and the adults have subsequently emerged in this country.

Figure 5.—*Hoplocerambyx spinicornis* Newm. **The Sal Heartwood Borer**

This longicorn is the most important pest of sal (*Shorea robusta*) which is perhaps the most important source of timber in North India. In Malaya, meranti is also attacked.

The adult beetle is a large (1½–2 in.) powerful-looking dark-brown insect with a prominent head and antennae of similar length to the body. The wing cases are covered with a slight greyish silky pubescence.

Figure 6.—*Hylotrupes bajulus* Linn. **The European House Borer**

This borer is very common in many parts of Europe, the U.S., and South Africa. In Britain it is known as the "House Longhorn Beetle", in Germany the "Hausbock", in France "Capricorne des maisons", and in the U.S. "The Old House Borer". All these names imply that this particular borer is an exception to the general rule that longicorns attack only green timber. *Hylotrupes* in fact *does* attack and infest seasoned wood and so can be a pest of major importance. It attacks conifers such as pine, fir, and spruce and so thoroughly excavates the timber that it causes severe structural damage. Hardwoods are not attacked by *Hylotrupes*.

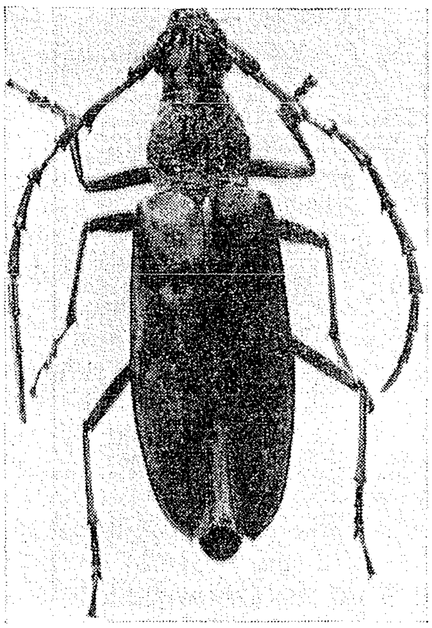


Figure 5

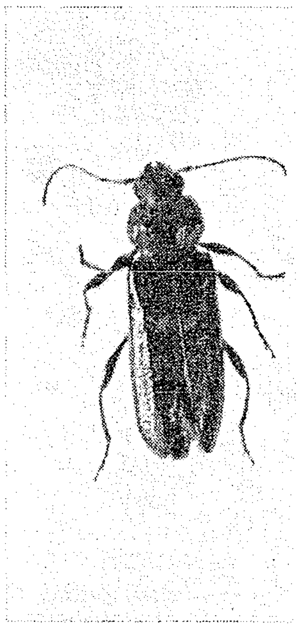


Figure 6

Although the average life-cycle in Europe is from three to six years, it can be as long as ten years or more. Some softwood timbers, infested in Europe and subsequently imported into Australia, have had adult *Hylotrupes* emerge from them more than ten years after their arrival here. However, quarantine fumigation and thorough inspection of many hundreds of pre-fabricated houses imported by various government departments shortly after the war, have prevented this most dangerous of all longicorns from establishing itself in Australia.

The adult beetle may vary in size from $\frac{1}{4}$–1 in. in length. Its overall colour is greyish-brown to black, and on each wing case are four greyish or whitish areas which tend to run together to form distinct patches.

Is a Joist Safe when it Shrinks?

By J. J. Mack, Timber Mechanics Section

A BUILDER RECENTLY asked the Division's opinion on a problem which must occasionally cause some concern to architects, builders, and building inspectors.

An inspector had rejected the hardwood floor joists in a building as being undersize. These joists had been fixed for about a month prior to inspection, and were reported to have been the correct size at the time of fixing. The joists had shrunk due to loss of moisture in the intervening period, and the question was—had this shrinkage in any way affected the safety and stiffness of the joists?

Any consideration of green joists must always assume that the correct size has been chosen to suit the particular span, spacing, and loading. However, the following effects must be considered when examining the behaviour of these joists after seasoning.

- *Effects of Shrinkage*.—It is well known that a piece of green timber shrinks as it dries. This shrinkage varies with the species of timber: for example, a 4 by 2 in. radiata pine joist will, on the average, shrink to about $3\frac{3}{4}$ by $1\frac{7}{8}$ in., while a 4 by 2 in. messmate stringybark joist will shrink to about $3\frac{1}{2}$ by $1\frac{7}{8}$ in., when dried from the green condition to about 10% moisture content.

Now the load that a joist can safely support, and its stiffness, are related to the size of the joist, and so the effect of shrinkage on these properties can be calculated. If size were the only factor, the safe load for the smaller messmate joist (treated as green) would be about 27% lower, and that for the smaller radiata pine joist (treated as green) about 11% lower. Similarly, the stiffness of these two smaller joists would be about 37 and 16% lower respectively.

- *Seasoning Effects*.—As timber dries, its strength and stiffness increase, due to changes in the properties of the wood fibres. For our two examples, mentioned above, if there were to be no change in dimension or density with drying, it could be shown that, due to seasoning from the green condition to 10% moisture content, the safe load for the messmate joist will increase by about 75% and that for the radiata pine joist by about 111%. The stiffness of the joists would increase by about 32 and 29% respectively.
- *Effect of Density*.—It is obvious that, as shrinkage occurs, there must be an increase in the density of the joist. Allowing for the known relationship between density and the mechanical properties of timber, we can calculate that the safe load and stiffness of a messmate joist, due to density increase alone will increase by 19% and that these properties of a radiata pine joist will increase by about 6%.
- *Total Effects*.—Obviously, all these effects are combined during the drying process until equilibrium moisture content is reached throughout the cross section of the joist. Thus, it is calculated that the safe load for the messmate joist when dry would be about one and a half times, and that for the radiata pine joist about twice the value for the full size green joist. Similarly, the stiffness of the messmate joist would be about equal to the green stiffness, and that of the radiata pine joist would be increased by about 15%.

In order to confirm these calculations for stiffness, a number of messmate stringybark and radiata pine joists were tested in bending at various stages during drying. The results were very close to the calculated effects described above.

Thus, it is clear that the shrinkage of a joist or any other timber member after it is sawn does not detract from its safety or stiffness.

Printed by CSIRO, Melbourne

CSIRO
Forest Products Newsletter
DIVISION OF FOREST PRODUCTS, CSIRO, P.O. BOX 310, SOUTH MELBOURNE, S.C.5, VICTORIA
REGISTERED IN AUSTRALIA FOR TRANSMISSION BY POST AS A PERIODICAL

NUMBER 309 JULY 1964

1964##309

Low Speed Wind Tunnel to Aid Air Seasoning Research

by R. M. Liversidge and R. Finighan, Seasoning Section

WHENEVER A NEW air drying yard is being planned or an old one remodelled, the major consideration is, clearly, to make the most efficient use of the area available. This involves a recognition of the various factors which influence yard performance. These include the design of the individual drying stacks, the stack placement pattern selected, the influence of wind flow, and the extent to which this is modified by associated site factors.

Results of field studies to date have shown that, of these, the relationship between wind movement and stack placement pattern is the paramount factor in obtaining fast and uniform drying, assuming that the individual stack variables generally conform to what are now recognized as acceptable standards. However, experience has shown that site testing does not lend itself to basic research on this relationship, partly because of the size of operation required, and partly because many natural factors are beyond the control of an investigator. For example, the re-arrangement of an air drying yard is a major and costly operation, and the complete picture would become apparent only after many such rearrangements. Furthermore, an evaluation of the various layout patterns would be complicated by the fact that each arrangement would probably be tested under different weather conditions.

One approach which appeared to have possibilities was to construct the layouts on a model scale and examine the air circulation in a wind tunnel.

Preliminary studies on these lines in a small wind tunnel were so encouraging that a large low speed tunnel has now been designed and constructed at this Division (Fig. 1). In this tunnel yard layout factors such as stack and road spacing can be varied, and the resultant effect on the air circulation determined. The extent to which yard circulation is affected by nearby buildings and other features associated with the overall plant layout can also be examined.

In addition to the model studies, other work planned for the wind tunnel includes:

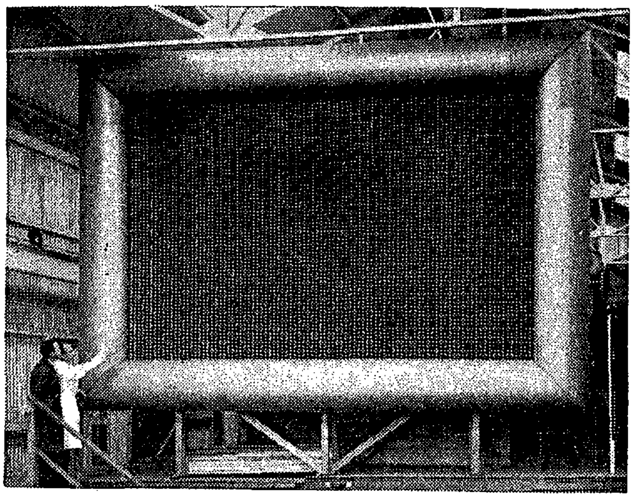


Fig. 1.—Front view of the wind tunnel showing air intake with plywood honeycomb.

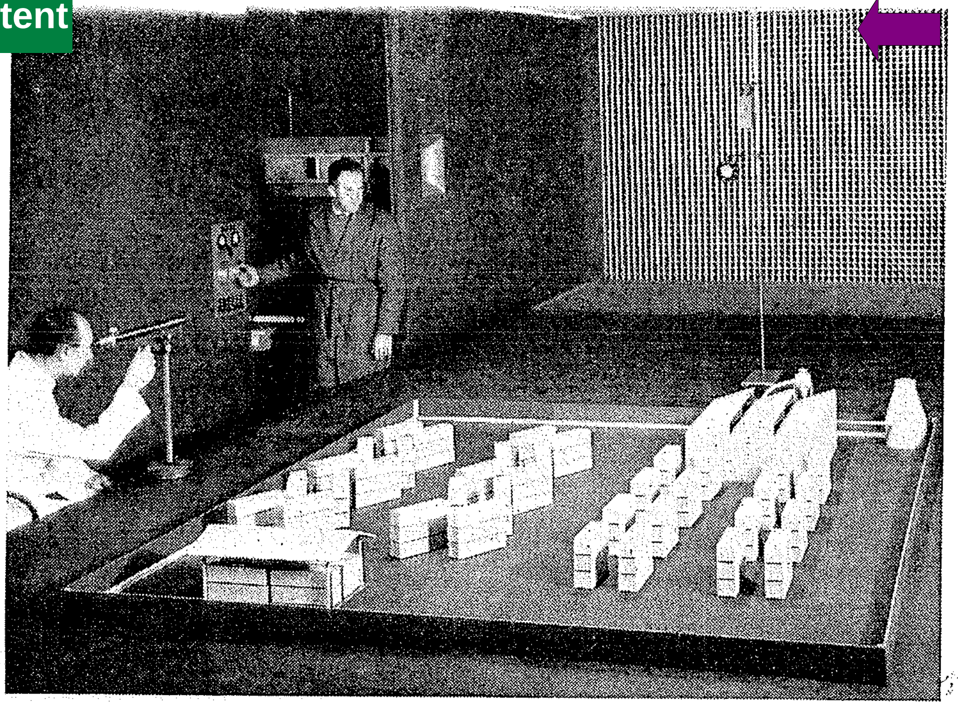


Fig.2.—Operators adjusting tunnel speed using variable speed control.

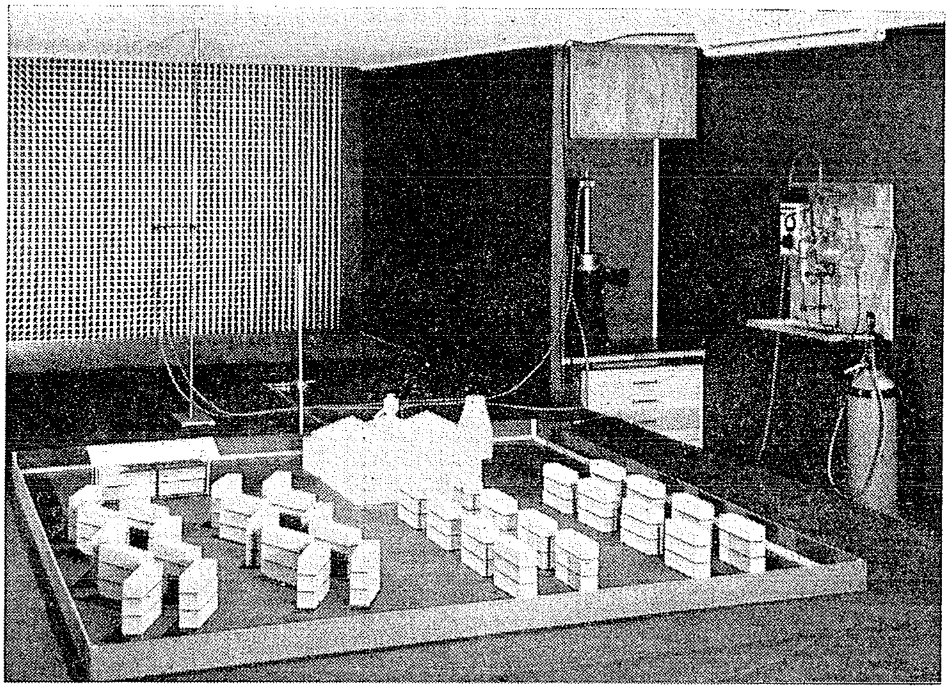


Fig. 3.—Model layout in position. Note smoke generator and precision manometer.

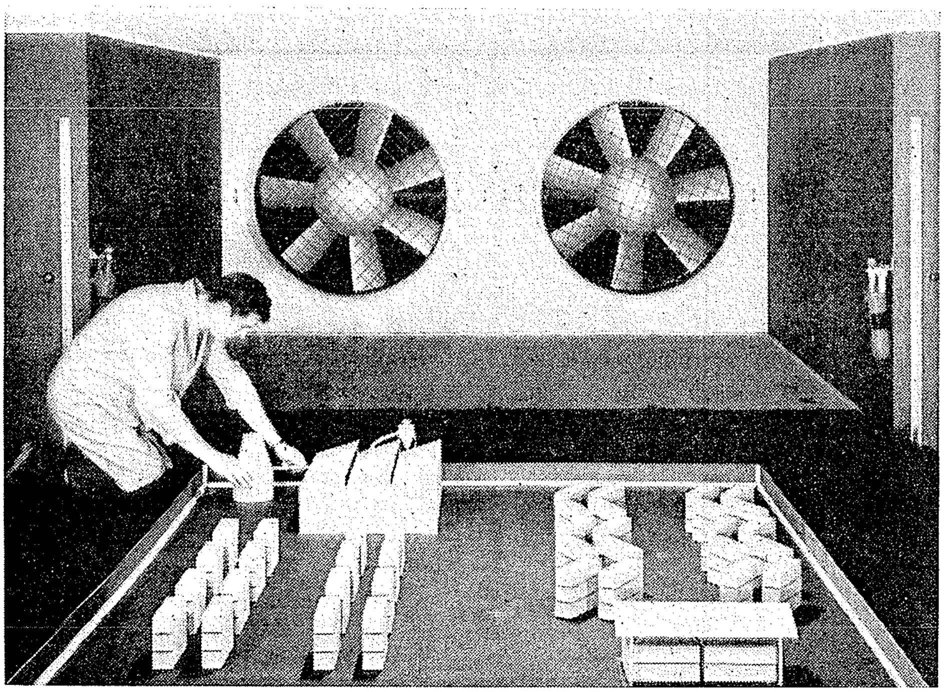


Fig. 4.—Stack patterns shown are typical of the many variations to be examined. Note the twin 48-in. tube axial fans.

(*a*) Investigations of some fundamental aspects of air flow through timber stacks using part of a full-size stack. These include the effects of surface roughness, stack width, and strip thickness on the resistance to air flow through the stack.
(*b*) Examination of various factors affecting the efficiency of forced air drying as a method of improving yard output.

The tunnel is 50 ft long with a cross-section 12 ft wide by 6 ft high. A 10-ft diameter turn-table has been provided in the floor of the working section to enable models to be rotated to simulate various wind directions. In the region of the working section, two side bays have been provided so that the operators can work within the tunnel without disturbing the air stream (Figs. 2 and 3).

The air flow through the tunnel is induced by two 48-in. diameter tube axial fans (Fig 4) driven by a 12 hp A.C. motor and a 3 hp D.C. motor coupled to provide a speed variation from 0–900 ft/min. To reduce any initial turbulence in the incoming air, the slightly greater than 2 : 1 inlet contraction has been provided with a 15-in. deep plywood honeycomb (2-in. square cell size) at the entrance.

The tunnel was prefabricated largely in the Division's workshops, using $\frac{3}{16}$ in. hardboard on 3 in. by $1\frac{1}{2}$ in. hardwood frames.

A Note on Wooden Ladders

by J. J. Mack, Timber Mechanics Section

At a conservative estimate, some 30,000 extension ladders are currently in service in Australia. Considering the very wide range of conditions of use, differences in quality of manufacture, and the varying periods of service, it is perhaps only to be expected that a few ladders will fail each year. Because of the very nature of a ladder and its use, its failure may result in serious personal injury, and occasionally in loss of life. Thus, even if only one ladder in every 1000 were to fail in any 12 months, apart from the personal cost in injury or worse, the cost of accident compensation would be heavy and of considerable concern to the employer.

The basic question is should failure occur even in as few as 1 in 1000 ladders? Must such a failure rate be accepted as reasonable in a fabricated structure that has been designed to be as light as practicable, and in the use of which there is always some small element of danger? The answer is no! Given well-made ladders of good quality timber, proper use, care in handling, and adequate maintenance, there should be no reason why the failure rate should not be as small as 1 in 30,000 or even less.

In a test made at the Division with a new 21-ft extension ladder supported against a wall at the recommended 70° angle, a load of 450 lb at mid-height was sustained without any sign of failure. This load is equivalent to a 16 stone man carrying 126 lb which, it will be agreed, is a most unlikely loading. The deflection at the centre of the ladder under this load of 450 lb was approximately 6 in., which is not considered severe. Several single sections of old extension ladders, the other sections of which had broken in service, were also tested, and the breaking loads were so high that it was clear that some reason other than an inherent weakness of the timber was responsible for the failures.

The Standards Association of Australia's Code of Recommended Practice for the Use and Maintenance of Portable Timber Ladders (A.S. No. CA29—1959) amply covers the scope conveyed by its title. However, from inspections of large numbers of ladders it is apparent that their treatment in service is often not up to the desired standard. There is evidence of ladders having been retained in service after damage resulting from falls, from incorrect carriage on vehicles, and even from being run over by a vehicle. Clearly, some form of regular inspection should have been carried out to ensure that such damaged ladders were discarded.

Occasionally, timber which should have been rejected has been used for ladder manufacture. Although Australian Standard No. A90 limits sloping grain to 1 in 20, grain slopes of up to 1 in 12 have been observed in many finished ladders, and in some cases slopes were even steeper. Severe sloping grain reduces considerably the strength and stiffness of the wood and, when present, can seriously reduce and even eliminate a ladder's margin of safety.

Also, characteristically brittle types of Douglas fir, not allowed by A.S. No. A90, have been detected in some ladders; this material can usually be recognized by inserting the point of a knife into the wood and lifting out a small splinter. If the splinter is short in length and brittle in appearance, then the piece of wood is probably also generally brittle and should be rejected as unsuitable for ladder construction. It is known that very fast- and very slow-grown Douglas fir have markedly inferior strength properties to timber of medium-growth rate. Thus, it is advisable to select this timber for ladder stiles only if it has more than about 8 and less than about 30 rings per inch.

It is common practice to insert a steel wire of about 10 gauge into a groove on the underside of each stile. The purpose supposedly is to hold the ladder together for a sufficient time, in the event of failure of the timber, to allow the user to jump clear. Some, however, mistakenly consider that the wire adds to the ladder's strength and stiffness. Tests made by the Division on matched stiles with and without the wire have shown positively that as normally fitted the wire in no way improves either property. In fact the fixing is generally so ineffective that, after a few severe flexings of the ladder, the wire becomes quite loose.

Standard A.S. No. A90 specifies that wire-reinforced ladders are not suitable where electrical hazards exist. Also, as no increase of stile size is suggested when a wire is not used, the Standard implies the ineffectiveness of the wire on the strength and stiffness of the ladder. However, an interesting development has been the recent attempts by several ladder manufacturers to increase these properties by gluing fibre-glass cord into the groove in place of the steel wire. Tests conducted on some experimental stiles indictate that, although no appreciable increase in stiffness has been achieved, the fibre-glass has slightly improved the strength. It is quite probable that with correct gluing technique and cord size, a significant improvement in properties will result.

Despite any such improvements in ladder design, the fact still remains that ladders, particularly long ladders, are really delicate structures compared to other forms of construction. If properly made they should have an ample margin of safety. When improperly used and badly cared for, they are potentially dangerous. Complacency with this state of affairs can only lead to trouble. Almost invariably, the blame for a ladder failure is placed on the quality of the timber, but more often than not the fault lies instead with the user.

D.F.P. PUBLICATION ABSTRACTS

Tolerance of *Poria* Species to Copper-Based Wood Preservatives by E. W. B. Da Costa and Ruth M. Kerruish (Preservation Section), *Forest Products Journal* (*U.S.A.*), Vol. 14, No. 3. D.F.P. Reprint 532. Availability—Research workers and commercial wood preservation companies.

In view of the world wide increase in the use of fixed waterborne wood preservatives based on copper compounds, the copper tolerance exhibited by some species of the wood-destroying fungus *Poria* is proving to be of considerable interest.

This paper describes, in considerable detail, the work carried out to assess the copper tolerance of the various species of *Poria*. The most tolerant species tested was *Poria vaillantii*, which grew on nutrient agar containing 8% of copper sulphate and caused some decay in wood treated with 4·8 lb/cu ft of copper-chrome-arsenic preservative.

In the case of this type of preservative, however, there seem to have been no instances recorded of early failure due to tolerant *Porias*, possibly due to the fact that *Poria vaillantii*, although widespread, is not particularly abundant in any one locality; also, treated wood is not normally used in conditions that would permit a gradual build-up of a resistant fungal flora by selection.

In view of the rapid and widespread adoption of the copper-chrome-arsenic type preservatives, the practical significance of the high tolerance found in the laboratory is now being investigated.

Printed by CSIRO, Melbourne

CSIRO

Forest Products Newsletter

DIVISION OF FOREST PRODUCTS, CSIRO, P.O. BOX 310, SOUTH MELBOURNE, S.C.5, VICTORIA

REGISTERED IN AUSTRALIA FOR TRANSMISSION BY POST AS A PERIODICAL

NUMBER 310 AUGUST 1964

1964##310

The Small Specimen Test

PART I

By J. Beesley, Wood Preservation Section

This résumé of the Division's very comprehensive test of wood preservatives has been written primarily for the information of the many people with a direct interest in the test, but also serves to illustrate the many and complex issues which are involved in planning such a project. More complete details on the design of the test are available, on request.

THE DIVISION has just established one of the most important and comprehensive tests of wood preservatives ever undertaken in Australia. It involved the treatment of over 6,000 test specimens that have now been installed in the field in 8 separate test sites. Known as "The Small Specimen Test", it has as its objectives:

1. To provide a basis of direct comparison between Australian tests of wood preservatives and similar tests from abroad. With this objective in view, creosote oils were specially imported from the United States and Great Britain, and a number of well-known proprietary waterborne preservative salts with an international reputation were included in the test.

2. To provide precise data on the effect of different loadings of preservatives against a variety of hazards. To this end, the majority of preservatives were used at the normally recommended commercial loading, as well as at double and half that loading.

3. To furnish reliable information on the effect of different environments (localities) on the performance of a preservative. The test sites are scattered from the Territory of Papua and New Guinea, in the north, through Queensland and New South Wales, to Victoria, in the south.

4. To form a basis for recommendations for the use of wood preservatives for the protection of timber in contact with the ground anywhere within the Australasian region. In order to widen the scope of the test, the majority of the preservatives were used in the sapwood of *Pinus radiata* and in the heartwood and sapwood of *E. regnans*, a eucalypt of major commercial importance.

This test has been most carefully planned and, at all stages, many alternatives were carefully considered. After examining the possible alternatives, the following decisions were made in respect to the choice of timbers, the size of specimens, their preparation and treatment, the selection of preservatives for testing and the loadings at which they were to be tested, the number and location of the test sites and, finally, the layout of the specimens at the sites.

Timbers

Choice of Species.—Since the test was to be one of preservatives, it was important to choose a test timber of low natural durability which could be impregnated without difficulty and, preferably, one which might be treated commercially. *Pinus radiata* sapwood was the obvious choice. It was readily available in the south-eastern States from Government-owned plantations, and met all other requirements well. However, as laboratory tests in Australia and elsewhere had shown that some waterborne preservatives showed different fixation characteristics in hardwoods and softwoods, there was an obvious need to include a hardwood in the test as a check on results obtained with pine.

Since the heartwood of few Australian hardwoods can be treated by normal commercial methods, most treated hardwoods are used in the form of natural rounds. Hence it was decided that the hardwood used in the test should be in the form of sawn specimens free of sapwood, and of natural rounds consisting largely of sapwood. This arrangement had the advantage of providing a double check on the fixation of waterborne salts in hardwoods and would indicate if there was any material difference between heartwood and sapwood. *Eucalyptus regnans* was chosen as the hardwood for use in the test. However, in order to check on the possible effect of density, or some other and unknown factor, on the performance of preservatives in hardwoods, a few specimens of *E. obliqua* and of *E. diversicolor* (heartwood only) were included.

Preparation of Specimens.—The sawn specimens of pine and heartwood were purchased from local sawmillers and air dried by the Division. The natural rounds were specially cut from regrowth by the Victorian Forests Commission, barked, and air dried. The saplings were selected so as to yield specimens between $1\frac{3}{4}$ in. and $3\frac{1}{2}$ in. in diameter.

After drying to about 15% moisture content, all timber was accurately docked into 18-in. lengths, taking care to cull out all knots and other defects from the sawn specimens and all large knots and irregularities from the round ones. The sawn pine specimens were then accurately machined to 2-in. squares and the hardwoods to $1\frac{7}{8}$-in. squares.

Experience with other tests had shown that a specimen length of 18 in. was a convenient size when specimens were to be planted vertically in the soil to a depth of 12 in. The sectional area of 4 sq in. for pine, and slightly less for the hardwood, was chosen so as to minimize the effect of attack by soft-rot fungi, which penetrate the surface layers very slowly and could mask the resistance of the preservatives to attack by termites or *Basidiomycetes*, the common wood-destroying fungi. With the larger cross-sectional area, most damage by soft-rot fungi could be ignored.

Randomization.—During preparation, and prior to treatment, all specimens were systematically randomized into storage bays, capable of holding 100 sawn specimens or 60 round ones. This procedure was adopted to reduce the effect of tree differences on the performance of the preservatives.

Treatment Procedures

The number of specimens required for each loading of each preservative was taken from the storage bays and arranged in order of weight (i.e. density, as all sawn specimens of each species were of uniform size). Cylinder charges were then made up so that the weight–range for each charge did not exceed 50 g. Test runs had shown that, with this small variation in density–range, the variation in preservative uptake by specimens in any one charge was also small. By this means, it was possible to get the requisite numbers of treated specimens for each retention of each preservative in each species, without treating any specimen more than twice and without diluting any of the preservative oils used.

All specimens in each cylinder charge were treated to refusal, as judged from the rate of uptake of preservative during the pressure period, and all variations in preservative retention were obtained by adjustments to the schedules used. The range of schedules used may be summarized as follows:

High Pressure (1,000 lb/sq in)

Used with *E. obliqua* and *E. diversicolor*. Only 40 sawn heartwood specimens of each species were used. Both species were treated together in SAA K55 creosote oil to give a mean preservative retention of 9·75 lb/cu ft in *E. obliqua* and 6·65 lb/cu ft in *E. diversicolor*.

Intermediate Pressures (200–1,000 lb/sq in)

Used principally with the sawn *E. regnans* specimens. Both Rueping and Lowry processes were used, but the main differences were achieved by adjusting the impregnation pressure.

Standard Pressures (below 200 lb/sq in)

Used mainly with the pine specimens and the round eucalypts. Variations in preservative retentions were obtained by adjusting initial air pressure or vacuum period.

Dip Treatments (16-hr cold soak)
A limited number of preservatives were used in this way, but no attempt was made to select specimens on the basis of preservative uptake following this treatment.

Extent of Treatments
Table 1 shows the actual number of treatments made and indicates the amount of work involved in obtaining the necessary numbers of specimens.

Preservatives
Forty-two different preservatives, or preservative mixtures, were used in this test (Table 2). For convenience, these may be listed as preservative oils or oily preservatives and waterborne salts, both of which were applied by pressure methods, and the six representative preservatives which were applied by dipping.

With the majority of preservatives, the nominal loadings selected were those considered to be a fair average commercial loading for use in the ground. Some minor adjustments were necessary in order to make the comparison between very similar preservatives more direct. This basic figure was then doubled and halved for most preservatives, so that some observations could be made upon the effect of these changes in

Table 1: Extent of Treatments

Treatment Methods	Timber and Condition	Number of Treatments		
		Oils, etc.	Water-borne	Total
Pressure methods	Pine (sawn)	227	92	319
	Hardwood (sawn)	35	66	101
	Hardwood (round)	77	50	127
16-hr cold soak	Pine (sawn)	9	2	11
	Hardwood (sawn)	9	2	11
	Hardwood (round)	10	2	12

—Continued overleaf

PROPERTIES OF AUSTRALIAN TIMBERS

SILVER QUANDONG

SILVER QUANDONG is the standard trade common name of *Elaeocarpus grandis* F. Muell. and *Elaeocarpus kirtonii* F. Muell. These are forest trees occurring in the coastal rain forests of northern New South Wales and Queensland. Both species grow into quite large trees, attaining heights of up to 120 ft; the trunks are heavily buttressed but lengths of clear bole up to 60 ft and with mid-diameters of about 2 ft 6 in. are not uncommon.

General Properties
The sapwood and the heartwood are both light in colour, ranging from almost pure white to pale brown. The timber is pored and has a rather open, coarse, uniform texture and a slightly waxy feel. The grain is straight and the timber saws and works easily; it is quite soft.

Silver quandong is a light timber, its density averaging about 29 lb/cu ft at 12% moisture content. It is in Strength Group D with respect to its mechanical properties and has a high strength–weight ratio. The sapwood is susceptible to attack by the lyctus borer but is readily immunized by treatment; the heartwood is classed as moderately durable, Durability Class 3.

Seasoning
Silver quandong is rather slow in drying but is not liable to collapse and does not warp to any extent. It can be kiln dried from the green but usual practice is to have a preliminary air drying period.

Shrinkage is low, 4·3% in a tangential direction, the width of backsawn boards, and 1·4% in a radial direction, the width of quartersawn boards.

Working Properties
Silver quandong is an easy timber to saw and work with both hand and machine tools. As a bending timber it is classed as very good. It takes nails well and can be glued satisfactorily.

Uses
Having a relatively high strength to weight ratio, silver quandong has been used for aircraft construction and is popular for the framing and planking of boats. As a substitute for spruce it is used for the manufacture of racing cars. Other uses are for interior trim, panelling, and light coloured furniture. It is most readily available as 1 in. stock and wide boards.

Table 2: Preservatives

Oils and Oily Preservatives	Nominal Retention (lb solution/ cu ft)	Waterborne Salts	Nominal Retention (lb dry salt/ cu ft)
Creosote oils			
Australian SAA K55 (blend)	4,8,16,12,20	Boliden K33*	0·4, 0·75, 1·2
,, SAA K55 (ii)	4,8,16	Boliden S25*	0·4, 0·75, 1·2
,, SAA K55 (iii)	4,8	Celcure A	0·4, 0·75, 1·2
Standard British*	4,8,16	Celcure (old)	0·75, 1·5
Standard U.S.A.*	4,8,16	Tanalith C	0·4, 0·75, 1·2
Brown coal (high residue)	4,8,16	Tanalith CA	0·4, 0·75
,, ,, (distillate)	4,8	Zinc-chrome-arsenic	0·4, 0·75, 1·2
Creosote oil (K55 blend)			
+ furnace oil (1 : 1)	4,8,16	Copper-chrome-boroarsenic	0·4, 0·75, 1·2
+ furnace oil (3 : 1)	4,8,16	Boron-chrome-arsenic	0·5, 1·0
+ tar (1 : 1)	4,8,16	Borax-boric acid	0·5, 1·0
Furnace oil			
No additive	4,8,16	"Dip-diffusion" salt	0·5, 1·0
Pentachlorphenol (pcp)			
5% in furnace oil	4,8,16,12,20	Wolman salts UAR*	0·4, 0·75
2½% in furnace oil	4,8,16	,, ,, UBR*	0·4, 0·75
5% in diesel fuel oil	4,8,16	,, ,, UR6*	0·4, 0·75
2½% pcp in furnace oil			
+ creosote (K55 blend) (1 : 1)	4,8,16	Wolmanit CB*	0·4, 0·75
+ dieldrin (¼%, ½%, 1%)	8 each	Copper-pentachlorphenate	0·2, 0·4, 0·75
+ benzene hexachloride (¼%, ½%, 1%)	8 each		
+ chlordane (½%, 1%, 2%)	8 each		
1,000 lb/sq in-Creosote K55 blend		**Dips—16-hour Cold Soak Treatments**	
E. obliqua	random		
E. diversicolor	random	Xylamon T*	
		Xylamon TA*	
		Copper naphthenate (20%)	
		5% pcp in diesel fuel oil	
		Creosote (K55)+10% middle tar oil	
		Celcure A (10%)	

* Specially imported for this test.

loadings on performance. This information could be particularly revealing for the preservatives which do not perform well at the median loading.

Unfortunately, it was not practicable to include every loading of each preservative at all sites. Therefore, some preservatives were used at several loadings in only one or two States, others were used at only one loading but in several States.

The concluding part of this article will appear next month.

Printed by CSIRO, Melbourne

CSIRO

Forest Products Newsletter

DIVISION OF FOREST PRODUCTS, CSIRO, P.O. BOX 310, SOUTH MELBOURNE, S.C.5, VICTORIA

REGISTERED IN AUSTRALIA FOR TRANSMISSION BY POST AS A PERIODICAL

NUMBER 311 SEPTEMBER 1964

1964##311

The Small Specimen Test

PART II

By J. Beesley, Wood Preservation Section

Test Sites

THE ESSENTIAL details of the eight localities in the four States in which the test has been established are shown in Table 3.

The two sites in the Territory of Papua and New Guinea (Fig. 1) were made available to the Division for this test by the Department of Forests, which also undertook to install the test and maintain the sites. In Queensland the Innisfail test site is at the Joint Tropical Research Unit operated by the Australian Department of Supply and the U.K. Ministry of Aviation, and the Millaroo site is on the State Department of Primary Industry's Agricultural Research Station. At both sites, resident officers assisted with the installation of the test and keep it under surveillance.

In New South Wales, the Forestry Commission has provided the sites and installed the test specimens. The Manning River site is on National Forest, and the Pennant Hills site is on the Commission's nursery reserve in a National Park. The O'Shannassy site, in Victoria, is on an area below one of Melbourne's water supply reservoirs and was

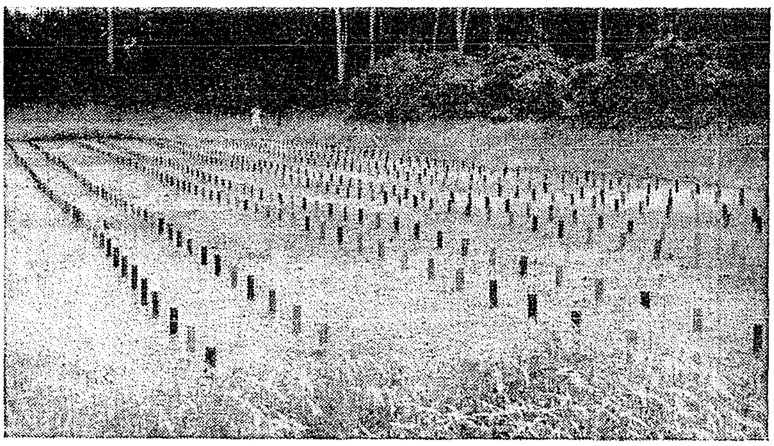


Fig. 1.—Brown River site (Papua). Decay-hazard site with specimens in closely spaced rows.

Fig. 2.—Walpeup site (Victoria). Termite-hazard site with specimens set in separated lines.

provided by arrangement with the Melbourne and Metropolitan Board of Works. The Walpeup site (Fig. 2), provided by courtesy of the Victorian Department of Agriculture, is on that Department's Mallee Research Station.

The Division has been fortunate in obtaining sites which offer security of tenure for the expected duration of the test, estimated at not less than 20 years, and which are under the surveillance of interested parties. The co-operation of the Departments and officers concerned is gratefully acknowledged.

Installation

In the sites where termites are regarded as the principal hazard, the specimens have been spaced out in single rows, with 50 or more yards between each row. This procedure reduces the possibility of any termite colony having easy access to more than one row, and increases the chances of a row intersecting the foraging area of more than one colony of termites. Within the rows, specimens have been spaced at 2- to 3-ft intervals.

Elsewhere, the rows can be laid closer together. At Keravat and Brown River, each row has been folded so as to make the test area more compact. At Innisfail, each row has been reduced to a block of several short lines. In decay sites, this variation in the layout of rows is considered unlikely to have any effect on the incidence of attack, and specimens have been spaced at intervals of only 18 in.

At all sites, the treatments within a row have been arranged in random order, with specimens numbered serially. Each row represents one complete replication of the test at that locality and contains one, and only one, specimen from each treatment used

Table 3: Test Sites

Name of Site	State	Mean Annual Rainfall	Natural Vegetation	Nature of Hazard	Layout of Test
Keravat	New Britain (near Rabaul)	100	Tropical rain forest	Tropical decay with termites	Spaced rows in a block
Brown River	Papua (near Port Moresby)	50–70*	Tropical rain forest	Tropical decay with termites	Spaced rows in a block
Innisfail	North Qld. (coastal)	139	Tropical rain forest	High decay and termites (no *Mastotermes*)	Scattered blocks
Millaroo	North Qld. (40 miles inland from Ayr)	29	Savannah woodland	High *Mastotermes* with decay	Well-spaced rows
Manning River	N.S.W. north coast (near Taree)	47	Wet sclerophyll forest	Subtropical decay	Spaced rows in a block
Pennant Hills	N.S.W. (west of Sydney)	52	South coast eucalypt forest	High decay and termite (*Coptotermes*) hazard	Spaced rows in a block
O'Shannassy	Victoria (near Warburton)	55	Cool temperature, moderate rainfall, eucalypt forest	Winter rainfall decay hazard	Spaced rows in a block
Walpeup	Victoria (Mallee)	13	Mallee scrub	High *Coptotermes* hazard	Well-spaced rows

* No recording station nearby. M.A.R. for nearest recording stations, respectively 46 in. and 94 in.

Table 4: Installation of Specimens

Site	Date Installation Completed	Number of Specimens Installed: Oils and Oily Preservatives			Number of Specimens Installed: Waterborne Preservatives			Total
		Sawn pine	Sawn hardwood	Round hardwood	Sawn pine	Sawn hardwood	Round hardwood	
Keravat	14.ii. 64	225	55	45	205	75	55	660
Brown River	4.iii. 64	225	55	45	205	75	55	660
Innisfail	15.xi. 63	270	65	55	65	40	45	540
Millaroo	20.xi. 63	270	65	55	65	40	45	540
Taree	17.vii.64	310	105	140	205	150	130	1040
Pennant Hills	19.vi. 64	310	105	140	205	150	130	1040
O'Shannassy	15.iv. 64	265	95	140	155	80	55	790
Walpeup	7.v. 64	265	95	140	155	80	55	790
Total		2140	640	760	1260	690	570	6060

there. Each site contains only five rows of specimens, but as the composition of the two sites in each State is identical, every treatment used in any one State has been replicated 10 times. There have been, however, quite large differences in the numbers of treatments and, therefore, of specimens used in each State, as shown in Table 4.

Inspections

Unfortunately, the installation dates for the various parts of the test (see Table 4) have been governed more by the availability of the specimens than by the convenience of the Departments cooperating in this test. Consequently, the approximate date of the first inspection at each site will have to be arranged in consultation with the Departments concerned but, thereafter, inspections will be made on an annual basis until the later stages of the test when the interval between inspections might be extended.

At each detailed inspection, specimens will be removed from the ground and carefully examined for the presence of decay or termite attack, the severity of which will be assessed before the specimens are replaced to their original depth in the ground.

Conclusion

The authors of this test expect that, within the next two years, it will yield results that will be useful in framing recommendations for the use of preservatives anywhere in Australia, and as the test matures, that it will furnish information for use as a basis for modifications and improvements in the formulation of wood preservatives. If these expectations can be realized in the form of cheaper and more lasting timber structures, the effort involved in setting up the test will have been fully justified.

D.F.P. PUBLICATION ABSTRACTS

Research on Pole Seasoning in Australia by F. J. Christensen and J. E. Barnacle (Timber Seasoning Section), *Australian Telecommunication Monograph* No. 2. D.F.P. Reprint 543. Availability—Pole suppliers, treaters, or users.

THIS PAPER gives details of the pole seasoning research being carried out by the Division. Increased utilization of less durable pole timbers, preservative treated by pressure methods, has introduced the need for pole seasoning which is an essential preliminary to the treatment process.

The paper describes three current research projects: the determination of relative air drying rates for eucalypt and pine poles in the Melbourne area; an examination of several accelerated pole drying methods; and an investigation into methods of controlling drying degrade.

Effect of Bark Retention on the Behaviour of Mountain Ash Pole Thinnings during Kiln Drying by S. J. Cowling and F. J. Christensen, *Australian Forestry*, Vol. XXVII, No. 2, 1963. Availability—Timber preservation industry.

THE UTILIZATION of small size thinnings of *Eucalyptus regnans* (mountain ash) is becoming increasingly important in Victoria and, where use as poles or saw logs is envisaged, the effects of degrade during seasoning can play a major part.

The experimental work described in the paper was carried out in order to determine the effects of the bark on drying rate and degrade development in smaller pole size mountain ash, under conditions approximating a summer day in southern Victoria.

It was found that retention of bark reduced the drying rate and end degrade, but had no apparent effect on barrel checking. Under kiln drying conditions, the drying rate of debarked pole sections was more than twice that of unbarked sections.

DONATIONS

The following donations have been received by the Division over the last few months:

Montague L. Meyer (Aust.) Pty. Ltd., Adelaide	£50 0 0
Wadlow Pty. Ltd., Alberton, S.A.	£50 0 0
Que River Sawmills Pty. Ltd., Burnie, Tas.	£100 0 0
Rankine Bros., Malanda, Qld.	£50 0 0
Mount Foster Pty. Ltd., Fingal, Tas.	£50 0 0
Black and Decker (A/asia) Pty. Ltd., Melbourne 9″ heavy duty saw with carrying case and spare blade. Approx. value	£75 0 0
Waygara Sawmilling Co. Pty. Ltd., Vic.	£52 10 0
A. A. Swallow Pty. Ltd., Melbourne	£100 0 0
B. G. Clennett Pty. Ltd., Hobart	£10 10 0
Bright Pine Mills Pty. Ltd., Vic.	£100 0 0

Brown Stains can be removed

BROWN STAINS frequently develop on concrete mortar or bricks when timber is used in contact with these materials in exposed positions. The stains are usually caused by a reaction of the alkaline content of the concrete, lime, or bricks with the tannins and other extractives in the timber. They may result when water leaches green or partly dry timber and washes over the other surfaces. Water which has passed over concrete can also cause staining if it subsequently comes into contact with timber. Hardwoods, owing to their high tannin content, are more prone to stain than are softwoods.

An effective method of removal is to brush and wash down the affected surface to remove any loose alkaline materials, then follow this by scrubbing thoroughly with a solution of hydrochloric acid. The concentration of acid required depends on the severity of the stain but a solution containing 1 part of commercial concentrated acid, 33% strength, to about 10 parts of water is sufficiently strong for most purposes. If removal of the stains proves difficult, higher concentrations of acid should be tried on small areas to ascertain how concentrated the most effective solution should be. Alternatively, the effectiveness of the acid can be increased by diluting with hot instead of cold water. After the stains have been removed the treated surface should be washed thoroughly with water to remove any excess acid.

Concentrations of the above order are not particularly dangerous but some care should be exercised in their use. Rubber gloves should be worn to prevent contact of the acid with the skin, and care should be taken to avoid splashes on the face and, in particular, the eyes.

Dark grey or blue-black stains are usually caused by contact of timber with iron, and further information on this can be obtained on application to the Division of Forest Products.

Printed by CSIRO, Melbourne

CSIRO

Forest Products Newsletter

DIVISION OF FOREST PRODUCTS, CSIRO, P.O. BOX 310, SOUTH MELBOURNE, S.C.5, VICTORIA

REGISTERED IN AUSTRALIA FOR TRANSMISSION BY POST AS A PERIODICAL

NUMBER 312 OCTOBER 1964

1964##312

The Effect of Stack Covers on Drying Degrade in Timber

By R. Finighan and R. M. Liversidge, Seasoning Section

ALL TIMBER dryers are aware of the degrade which can take place in the upper layers of air-drying stacks. The losses arising from checking and warping are so serious with certain species and thicknesses that, unless some protection is given, most of the material in the top rows is down-graded. While many dryers are aware of these losses, as often as not no stack covering is used and few provide an effective form of cover; the most common practice is to place a layer of waste material on top of the stacks. Although this method appears to be fairly useful in preventing sun checks, it affords little protection against rain and, as alternate wetting and redrying cause much of the degrade, some form of watertight cover has obvious advantages.

Experimental work was, therefore, carried out by the authors to clarify aspects of stack cover usage.

In assessing the various constructional materials which could be used, two distinct groups were considered:

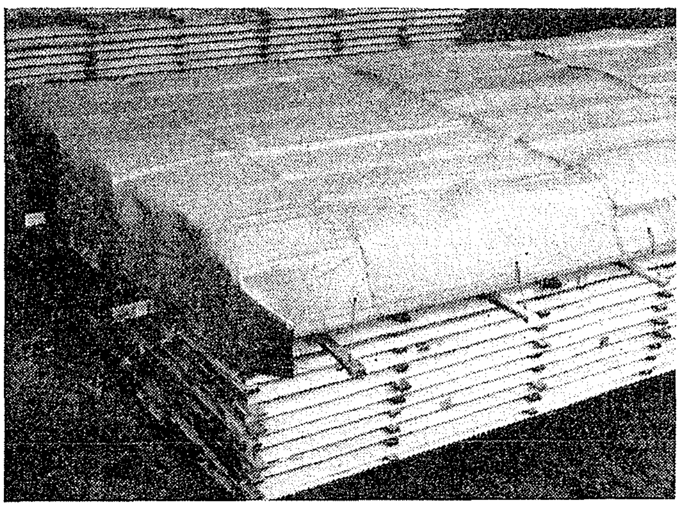
(1) those having a limited life of, say, 12 to 18 months, for which materials such as Fibreen, Polythene, or vinyl plastic film would be satisfactory,

(2) those having an extended life, for which materials such as corrugated galvanized iron, aluminium, or some types of reinforced plastic sheet would be necessary.

For the tests reported herein, Fibreen, corrugated galvanized iron, and two thicknesses of black Polythene film were finally selected as representative of the materials available for this type of usage. The Fibreen was laid directly on the top boards and extended about 12 inches over the sides and ends. Eyelets were sewn into the cover (Fig. 1) and fastening was made by wire to protruding stickers, producing an eaves effect. A similar arrangement was used with the plastic films (Fig. 2). The galvanized iron was nailed to a wooden frame and projected beyond the stack about 2 inches on each side and 12 inches on each end, and the cover was fastened to the stack by a spring and hook arrangement (Fig. 3).

To determine the extent to which covers can reduce drying losses in "ash-type" eucalypts, packs of select quality, 1-in.-thick

Fig. 1.



material were dried together in covered and uncovered stacks and the resulting degrade in each was compared. As this arrangement also lent itself to an examination of the effect of rain wetting on the drying rate of timber stacks, the same set of stacks was allowed to remain in the yard for about 15 months.

The useful life of the covers tested was:

Black Polythene 0·004 in.:—3 to 4 weeks;
black Polythene 0·008 in.:—3 to 4 months.

This material failed at the welded joints; possibly an unwelded sheet would give a longer life.

Fibreen:—15 to 18 months.

After 15 months, this material showed signs of deterioration but probably would have given protection for another season.

Galvanized iron:—no significant damage after 18 months.

The galvanized iron covers were used for a further 2 years, and suffered little damage during this period; with reasonable care this type of cover should last for many years.

In a later laboratory experiment, a number of nylon and fibreglass mesh reinforced plastic sheets were given accelerated weathering tests. The best of these showed high tensile strength and puncture resistance, and could be well suited for use as stack covers.

To assess the protection provided by stack covers, the upper layer from each of (i) a Fibreen covered, (ii) a galvanized iron covered, and (iii) uncovered stack, was selected for machining after drying. The boards were first cleaned up by dressing 1/16 in. off both faces. This removed all the checks in the upper and lower faces of the *covered* material, but only those on the lower faces of the *uncovered* material; the upper face of the *uncovered* material still retained bad weathering checks. At this stage, if these boards were machined into flooring with the checked surface as the back, all material would be graded as select.

To determine the depth of checking, two more cuts of 1/16 in. were taken from the upper faces of the top boards of the *uncovered* stack, reducing the thickness of this material to $\frac{3}{4}$ in. After this additional machining, 40% of the boards from the top row of the *uncovered* stack still showed some checks on the upper face; these boards would have been unsuitable for any application where two clear faces are required.

The results show that for 1-in.-thick "ash-type" eucalypts in the Melbourne area, the reduction in degrade by the use of stack covers will not usually result in large savings. However, where thicker material or more severe conditions are involved, savings from stack covering could be considerable and the protection provided would be important, particularly where check- or warp-susceptible or valuable timbers were being dried.

Apart from its use in reducing drying degrade, stack covering has an important function in (i) improving the drying rate, (ii) ensuring more uniform drying, and (iii) preventing the rewetting of dried material. These aspects will be discussed in a future article.

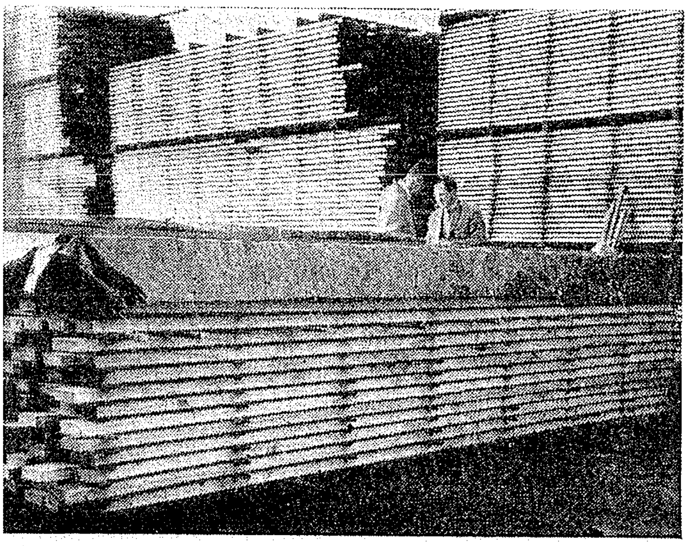


Fig. 2.

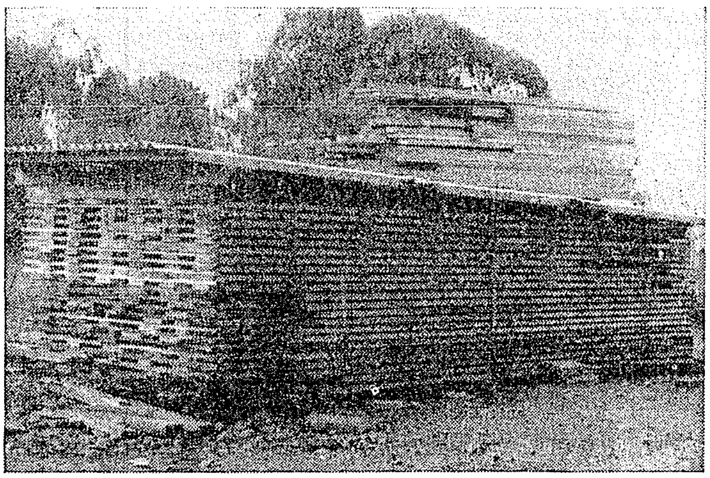


Fig. 3.

Corrosion Hastens Wear of Cutting Edges in Green Wood

By W. E. Hillis and W. M. McKenzie

There is no doubt that saw teeth and other types of cutters working in green wood are subject to mechanical wear and tear. Often the worst damage is caused by dirt, and steps such as log washing and barking may be introduced to reduce this.

When such gross damage is eliminated, friction remains as an important cause of wear but there is new evidence that it is often assisted by chemical attack. An everyday sign is the blue-staining of steel tools, especially those working in eucalypt timber. This has been studied more closely in the laboratory, where polished cutters showed staining after only a few inches of slow cutting even in radiata pine, which is not normally regarded as a corrosive wood.

Microscopic examination of the stained area revealed a raised layer of material which resisted organic solvents but could be dissolved with dilute caustic soda. On removal it was found that the polished surface layer of the steel had been etched away to reveal the grain structure. The contrast is shown in the three photographs in Figure 1. With red ironbark (*Eucalyptus sideroxylon*) the process was, of course, even more rapid (Fig. 1*c*).

The rapidity of staining and etching suggests that, in practice, wear would be hastened by repeated staining and abrasion of the relatively soft stain layer.

Some experiments were carried out to investigate the two chemical processes most likely to be involved. Acetic acid commonly occurs in the moisture of wood, and the concentration is quite high in hardwoods, especially eucalypts. It was found that drops of a solution containing this acid at pH 3, a value which is frequently found in green eucalypts, rapidly attacked tool steel in a process of acid corrosion. This, in hardwoods, is probably a common mechanism contributing to wear. However, when the acid was diluted so that its pH rose to 4, a value more typical of softwoods, its activity was reduced to a level which would not be significant unless, perhaps, it was assisted by the rubbing which occurs in cutting.

However, there are phenolic compounds (e.g. tannins) in wood extractives, some of which are known to combine with iron. This property is related to the occurrence of two or more adjacent hydroxyl groups in the molecule and the product, known as chelate, is rather stable, being soluble in alkali but not in organic solvents. Solutions of typical phenolic compounds of this type appeared to be as active as acetic acid at pH 3, but at pH 4 they were much more active than acetic acid, demonstrating the differences in the nature of the reaction and the possibility that such substances may contribute to wear even in weakly acid woods. Radiata pine is only weakly acid and was not considered to contain a significant concentration of phenolic substances, but the ferric chloride–potassium ferricyanide reagent produced quite a strong blue stain on specimens from various sources, indicating that these substances are probably generally present in this species. They are, of course, abundant in eucalypts, and similar tests of a number of non-eucalypt woods such as beech and Douglas fir showed that such compounds are more widespread than commonly supposed.

With some insight into the nature of chemical attack on steel tools, suggestions for preventing it may be offered. Stainless steels, which contain 18% of chromium, are resistant but steels containing an adequate amount of this or other corrosion-resistant substances do not at present make satisfactory wood-cutting tools. However, plating with these metals is a procedure that has already proved to be successful in some applications, such as power chain saws. Sintered tungsten carbide was found to resist corrosion and might be used for green wood on this account, where the cost might not otherwise be justified. However, it could not be used where a small wedge angle is required, as in veneer cutting.

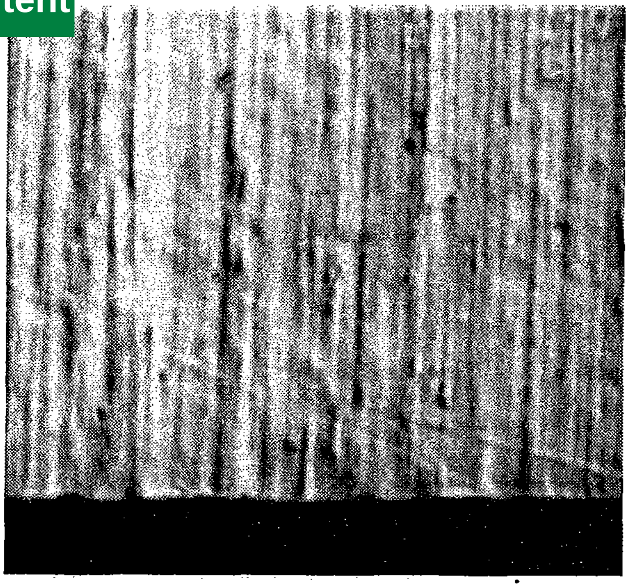
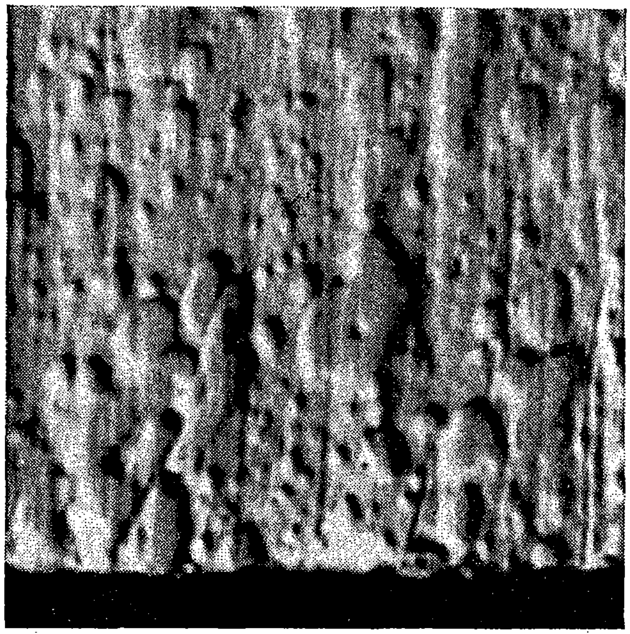
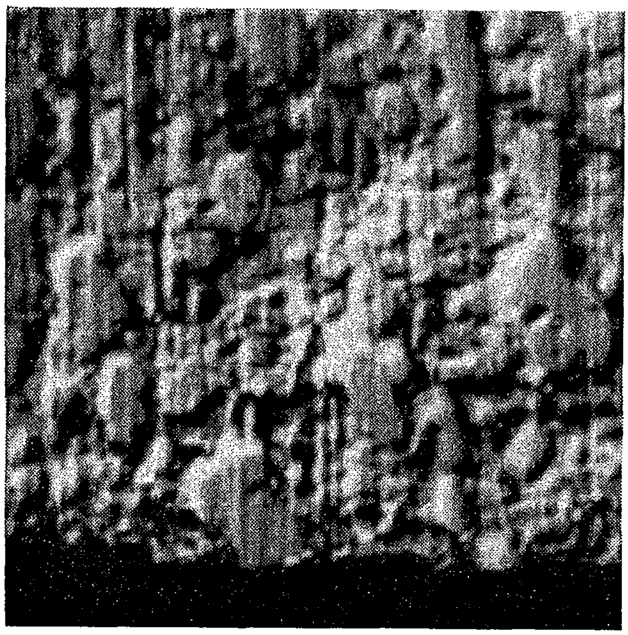


Fig. 1.—Successive stages in the deterioration near the edge of a cutter (2% carbon, 10% chromium) during slow linear cutting of thin chips in wet wood.

(a) Original state.



(b) After cutting a chip 3 in. long in radiata pine.



(c) After cutting a further chip 3 in. long in red ironbark.

The electrochemical characteristics of these two reactions have been utilized to prevent them occurring in laboratory cutting tests. When steel is in contact with wet wood, the reactions are associated with a very small electric current flowing from the carbon in the steel or some exterior electrode through the wood moisture to the iron, which is attacked. Of two possible ways of reversing the direction of this current, one is to apply an external negative voltage to the cutter, forcing the current to reverse. This has actually been done, without a close knowledge of the mechanics, in cutting experiments by Russian and Finnish workers who found that a high voltage reduced the blunting rate substantially. It is apparent that a high voltage was needed because of a long current path through the wood, which could be reduced by bringing the positive electrode into contact with the wood close to the cutter.

A more subtle way of reversing the current, based on a well-known method of corrosion prevention and used successfully in this laboratory, is to make the other electrode of a metal electronegative to iron, such as aluminium or zinc. If this electrode is placed in contact with the wood very close to the cutter and the circuit closed, the current flows through the wood away from the cutter, which is preserved at the expense of the other electrode. A minimum current flow is required for success, so that the sacrificed electrode must be very close to the cutter in order to keep the resistance due to the wood as low as possible. The difficulty of doing this or, alternatively, of applying a high voltage, may limit the practical possibilities, but there are some cutting operations where the obstacles do not appear too formidable.

Printed by CSIRO, Melbourne

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Forest Products Newsletter

DIVISION OF FOREST PRODUCTS, CSIRO, P.O. BOX 310, SOUTH MELBOURNE, S.C.5, VICTORIA

REGISTERED IN AUSTRALIA FOR TRANSMISSION BY POST AS A PERIODICAL

NUMBER 313 NOVEMBER 1964

1964##313

The Control of Surface Checking during Drying

Part I

By G. S. Campbell, Seasoning Section

ONE OF THE outstanding problems facing the Australian hardwood timber industry today is to find a means of reducing, and preferably eliminating, the surface checking which develops in the sawn stock of many of our native species during air and/or kiln drying. For example, backsawn stock is generally prone to this form of degrade, and it has long been recognized that the "ash-type" eucalypts of south-eastern Australia have to be quarter-sawn to reduce the risk of face checking.

However, sometimes this practice only transfers a problem, and edge checking can then be so extensive with some species that many sawmillers are reluctant to cut thicknesses above 1 in. because of the seasoning losses incurred with the thicker sizes. Furthermore, in some areas it has been observed that quartersawn stock is prone to a type of face checking known as "ring" checking which occurs at the junction of the early wood and the late wood. Where both edge and face checking occur in the one board, the problem becomes really serious and has prompted industry to request help from the Division in finding a satisfactory solution. Work currently being carried out is producing encouraging results and may lead to the answer to the problem. However, before discussing this work, it will be of value to review existing approaches to this problem of how to overcome surface checking.

The first is to give protection against weather conditions. In fact, during air seasoning, considerable savings can often be made by carefully drying the thicker sizes under roof cover. Protection from the sun as well as rain is necessary, otherwise there is a risk of weathering checks occurring in the top layers, a form of degrade to which many Australian hardwoods are susceptible. In Figure 1, the effect of drying 2-in.-thick Tasmanian *E. obliqua* under cover in a sheltered position is compared with that on matched material dried in an exposed outdoor position. *The importance of cover at all times cannot be over-emphasized.*

The time of year when check-susceptible timber should be cut and stacked out for air drying is also important. For example, it has been found disastrous to bring green, 2-in.-thick Tasmanian *E. obliqua* from some areas of Tasmania into Victoria for air seasoning over the summer months. The

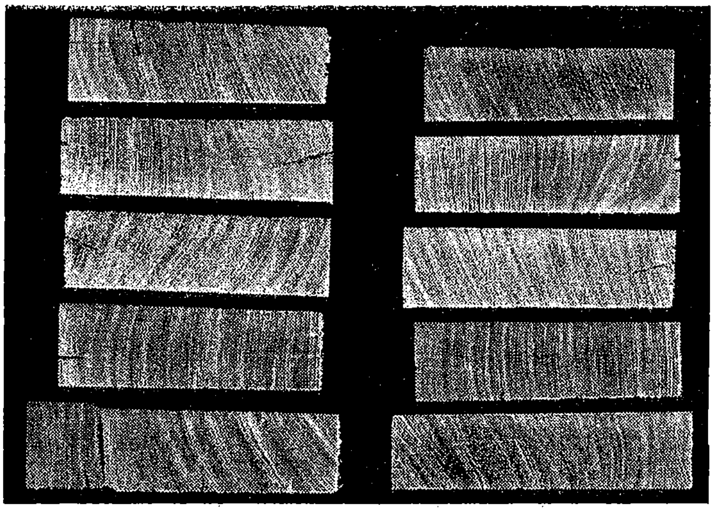

Fig. 1.—Shows the value of air drying 2-in.-thick Tasmanian E. obliqua *specimens under roof cover (right), compared to drying specimens without cover (left).*

initial drying of such timber should be carried out during the slowest drying period of the year.

A second approach is presteaming*. This technique is often effective in reducing the amount and severity of checking with some species, but it does not completely eliminate it.

A third is the choice and control of kiln drying conditions. Where check-susceptible material is to be kiln dried, either from the green or partly air-dried state, care must be exercised by the kiln operator to prevent drying conditions becoming more severe than intended by the schedule. Surface checks usually occur during the early stages of air drying and by the time the stock is ready for kiln drying they have usually closed completely. In general, fresh checks do not develop during kiln drying from the partly air-dried condition (30% or less), but existing checks may reopen and become more pronounced if unsuitable drying conditions are used. Weathering checks, on the other hand, often remain partially open throughout the whole of the drying cycle, and are, therefore, susceptible to staining.

However, closed checks, formed during either air or kiln drying, often give trouble during reconditioning and redrying, as this treatment usually causes them to reopen considerably, and to deepen and extend in length. In fact, if the charge contains a fair percentage of backsawn, or near-backsawn boards, the result is often catastrophic, and nothing can be done to alleviate the condition. In some cases, therefore, it may be better to forgo the reconditioning treatment and sacrifice recovery in order to keep the checks closed, and the timber still in a usable condition. Of course, if collapse is pronounced, the operator has no alternative other than to recondition, in which case the use of comparatively low steaming temperatures, say 180°F instead of the usual 212°F, will often mitigate the checking problem. Interestingly enough, reconditioning usually has the effect of closing internal checks, at least in the collapse-susceptible species.

Chemical seasoning treatments* of green timber can also help in reducing surface checking and have shown promise for several Australian species, but such treatments have not, as yet, been readily accepted by the Australian industry as an answer to this problem. This is probably because of the additional handling and equipment charges involved, the possible after-effects from the presence of any salt remaining in the wood after machining, and because dip treatments in salt solutions have usually been found to be ineffective.

Next month, the second part of this article will deal with the treatment of check-susceptible wood surfaces with a surface coating while in the green condition, and will also discuss the merits of this method of controlling surface checking.

* See Newsletter No. 263. Presteaming cuts drying time of "ash" eucalypts.

* See Newsletter No. 251. Can chemical seasoning help the timber industry?

MORE ABOUT TRUSSES

Shortening the Span

By H. Kloot and G. Reardon, Timber Mechanics Section

THE NEED TO support some of the trusses in a roof structure on a span shorter than that for which they have been designed is not uncommon, particularly in houses where some attempt is made to get away from a perfectly rectangular plan. In a previous article (Newsletter No. 302), the need was emphasized for properly modifying the truss if it was to be used on a shorter than usual span. The effect of not doing so is illustrated in Figure 2.

Usually the roof load is transferred to the supporting wall frame or post right at the heel joint of the truss, as in Figure 1, so that the top and bottom chords of the truss are stressed more or less in simple compression and tension respectively. If, however, the truss is supported some distance in from the heel joint, as in Figure 2, the lower chord then has to cope with a severe bending load as the roof load can only be transferred to the support via this chord. The roof load may be up to 10 times greater than the load from the ceiling which is all the lower chord is designed to support, so even if failure of the truss does not occur, there would be considerable distortion of the lower chord and a pronounced droop at the eaves line as illustrated in Figure 2. Quite apart from the undesirability of an excessive sag in the truss itself, the effects on the gutter slope when some trusses are correctly supported and others are not, could well be disastrous!

A fairly obvious way of dealing with the problem would be to stiffen greatly the lower chord so that it would be capable of carrying the high bending load without significant deflection. This solution is, however, generally clumsy and expensive. The expedien- of inserting a short vertical strut as in Figure 3 has been tried by a few builders. However, this does very little to prevent the heel joint and overhang from sagging.

Tests have been carried out at the Division to study means of modifying trusses for use on shorter spans, and the recommendations given below are based on the results of this work.

1. Nailed, Gusseted Trusses

Trusses made on-site or in the builder's workshop are usually gusseted with hardboard, plywood, or sheet steel, the gussets being attached with nails or rivets to the timber members. To modify such a truss so that it may be used over a shorter span, the following procedures are recommended:

(a) *Trusses with a Pitch Greater than* 15°

(i) If the proposed position of the truss support is 6 in. or less away from the normal position, no modification is necessary.

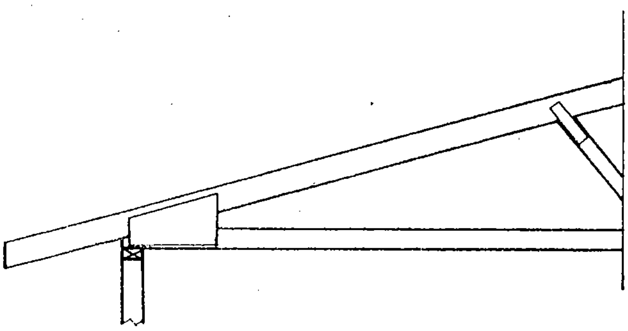

Fig. 1.—Truss supported on normal span in correct manner.

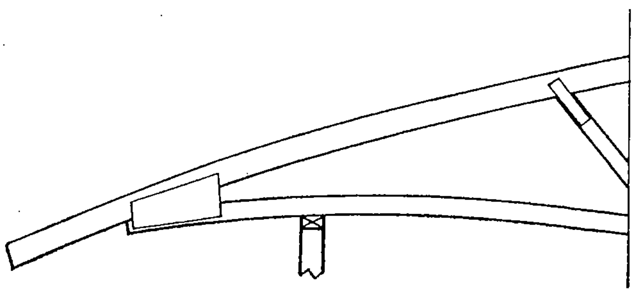

Fig. 2.—Truss incorrectly supported on shorter span. Note bending of chords leading to sag of eaves line.

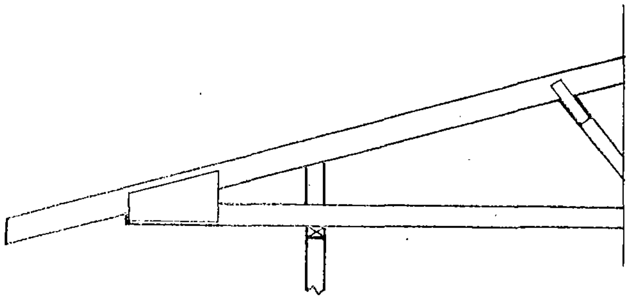

Fig. 3.—Insertion of vertical strut above support serves little useful purpose. This truss will deform almost as badly as the one in Figure 2.

(ii) If the proposed support position is more than 6 in. from the normal position, a sloping strut should be inserted as shown in Figure 4. This strut should be positioned over the support, or as near as practicable to it, but not more than 4 in. away, and should be gusseted at both ends to the main chords with as many fastenings as have been used in the main heel joint. The strut should be of the same cross-sectional dimensions as the upper chord of the truss.

(*b*) *Trusses of* 15° *or Lower Pitch*

(i) If the proposed position of the truss support is 12 in. or less away from the normal position, no modification is necessary.

(ii) If the truss is to be supported more than 12 in. from its normal position, then the procedure detailed in (*a*)(ii) above should be adopted.

2. Toothed Plate Gusseted Trusses

For some time, a number of firms throughout Australia have been marketing trusses with toothed plate gussets which, as regards pitch and span, are custom built to the purchaser's requirements. When ordering a house-lot of trusses, the purchaser should draw the manufacturer's attention to any of the trusses that are intended to be supported on a shorter than normal span. With the technical knowledge available to him, the manufacturer can make the necessary modifications and in doing so will assume responsibility for a satisfactory performance of the modifications. On no account should on-site alterations be made to a factory-manufactured truss unless appropriate technical information has been sought from the manufacturer.

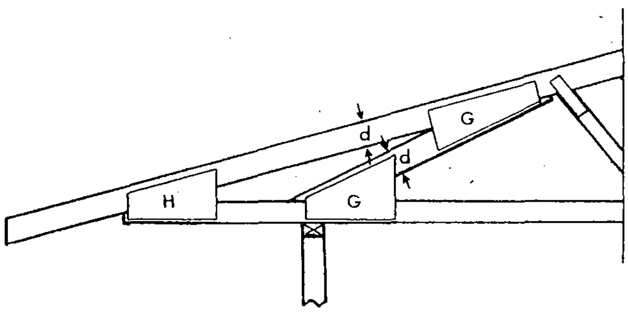

Fig. 4.—Recommended method of modifying truss for use over shortened span. Number of fastenings in gussset (G) *to be the same as in heel joint* (H).

Plywood Specialist visits Australia

THE DIVISION of Forest Products recently arranged, through the U.S. State Department, for the visit to Australia of Nelson S. Perkins, an American specialist on plywood and timber. During his five-week visit, from early October, he had discussions with officers of the Division and later gave technical lectures to timber industry managements and to members of the timber and plywood trade generally.

Mr. Perkins has been an officer of the U.S. Department of Commerce, and recently retired from the position of Technical Director of the Douglas Fir Plywood Association. He has published many books and articles on timber, and has been concerned with the application of standards, building codes, research, and engineering in the timber field.

The purpose behind his visit, which was sponsored by the Cultural Exchange Office of the U.S. State Department, was to provide expert advice and guidance to the timber industry at a critical stage in its development. The Division of Forest Products and the Timber Development Associations in the various States cooperated in the organization of Mr. Perkins's tour.

Printed by CSIRO, Melbourne

CSIRO

Forest Products Newsletter

DIVISION OF FOREST PRODUCTS, CSIRO, P.O. BOX 310, SOUTH MELBOURNE, S.C.5, VICTORIA

REGISTERED IN AUSTRALIA FOR TRANSMISSION BY POST AS A PERIODICAL

NUMBER 314 DECEMBER 1964

1964##314

The Control of Surface Checking during Drying

Part II

By G. S. Campbell, Seasoning Section

RECENT RESEARCH in this Division has shown that treatment of check-susceptible wood surfaces with a surface coating while in the green condition can reduce checking very considerably, and that this approach has distinct possibilities of being a practical and cheap method of alleviating the occurrence of surface checking.

For example, drying schedule studies on uncoated, backsawn planks of Malayan kapur (*Dryobalanops aromatica*) from $2\frac{3}{16}$ to $3\frac{3}{16}$ in. thick showed that it was impossible to kiln dry test specimens without the occurrence of pronounced face checking. In particular, one run of $3\frac{3}{16}$-in.-thick material which was fully kiln dried from the green condition developed very severe checks up to $1\frac{1}{4}$ in. deep along the faces. The checks were generally numerous and were sometimes the full length of the board, the condition of the specimens at the end of kiln drying being very poor indeed. The kiln drying schedule used was as follows:

Moisture Content Change Points (%)	Dry Bulb Temperature (°F)	Wet Bulb Depression (°F)
Green	100	10
30	110	15
20 to final	130	20

By the simple expedient of brushing on one coat of a micro-crystalline wax emulsion to all surfaces of the green timber (after a 3-hr presteaming treatment), it was found possible to *kiln dry specimens end-matched to those above, completely free of degrade under a much more severe drying schedule.* In this case, the kiln drying schedule used was as follows:

Moisture Content Change Points (%)	Dry Bulb Temperature (°F)	Wet Bulb Depression (°F)
Green	100	10
45	120	15
40	130	20
30	140	25
20 to final	160	30

Kiln drying was continued until an average moisture content of 17% was reached. The total kiln drying time required approximated 35 days. The uncoated specimens required nearly one extra day to dry to the same final moisture content under the milder schedule.

Figure 1 shows the check-free faces of kiln-dried $3\frac{3}{16}$-in.-thick kapur coated with the wax emulsion before drying, compared to the badly checked faces of the uncoated matched controls.

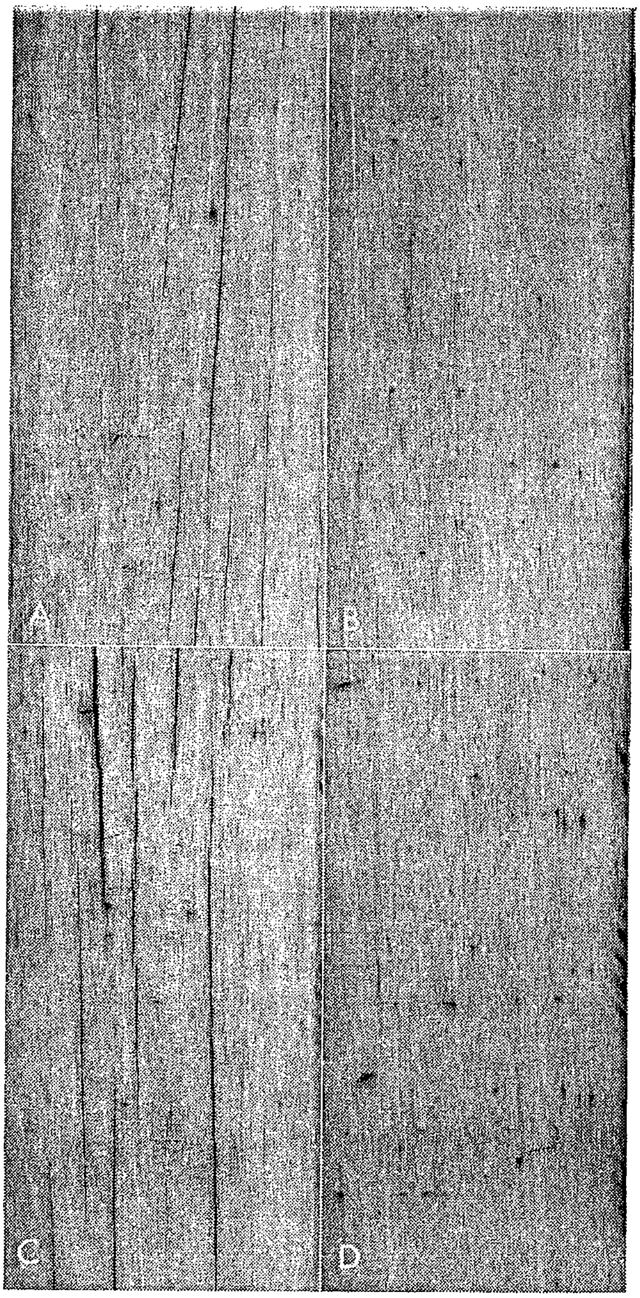

Fig. 1.—Shows the absence of checking in coated kapur specimens (B *and* D) *compared with severely checked uncoated matched controls* (A *and* C).

The coated specimens were "tacky" to touch throughout the early stages of kiln drying, but by the time this was completed they were quite clean to handle and presented no problem to the wood machinist who easily removed the coating with light machining. While it is still too early to assert that there would be no special problems regarding handling, machining, or finishing timber coated in this way, the initial trials suggest that they would not be of a serious nature, and would be far outweighed by the tremendous advantages obtained, particularly for timber needed for joinery and related purposes.

Further experimental work is proposed, and it is planned to investigate the effectiveness of several other types of coating on some of the check-susceptible Australian hardwoods. Whether or not a presteaming treatment is a necessary adjunct to the process remains to be determined. In the case of kapur, it was given because it had already been shown that presteaming increased the drying rate of this species considerably, and it was thought that this factor would tend to compensate for a slowing down in drying rate expected from coating the surface. It may well be that drying under the more severe kiln drying schedule without presteaming is sufficient.

Further research on this aspect will be carried out.

Timber Engineers visit Division

To assist in their training as specialists in timber engineering, two interstate visitors have spent several weeks at the Division of Forest Products. Mr. Malcolm Powell, who recently joined Hancock Bros. of Queensland as Development Engineer, spent three weeks mainly in the Sections of Plywood Investigations and Timber Mechanics studying the Division's work in these fields.

Towards the end of his stay, Mr. Powell had the opportunity of sitting in on the discussions between the Division's officers and Mr. Nelson Perkins, the visiting American specialist on wood and plywood.

Mr. Dennis Miller, Engineer Officer of the Timber Development Association, Perth, was at the Division for four weeks and followed a programme similar to Mr. Powell's, but with rather more emphasis on timber engineering design.

The Load-bearing Capacity of Saw Teeth

By D. S. Jones, Utilization Section

A SAW TOOTH is essentially a cutting tool and, because this aspect of a saw tooth is so important, sight is generally lost of another important feature. The cutting edge, upon which most of the forces of cutting are imposed, must be maintained in its intended path of cutting by the rest of the tooth which supports the edge. The tooth as a whole must accordingly withstand forces in the plane of the blade, lateral deflecting forces, and sometimes bending movements. However, this load-bearing portion of the tooth is usually formed merely by projecting the hook and clearance angles at the edge in straight lines to form the front and back faces of the tooth and then joining the straight lines of adjacent teeth with curves. A common profile is similar to shape 1 of Figure 1.

Teeth developed in this manner are very common in Australia and elsewhere and the profile lends itself ideally to both hand and automatic preparation. Whenever additional stiffness is obviously needed, the back of the tooth is raised by reducing the clearance angle, or the height of the tooth is reduced to produce a more squat profile. However, even when tooth stiffness is *apparently* adequate, there is growing evidence from both laboratories and sawmills which suggests that a great deal of saw mal-functioning is directly attributable to using teeth with insufficient stiffness. For example, it has been clearly demonstrated that this is one of the factors sometimes responsible for the snaking of bandsaws.

The problem of tooth stiffness was first recognized in the Division of Forest Products as placing a limit on the development of thinner circular saws, and considerable research on the problem has since been completed. The position and magnitude of the maximum stress in teeth due to lateral load were investigated in relation to tooth shape, so that the profile modifications necessary to reduce this stress and the accompanying deflection could be determined. It has already been shown* that the maximum stress due to lateral load is situated near the lower front of the tooth and that, to improve the load-bearing capacity of the tooth, reinforcement must be provided in this area. These conditions were met, without altering the angles adjacent to the cutting edge, in tooth shape 2 of Figure 1. Note that reinforcement provided along the back of a tooth by reducing clearance angle has a lesser influence upon tooth stiffness and stress.

More recently it has been possible to investigate the effects of small refinements of profile with the aid of the accurate and sensitive photo-elastic system of measuring stress. In addition, the effect on stress of tangential cutting loads has been considered. A full report of this work will be published later, but the main result is of sufficient interest and significance to justify an early preview now.

* Jones, D. S. (1963).—Towards stiffer saw teeth. *Aust. Timb. J.* **29** (8): 35.

SHAPE 1 SHAPE 2 SHAPE 3

Fig. 1.—Profiles of saw teeth. Shape 1 represents a standard profile, and shapes 2 and 3 represent reinforced profiles. The angles at the cutting edge are identical for the three profiles.

The reinforced tooth, shape 2 of Figure 1, was mainly of hypothetical interest. While it can easily be prepared on hand-operated sharpening machines, it would be rather difficult to develop with automatic equipment. Moreover, although the maximum stress was much lower and stiffness was improved, the somewhat abrupt change of direction near the cutting edge produced an unfavourable stress concentration, and could also give rise to a sudden discontinuity in the flow of sawdust. Consequently, the shape of the front of the tooth was modified to compromise between maximum structural reinforcement and other factors. It was ultimately demonstrated that the front portion of the hypothetical tooth could be replaced by a circular arc beginning a short distance from the tip without significantly altering the maximum stress, and still retain a 25% greater stiffness than that of the standard tooth, shape 1. Thus, tooth shape 3 of Figure 1 emerged.

The stiffness and stress values for the three types of teeth subjected to lateral load only are summarized in Table 1. The values for shape 1, the standard tooth, are given as unity and the figures for the other shapes are expressed as ratios of the values for the standard tooth. The stiffness is the reciprocal of the deflection for a given lateral load applied at the tip.

Table 1: Stiffness and Stress Ratios due to a Lateral Load applied at the Tip. Support through the Base of the Gullet. Values given as Ratios of Tooth Shape 1

Tooth Shape (Fig. 1)	Stiffness Ratios	Stress Ratios
1	1·00	1·00
2	1·50	0·70
3	1·25	0·74

Table 1 shows that the stiffness of tooth shape 3 was $1\frac{1}{4}$ times that of the standard tooth, and the maximum stress for the same load was only $\frac{3}{4}$ that of the standard tooth. While these relationships were established for pure lateral load, it was demonstrated that tangential loads had comparatively little influence on stress values. The effect on stress and deflection of the bending movement developed when tangential load applied to spring-set teeth was similar to the effect of pure lateral load.

Tooth shape 3 will be recognized as a profile which is frequently used, mainly for bandsaws, both overseas and in this country, and which often appears in research papers, saw manuals, and textbooks. It is not without significance that this research has arrived independently at this profile by a new approach to saw tooth profile design.

While there has not yet been time for the characteristics of saws with tooth shape 3 to be compared in this laboratory with others, this tooth shape has been well tried elsewhere. To the best of our knowledge the use of this profile has met with nothing but success and, until a better one is developed, it is the intention of this Division to promote its use for all types of ripsaws, especially for band saws and circular saws.

D.F.P. PUBLICATION ABSTRACTS

Structural Uses of Radiata and Other Plantation Pines by J. D. Boyd, *Australian Timber Journal*, Vol. 30, No. 7, D.F.P. Reprint 582. Availability—Timber trade, architects, and engineers.

RADIATA PINE and similar plantation species have many good structural properties and their less desirable characteristics may generally be modified to increase the acceptability of such timbers for a range of engineering uses. It is felt that the development of grading machines will greatly reduce the problem of the wide variation of strength that occurs with age or growth of the trees.

Many structural applications of the plantation pines are discussed, and it is pointed out that where necessary, to give high durability against decay and insect attack, they can be treated readily with wood preservatives. In addition, they lend themselves to fabrication into a variety of structural members and prefabricated sections.

This paper also includes the warning that it will not be practicable to develop the full potential of these structural uses unless very strict quality control is exercised over the grade of sawn timbers and manufactured products.

Printed by CSIRO, Melbourne