PROCEEDINGS

NINTH

FOREST PRODUCTS RESEARCH CONFERENCE

HELD AT

THE DIVISION OF FOREST PRODUCTS,

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION,

MELBOURNE

NOVEMBER 24-28, 1958

REPRESENTATION

New Guinea: (Department of Forests)	S. J. Colwell (Chief of Division of Utilization)
Queensland: (Department of Forestry)	S. G. Jennings (Officer-in-Charge, Forest Products Research Branch) K. V. Cokley
New South Wales: (Forestry Commission)	E. B. Huddleston, (Chief, Division of Wood Technology) K. Bootle D. W. Edwards
Victoria: (Forests Commission)	A. L. Benallack (Chief, Division of Economics and Marketing) C. J. Irvine
Tasmania: (Forestry Commission)	Not represented
South Australia: (Woods and Forests Department)	B. H. Bednall (Conservator) B. Brown (Part only)
Western Australia: (Department of Forests)	A. C. Harris (Conservator) H. C. Wickett
New Zealand:	J. S. Reid (Engineer in Forest Products, Development Division, New Zealand Forest Service) R. H. Orman (Senior Forest Products Officer, Forest Research Institute) T. Foley (Trade Commissioner (Timber) (Sydney))
Forestry and Timber Bureau:	D. Blight
C.S.I.R.O., Division of Entomology:	F. Gay (Principal Research Officer)
University of Melbourne:	J. H. Chinner (Reader in Forestry) A. J. Leslie
C.S.I.R.O., Division of Forest Products:	S. A. Clarke Dr. H. E. Dadswell C. S. Elliot; and officers.

Chairman - S. A. Clarke

Secretary - A. P. Wymond

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CONTENTS

THE CONFERENCE WAS OPENED BY MR. G. B. GRESFORD, RESEARCH SECRETARY (PHYSICAL SCIENCES), C.S.I.R.O.

ITEM 1. WOOD STRUCTURE, SILVICULTURAL RELATIONS, EXTRACTIVES*

(a) SUMMARY OF RESEARCH ACTIVITIES

Those of you who read our Quarterly Resumes of Work are possibly somewhat surprised and even disturbed at the wide range of activities in apparently unrelated fields. At the outset, therefore, I want to assure you that all these activities are related and are part of a definite plan. The whole object is to obtain as much information as possible about the growth of those cells which are designed to become the woody stem. To do this effectively it is necessary to investigate growth processes and, therefore, at times we are concerned with what reactions take place in the leaves of the tree and at other times with the actual changes that occur during growth in cells from the oat coleoptile, the hairs from onion roots, and plants other than trees. Then, too, we have found it impossible to divorce our morphological studies from biochemical investigations; the two must go hand in hand. The only way in which we can gain adequate knowledge of the structure and composition of the chemical constituents of wood (including cellulose, lignin and extractives) is by a fundamental study of the biosynthesis of these constituents. It is now fully accepted that the structure of the developing cell, and for that matter its chemical composition, can be altered during development as a result of external influences. The well known example here is, of course, the formation of reaction wood, which wood is markedly different both structurally and chemically from normal wood. Its development is brought about by changes from the normal conditions of growth. Thus, the more information we can get about the developing cell the better our understanding is likely to be of the chemical and physical behaviour of the wood that is eventually formed.

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*Presented by Dr. Dadswell.

For all this work it is necessary from time to time to sample the growing tree. This can be done either by stripping the cambium from the stem at times most advantageous for its examination, or by growing seedlings under varying conditions in order to study the effects of such conditions on cell growth and development. Although the emphasis of our work has been shifted towards what takes place during growth and development, and the connection between this and wood properties, the more classical wood anatomical investigations have been continued. Some highlights of the major lines of investigation are referred to below.

(a) <u>Cell Growth</u>

Work in this field has continued using root hairs, oat coleoptiles, New Zealand flax, and the differentiating fibres from <u>Pinus radiata</u> and <u>Eucalyptus regnans</u>. The interesting thing to record is the development of autoradiographic techniques in order to determine the location of cellulose synthesis in the various cells. In the case of <u>Eucalyptus regnans</u> and <u>Pinus radiata</u>, for example, we have taken young plants and allowed them to grow for short periods in atmospheres containing carbon dioxide labelled with carbon 14. This labelled carbon dioxide is quickly incorporated into the cellulose of the cell wall and one can observe the distribution of the labelled material in autoradiographs of cross-sections or of isolated fibres. Such observations as have been made on tracheids, fibres, and xylem parenchyma have, for example, given no evidence of localized synthesis of cellulose and thus appear consistent with the mechanism of multi-net growth proposed for other cells. In these investigations too, the techniques of X-ray diffraction and electron microscopy are used. Considerable advances have been made in knowledge of surface growth in plant cells and our work in this field has achieved much recognition overseas.

(b) Lignification

It can be readily appreciated that the more we know of the process of lignification in the woody stem the better our chances of understanding the chemical composition of the lignin in its natural state in the wood, and the better our chances of finding out easier methods for removing the lignin. One way to study lignification has been by the investigation of what might be termed "model systems". In them unlignified plant material, as well as in some cases lignified material, is treated in a mixture of peroxidase, eugenol and buffer. When this is done a material having many of the properties of natural lignin is deposited in the cell wall. Any close analogy with natural lignification must be drawn with caution. However, the results of the experiments are exceedingly interesting and they may give a lead to what happens in the living plant. Here again the use of labelled materials should prove a valuable aid. The actual location of lignin and of synthetic lignin in cell walls has been studied by ultra-violet and interference microscopy.

In all this work on lignification close co-operation is maintained with the section of Wood Chemistry. From the purely biochemical approach there is a need to know just what the lignin precursors are and where they occur in the living stem. In this work cambial tissue at various stages of activity is being examined and, as far as possible, the chemical constituents present determined using ultra-violet absorption and chromatographic methods.

(c) Cell Wall Organization

The knowledge gained in our detailed studies of cell wall organization has been used in an investigation of the structure and properties of fibres isolated by various mechanical and semi-chemical processes. It has been shown, for example, that in the cold soda process, where chips are treated for various periods of time in dilute alkali and then passed through an attrition mill, the separation occurs mainly between the layers S1 and S2, thus exposing the outside of S2. On the other hand, in the Masonite process and Asplund process the separation occurs more in the middle lamella zone between the layer P and S1. It is, therefore, easy to understand why it is possible to develop some strength in cold soda hardwood fibres on beating, whereas the beating of Masonite and Asplund fibres will not produce any strength development.

Work has also been carried out on the investigation of the structure of the inner layer of the secondary wall and particularly on the membrane with wart-like markings which is found on the lumen side of the inner layer. During recent months we have had with us Dr. W. Liese, of the University of Freiburg, and he has examined large numbers of species for the presence of these wart-like markings. It was found possible to isolate the wart-like material and to examine its structure in the electron microscope. Its exact nature is being investigated.

The structure of the bordered pits occurring in fibres, vessels, and parenchyma of *Eucalyptus regnans* has been studied. The pit membrane has been shown to have the same structure as the primary wall and it has been found that it is impossible to pass particulate suspensions of carbon and gold through it. The study of pit structure, particularly in relation to penetration of liquids into wood, is being continued. In this connection it is of interest to record that certain cell contents, possibly similar in nature to the wart-like material, were associated with the lack of penetration of waterborne preservatives into *Pinus radiata* sapwood. These materials stained readily with osmic acid and could be observed blocking the pit membranes.

(d) Anatomical Investigations

In this field the main work is still being directed towards the examination of the timbers of the south-west Pacific area. Numbers of wood specimens are still being received from New Guinea, in recent months mainly from the Land Research and Regional Survey Division of C.S.I.R.O., and not so much from the New Guinea Forests Department. In addition, however, we have received some specimens and are about to receive quite a large shipment of authentic wood samples from Netherlands - New Guinea. Our collections from the New Guinea region must now be considered to be fairly complete; we seldom get material from a new genus, although there are always a number of new species. More active work on the anatomy of timbers in selected families is handicapped because botanical classification is slow in a number of cases. Our work on the timbers of the Burseraceae is completed, but we are awaiting final settlement of a number of taxonomic problems. This is also the case for Sapotaceae, in which family quite a lot of botanical work is being done. The card sorting key for the timbers of the New Guinea region has been revised and a number of sets prepared. Distribution of these sets has, so far, been to the New Guinea region only.

The work on the anatomy of the important members of the genus Eucalyptus is continuing and we are building up a fund of information on these timbers. However, the staff available for this work is limited and progress is slow; publication will not be ready for some years yet. The anatomy of the bark of various members of the Myrtaceae, particularly those belonging to the Eugeniinae, is being studied and it appears that bark anatomy supports results of wood anatomy in the classification of this particular group.

(e) Bark and Wood Extractives

The important role of extractives in determining certain properties of wood is recognized. The problem is to find out just how they are formed by the tree and just what is their chemical nature. For this purpose it has been necessary to look at the distribution of certain precursors in leaves and in cambial tissue. In this connection shikimic acid is apparently quite important and its occurrence in leaves under varying conditions of growth has been studied. Here again use will be made of radioactive tracers in order to learn more about the precursors of heartwood extractives.

Some of the most important extractives from the commercial point of view are the tannins and these are being intensively studied. Knowledge of the type of reaction that occurs between tannin and formaldehyde is needed in order to understand more about tannin-formaldehyde adhesives. For such work model compounds are being used.

Extractives from hardwoods are apparently important in other directions; for example, it has been shown that ellagic acid and related compounds are involved in the blocking of pipes from digestors used in commercial pulping of hardwoods.

(f) Assessment of Wood Qualities for Tree Breeding

This particular phase of our investigations is being discussed subsequently. Mention should be made here, however, of the fact that fibre length is one of the features considered most valuable for any assessment work. Variations in fibre length can apparently be expected around a particular growth ring at any one level, especially in trees grown in areas where the influence of sunlight can be felt. Dr. Liese has shown that in the northern hemisphere the fibres from the southern side of a growth ring are appreciably (some 10 per cent.) shorter than those on the north side of the ring. In work done since he has been in Australia it has been found that in the southern hemisphere the fibre length is shorter on the north side. The effect is more manifest in the upper portions of the tree although apparent to a certain extent at butt level or levels around 3 ft. These results become important in relation to the work being carried out on the assessment of wood qualities and it is necessary to be certain that material selected from elite trees for assessment work is derived from butt regions and from a pre-determined radius so as to minimize any effect such as indicated above.

(g) Delignification

Knowledge gained on the process of lignification can be extremely helpful when investigating ways and means of delignification. If cheaper methods for removing the lignin from wood or altering it chemically can be worked out then it might well be possible that fibre separation can be carried out in many localities, particularly tropical areas, where ordinary commercial pulping operations are uneconomical. Therefore, considerable attention has been paid to the development of simple processes of fibre separation which, of course, involve delignification. It has been found, for example, that in older stems the ease of fibre separation increases towards the centre of the tree. In such trees a certain degree of acid hydrolysis has proceeded with age.

In the laboratory it has been possible to delignify wood in the form of chips by means of a sodium-chlorite treatment. Such delignified chips are readily converted into free fibres by alkaline treatment.

It has also been shown that the cold soda process can be used followed by a bleaching treatment to remove lignin to give good quality pulps. In both the examples quoted the processes are comparatively simple and following application to chips of Pinus radiata and Eucalyptus regnans we have obtained information on optimum chemical composition for pulp strength.

(h) Influence of Morphological Characters on Fibre Strength Properties

In all our work regarding assessment of wood qualities for tree breeding experiments, emphasis has been placed on the need for higher than average fibre length for good pulp strength properties.

From what has been done to date this seems to be the correct emphasis. However, to make sure that the claims of the papermakers are supported by fact we are preparing a number of pulps from one species each with a pre-determined average fibre length (varying from 1 to 8 mm). Thus it is hoped to determine exactly what effect length has on pulp strength properties when all other factors are constant.

(i) Wood Polysaccharides

Cellulose is, of course, the most important wood polysaccharide. However, the non-cellulosic polysaccharides are also of practical importance with respect to pulp yields, strength, and behaviour during beating. Fundamental work on the chemical structure of such non-cellulosic polysaccharides is in hand.

(j) Paper Physics

Work in this field has been concerned with the physical behaviour of fibre suspensions, structural factors influencing paper properties and certain physico-chemical properties of cellulose related to paper formation and properties. The influence of beating and fibre type on the drainage rate and flow resistance of pulps has been determined. The inter-fibre bonding of paper has been investigated by varying the chemical and crystalline nature of the cellulose. Physical methods including infra-red spectroscopy and viscosity measurements have been used to study the reactivity of cellulose. The nature of thermal degradation in air at 200 - 300°C has been investigated. Full accounts of these studies have appeared in recent issues of various journals.

ITEM 1(b)

NEW GUINEA TIMBERS*

Pulping and Papermaking Investigation

Investigations since the last Conference had been directed more at the examination of different pulping processes, especially those requiring a relatively small capital expenditure, rather than pulping additional species.

Groundwood. A small laboratory grinder has been constructed and groundwood prepared from klinki (using thinnings, top logs and mature timber) and several low density, light-coloured hardwoods. All pulps were compared with groundwood from Swedish spruce. In all cases the groundwood produced from klinki was inferior to that from spruce in both strength and colour. The best groundwood was produced from *Excoecaria* spp.

Chemi-ground. The groundwood investigations were extended to billets treated with various chemicals before grinding. The chemical pre-treatments produced a general improvement in strength properties, but the ranking was not changed.

Semi-chemical. Semi-chemical pulps were produced from klinki and the various hardwoods, mainly by the neutral sulphite and the cold soda processes. Klinki gave poor quality semi-chemical pulps, but the hardwoods in general gave good quality pulps in high yield by both processes. Mixtures of the different species could also be treated without difficulty. *Excoecaria* spp. once again proved to be the most satisfactory pulpwood.

Chemical. Earlier investigations by the sulphate and sulphite processes had indicated that tamagara and *Excoecaria* spp. were both good quality pulpwoods. The investigations, however, were

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*Presented by Mr. A. Watson.

made on a very limited sample range. These earlier results have been confirmed using a more representative sample.

Klinki thinnings and top log sections have been pulped by the sulphate process. Good quality pulps were obtained in all cases, but tearing strength was lower than that obtained when pulping butt logs of mature trees. The knots in the top logs also tended to reduce the yield.

Discussion

Mr. Colwell asked whether work in this field was still in progress. Mr. Watson replied that it was, and other processes were now being examined. He is awaiting the arrival of further material for testing.

Mr. Bednall asked if semi-chemical methods were unsuitable for all softwoods as well as *Araucaria*. Mr. Watson said that semi-chemical methods are better for hardwoods but have been used overseas on softwood species.

ITEM 1(c)

ASSESSMENT OF WOOD CHARACTERISTICS OF ELITE TREES*

There is a definite interest in many parts of the world in the determination of wood characteristics for those trees that have been selected as parents for tree breeding experiments. Recent publications from the United States show how they have now come to consider the wood properties in hardwoods and softwoods in this connection. Considerable work has been carried out at the United States Forest Products Laboratory on the determination of wood characteristics in relation to wood properties and tree improvement programmes; the Texas Forest Service has also an extensive forest

*Presented by Dr. Dadswell.

tree improvement programme in which wood properties, particularly specific gravity, have been taken into account. Dr. Bruce Zobel, formerly of Texas Forest Service and now of the North Carolina State College, is actively engaged in tree genetic work, paying particular attention to the importance of various wood features. Similar investigations are being carried out at the Institute of Paper Chemistry, Appleton, Wisconsin, on hardwoods, in particular poplar, by Dr. Joranson.

The Queensland Forestry Department has been expressly interested in the wood characteristics of elite trees of P. elliottii, P. taeda, hoop pine and kauri, and the Forestry and Timber Bureau in those of Pinus radiata grown in A.C.T.

From both Departments samples have been received for examination, and I think that it may safely be claimed that here in Australia we are the first to suggest a method whereby the wood features in those trees selected for breeding purposes can be assessed.

The major problem has always been how to investigate the wood properties of selected parent trees without damage to the tree. Increment borings have always been possible, but these do not meet requirements because they do not give sufficient material for investigation and they do not usually extend to the centre of the tree. In our opinion it is important that the wood from the central portion of the tree be examined because it is here that there is the greatest variation in structure and properties from the normal mature wood of a tree. Recently Echols and Mergen showed, in the United States, that a comparatively large specimen could be obtained from standing trees without prejudicing the value of such trees as potential parents. Their work has been followed by Brown and Fielding of the Forestry and Timber Bureau, who have developed a method for obtaining a much larger specimen extending from bark to bark through the pith. These larger specimens give ample material for a number of determinations of both structure and properties. The method which has been followed is to sample trees that have been previously selected on the basis of form, vigour, size, straightness of bole, etc.

The investigations undertaken in the Division have been designed to show (a) the importance of selected structural features with respect to properties, and (b) methods for assessing the parent trees on the basis of desirable properties for future use. A number of correlations between structure and properties have been established over the years, for example, in any one species cell wall thickness is closely correlated with density and density is accepted as being a good guide to strength properties of timber. In coniferous timbers there is a close correlation between percentage late wood and density, and, therefore, percentage late wood can also be used as an index to certain wood properties.

The fine structure of the cell wall has also been shown to be associated with certain wood properties, for example, Garland (1939) and Kraemer (1951) showed that the micellar angle (that angle made by the microfibrils in the middle layer of the secondary wall with respect to the longitudinal axis) was correlated with certain strength properties. When this angle was large the properties were lower than when the angle was small. Wardrop in this Division has also shown the relationship between fine structure and certain properties, particularly tensile strength. Micellar angle has also been related to longitudinal shrinkage; when the angle is large the longitudinal shrinkage is comparatively large. The determination of micellar angle is then of importance in examining wood structure in order to assess properties. However, such a determination is not a simple one as it needs some elaborate equipment. But, in any one species there is a close correlation between the micellar angle and the fibre length. This correlation, which was first demonstrated by Preston in 1934, is of the form $L = a + b \cot \theta$. As a result of this correlation fibre length can be accepted as indicative of properties within any one species, and variations in fibre length will be associated with variations in properties.

Therefore, in the examination of the wood samples taken from standing trees it is not always necessary to carry out determinations of various properties. An estimation of average fibre length and its variation through successive growth rings from the pith together with a determination of basic density, again through successive growth rings from the pith, gives considerable information regarding the properties of the wood and the results obtained can be used to assess the various trees for a particular species.

In our work the average fibre length is obtained for the last formed late wood of each growth ring; basic density determinations for individual growth rings are also carried out. Separate measurements are made of the degree of longitudinal shrinkage in the late wood and the percentage late wood in each individual ring is determined. The incidence of both compression wood and spiral grain is recorded. Average figures for fibre length, basic density, percentage late wood, longitudinal shrinkage, and micellar angle are obtained and plotted. At the same time the extremes for each of these parameters are also plotted. Results for individual trees can then be compared on the same scale directly with the average and extremes. In this way each tree can be listed in order of merit for each of the selected parameters. It is then important, of course, to determine which parameters are the ones to be given the most weight in assessing the value of the wood in the particular tree. Our opinion is that the two most important are fibre length and basic density.

It is all very well to state that the wood from selected trees will be assessed on the basis of fibre length and basic density. It is most important to know whether these two features can be transmitted from parent to progeny. Results obtained in recent work in the United States seem to demonstrate clearly that both fibre length and density are heritable and when a selection is made on the basis of these features it can be confidently expected that they will be transmitted to the progeny.

There is one other point that needs to be borne in mind. It appears that there is a variation in fibre length around the stem, this variation being correlated with the cardinal points. In the southern hemisphere the average fibre length in any one growth ring is 8 - 10 per cent. shorter on the northern side of the tree than on the southern side and the opposite is the case for trees grown in the northern hemisphere. Therefore, in selection of material from parent trees for the examination of wood it is essential to have all the trees sampled along the same radius and we have chosen the northern as the most satisfactory.

To date we have completed work on thirteen elite trees of Pinus elliottii from Queensland and twenty-nine elite trees of Pinus radiata from Australian Capital Territory. Other specimens of Pinus radiata from South Australia will be examined.

Discussion

Mr. Irvine asked whether there was any correlation between spiral grain and any other properties.

Dr. Dadswell replied that there was a correlation between spiral grain and longitudinal shrinkage, but it has not been examined here because our specimens were specially selected with straight grain.

Mr. Orman asked for average figures for trees regarding fibre length and basic density. Dr. Dadswell replied that the average fibre length is about 2 mm but average basic density is unknown.

Mr. Orman asked whether any work had been done on non-elite trees. Dr. Dadswell replied in the negative. Mr. Orman remarked that the New Zealand Forest Research Institute had studied natural populations in the same way and could give figures on request. Their genetic section was still studying natural populations and elite trees.

Mr. Jennings has figures on parents and progeny and also crosses. He wondered whether environment could effect these figures. Dr. Dadswell said that environment was quite important.

Mr. Jennings said there was some indication that *P. caribbea* had higher basic density as they went north, because of greater amount of late wood.

Mr. Irvine asked whether Mr. Jennings had examined selfed trees and progeny. Mr. Jennings said he had.

Mr. Orman stated that he had examined the resin content and asked whether such work had been done in Australia. Dr. Dadswell replied that it may be done later.

ITEM 1(d)

REVIEW OF TANNIN MARKET*

The following production figures for tannin extracts are quoted in order to help give an overall picture of the tannin market.

Quebracho	-	2 - 250,000	tons p.a.	
Wattle	-	120,000	" " "	
Chestnut	-	100,000	" " "	
Myrabolam	-	20,000	" " "	
Others	-	20,000	" " "	(approximately)

Whereas previously there was a deficiency, there is now a surplus in the world supply of extracts. The reasons for this should be considered from several angles.

*Presented by Mr. Hillis.

(a) Leather Market

At present there is a strong trend to the use of pale-coloured flexible leather as soles and uppers in footwear in the Western World, there is increasing competition by leather replacements such as the plastics, and the tanners are losing markets. Recent work in the United States has tried to overcome this competition by new processes for treating hides using synthetic tanning agents alone, or with small proportion of tannin. As approximately 40 per cent. of tannin enters the hide to form leather, tanners are demanding lower prices in the vegetable tannin extracts so that they can produce cheaper leather. The loss of leather markets is reflected in the extract market.

In the Eastern World, leather consumption will increase in many countries as the standard of living improves. Consumers are becoming less satisfied with the dark, inflexible leather produced from indigenous tannin extracts. Wattle and chestnut are being used in increasing amounts.

(b) Uses of Tannins in Other Fields

(i) Very large quantities of tannins are used in oil-well drilling - of the order of 40,000 tons in the United States. Formerly, quebracho was almost exclusively used for this purpose, now others are used.

(ii) Other uses consume only a small portion of the production of tannin at present.

(c) Production of Tannin Extract

Up to the beginning of 1956 there was an increasing shortage of vegetable tannins. It was considered that quebracho would be cut out by 1980. Early in 1956 a large company of extract manufacturers completed a survey of the Chaco region of the Argentine and found there areas of quebracho large enough to meet the demand for some hundred years. As a result that company's wattle planting programme in Rhodesia and other parts of South Africa was cancelled. However, wattle planted before that time will come into production within the next 8 years. It is considered that an extra area equal to one-third of the present area will be producing wattle bark between 1960 and 1966. On present indications there will be a great surplus of production at that time. Within the last 18 months the price of wattle extract has fallen by £A20 per ton but it could fall further and still remain a profitable crop.

The chestnut extract manufacturers can increase their output and are looking for new markets. An extract from the bark of Western hemlock has been found to be an efficient agent for the control of viscosity of the muds in oil-well drilling, and a large factory has been erected to produce it. Recently a modified chestnut extract has also been used. These will make serious inroads in the consumption of quebracho for oil-well drilling.

Many tannins from Australian sources have inferior properties such as colour and astringency and they can only be used in minor proportions in tanning. Other uses where these properties are not important must be found for them. Work in this Division has shown that a possible use lies in the field of plywood adhesives but at this stage wattle extract appears to be the best extract. Much work must be done to improve other tannins for this and other applications.

It should be pointed out that there may be a tendency on the part of some interests to exaggerate the present supply position caused by the discovery of the new quebracho forests. These forests are a considerable distance inland, the trees are scattered, and transportation costs alone would be high. At the present time quebracho is one of the more expensive tannins and the extra production costs may mean that quebracho will cease to be the main extract on the market. If this is true, then the tannin supply position is likely to return to a more balanced one.

Discussion

Mr. Harris commented that there was increasing consumption of mallet bark, Germany taking a considerable portion.

ITEM 2. TIMBER MECHANICS, TIMBER ENGINEERING

(a) SUMMARY OF RESEARCH ACTIVITIES - MINOR ROLE OF SPECIES TESTS*

During the last Conference mention was made that the work of the Timber Mechanics Laboratory was moving away from true timber mechanics and that timber engineering was assuming considerably increased importance in our programme. You will recall that much of our earlier work was concerned with species testing, and with associated studies directed towards standardization of test methods and conditions, and scientific adjustment of test results. The latter studies allow us to make reliable comparisons between species, not only those tested in our laboratory, but also species tested in other laboratories throughout the world.

Since the last meeting we have published a Bulletin detailing the mechanical properties of some 100 timbers of Australian and New Guinea origin. This publication makes available most of the species test results accumulated over the years. We are also drafting another publication which will contain data on the properties of other timbers used in Australia, but which generally have not been tested by this laboratory.

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*Presented by Mr. Boyd.

With the substantial completion of species projects, we have felt there was an increasing and urgent need to provide engineering information and advice to architects, builders and others interested in timber construction. Accordingly the emphasis of our work has changed. This does not mean we will not do such additional species testing as might seem warranted from time to time. However, species work is slow and costly, and with data already providing a fairly good coverage of our Australian timbers, proposals for additional species tests must be justified in the face of other urgent projects including, for example, the sponsored pole project, and the very considerable demand for structural work. Thus species testing must now be relegated to a very minor position in our research programme and must be fitted in as opportunity offers between other projects.

There will continue to be a few other mechanics projects which must be fitted in with our timber engineering work. Perhaps the most notable, and presently the most active of these, is that concerned with the silvicultural-strength properties of timber. At the present time the major emphasis here is on studies of plantation-grown softwoods. Much of this work has previously been reported to this Conference; however, other work is proposed in co-operative studies with the Wood and Fibre Structure Section. A not unrelated investigation is that involving comparisons of regrowth and virgin growth timber. At the present time, for example, some tests are being made on regrowth jarrah and karri, with a view to studying properties and market possibilities, and establishing economic justification for thinning and other silvicultural treatment of this material.

Another project proposed for the immediate future concerns the strength properties of various Australian structural plywoods. This material is being supplied by the Australian Plywood Board, and of course the tests are directed to obtaining information for structural design purposes.

It might be mentioned here that some tests have already been made on karri plywood in our laboratory annexe in Western Australia, and the results will be prepared for publication shortly. A great deal of effort also has been applied to the preparation of design data for the use of plywood as concrete formwork. This information has recently been published by the Australian Plywood Board.

ITEM 2(b)

POLE STRENGTH INVESTIGATIONS*

At the last Conference it was mentioned that a pole strength investigation had been organized, that some funds for the project had been received from the pole-using authorities, and also that some pole timbers had been donated by the Victorian Forests Commission for testing. Since that time a very considerable amount of work has been done and some progress reports issued. Tests have been completed on the green material for five species, messmate stringybark, grey ironbark, yellow stringybark, jarrah and radiata pine, which of course represent the four strength groups. However, the radiata sample was not a complete one, and it is proposed to obtain more poles of this species, especially some of unusually fast, and some of very slow growth rate.

Poles which have been allowed to season to a moisture condition suitable for preservation treatment have subsequently been tested for strength. This was done after re-soaking the sections subject to maximum bending stress, so as to simulate service conditions. Species so tested include messmate stringybark and yellow stringybark. It is hoped to complete similar tests on grey ironbark and jarrah this summer.

Associated with this investigation on poles, tests have been made on small specimens cut from them, with a view to correlating

*Presented by Mr. Boyd.

results with our standard test data. Also after some exploratory tests on the effect of some preservation treatments and pre-treatments, an investigation has been planned to check the effect of various heat and treatment schedules on strength.

Waterborne and creosote preservative impregnations have already been made of small section sticks and short logs, and the strength of this material will be checked to determine any strength influence of the preservatives. Some of the strength tests will be made after a considerable delay period to allow for possible chemical effects on the wood. Provision has been made also for soaking specimens so that conditions at the time of test are comparable with those at the maximum stressed position of the pole near the ground-line.

It is hoped soon to commence preparation of reports on these pole timbers although it may be as much as 12 months before all tests are complete. Even then results will not be available from the longer delayed tests of the effects of preservative on strength. However, in view of the urgency of publishing this information to allow maximum economic benefit to the sponsoring authorities, it is considered best to analyse the delayed results in supplementary publications.

One aspect of this investigation which I would like especially to comment on is the very considerable co-operation we have received from interested parties. Almost without exception the pole-using authorities throughout Australia have contributed towards the cost of the work and shown a very definite interest in it. Also four of the State Forestry Services, Victoria, Queensland, Western Australia and South Australia, have made major contributions by way of material, and their co-operation has been very much appreciated. As a matter of interest, the Conference might like to know that a sum of approximately £26,700 was contributed in cash towards the cost of this investigation.

Discussion

Mr. Reid asked if any particular aspects in a specification for radiata pine for poles had been considered, i.e. what was the approach to limiting the size of knot whorls and the importance of the percentage of mature wood in the pole.

Mr. Boyd replied that as only average growth pine had been sampled and the data on defects and their effect on strength was correspondingly limited, insufficient information was available for specifications of the nature suggested by Mr. Reid. Work will be done on fast and slow grown and young pines.

Mr. Orman mentioned their work on Douglas fir, larch and pine, untreated and treated with creosote and pentachlorphenol. Fir and larch showed a large degrade factor with treated poles on basis of tests on small clear specimens, probably due to treatment.

Mr. Boyd said that he had no information on this as yet. He had found modulus of rupture of green hardwood poles 1.0 to 1.3 times the modulus of rupture given by static bending specimens taken from poles. The ratio of 1.0 would probably cover dry poles. Green radiata pine poles gave much the same ratio as green hardwood, but there are no test results for dry radiata poles.

In reply to a query by Mr. Irvine, Mr. Boyd said that knot clusters in the pole did not normally define the zone of failure. A few tests had shown that shaving a pine pole to remove major bumps caused by whorls reduced the strength to 60 per cent. of the unshaved poles.

ITEM 2(c)

TIMBER ENGINEERING*

At the last Conference I discussed the various aspects of timber engineering in which we were particularly interested. Of these aspects most attention has since been given to nailed joints, glued joints, column tests, scantling tests, and general structural developmental and design work.

(a) Nailed Joints

We have continued our work on this project; a large amount of data has been assembled and much of it prepared for publication. This study has considerably increased our knowledge of the strength of nails in Australian timbers, and on the basis of test information we have already included modified recommended working loads for nails in our new Timber Engineering Design Handbook. However, until analyses are completed and reports written the precise significance of some of this work, particularly from the more fundamental viewpoint, cannot be clearly assessed.

(b) Glued Joints

It was indicated earlier that we proposed to give considerable emphasis to a study of the use of glue in the fabrication of engineering structures. In this connection we have designed a considerable number of structures depending on the strength of a variety of glued joints. Included amongst the variables are various shapes of joints and various materials such as different species of timber, hardboard and plywood.

Because of a dearth of knowledge, we anticipated difficulties in the fabrication, and more particularly in the performance of glued structures, especially those of a novel design. This, in fact, proved to be the case.

*Presented by Mr. Boyd.

Even with the technique of gluing, which appeared to be a relatively simple and straightforward matter, serious troubles occurred. It became obvious that good tradesmen, having all reasonable facilities available and the advice of specialists on glue, could not produce good structural joints without a great deal more specific instruction than was available. After studying a number of failures of structures and their causes, we decided it was desirable to produce a specification for structural gluing procedure, and this is now being drafted.

In the testing of a number of structures, types of failures which were not attributable to the gluing technique, were observed. It was apparent from these that there were serious gaps in our technical knowledge of stress distributions in certain types of joints. These matters are now being given serious thought and the more urgent will be critically studied in the near future. It has been shown clearly on a number of occasions, for example, that although the average glue stress in a joint would appear to be reasonable, local high stresses due to secondary effects of bending in the structure, or due to pre- or post-stressing of the structure to produce camber, could be serious. Also, stressing due to differential movements between joint components, resulting from moisture changes, must be carefully studied.

Until more is known about the above effects, the use of glue other than for glued laminated construction and simple built-up beams and panels will be seriously hampered. Proof-testing of structures is one way of overcoming this difficulty, but this is not always convenient or economic.

(c) Columns

The project concerned with columns has been continued with more emphasis recently on setting up columns in seasoned timber. Under these circumstances, the columns, even at the higher loads relative to short-duration failure loads, tend to sustain load considerably longer than when columns are erected green. Thus the results and conclusions from this portion of the project will be much slower forthcoming.

Overall there has been no marked change in the earlier indications from this investigation, and it appears that our past recommendations for column design will be substantially justified.

(d) Scantling

It was mentioned at the last Conference that we had begun scantling tests on jarrah. Results of this study have now been published, and it has been shown that the grading rules formerly applied to this species are not fully supported by the test results, and particularly that the strength of timber having sloping grain is rather higher than might have been expected when judged from the grading rule assessment and the originating data in overseas publications.

Another important aspect which came out of the study was that blemishes tend to affect the stiffness of this timber to a degree quite similar to their effect on strength. This relationship had not been previously recognized in publications, and again is out of line with statements made by overseas authorities.

Recently we made a number of strength tests on radiata pine scantling. This project is by no means complete, and in addition to the tests made at the Division, we hope to co-ordinate our work with radiata scantling tests already made or being made at the Forest Research Institute in New Zealand, and also projected work at the Division of Wood Technology, New South Wales. One of the interesting aspects of results of this work to date is again that the basis of assessment of grade used overseas, and particularly in America, is by no means satisfactory when applied to radiata. There is a very strong indication also, as was the case for jarrah scantling, that defects affect the stiffness in a way and to a degree comparable with their effect on strength. This latter factor is a very significant one when considering the utilization of this material.

(e) Structural Design

Some of you may have heard of the enquiry received by the Division for the design of a suitable roof covering for the Sidney Myer Music Bowl in Melbourne. This will be a quite unique structure with a very large clear floor area. Structurally it is dependent on a network of cables supported on two columns at the front and anchored to bedrock at the sides and back of the building. Originally the proposal was that the covering to be applied to the flexible structural cable system should be concrete. However, we (and others) advised the architects and engineers there would be many difficulties associated with water-proofing such a roofing; finally we persuaded them that the most satisfactory roofing would probably be one of plywood. As a consequence, we were asked to design such a roof.

Unfortunately the inadequacy of general design information available from the architects and consulting engineers required that we construct a scale model and make tests to find the stress distribution and deflection characteristics of the structure under a variety of wind loadings. Based on our test results, it was shown that the design system proposed by the engineers was more costly than need have been used. In addition, of course, we provided the design which originally was requested for the jointing of the aluminium-sheathed plywood roofing sheets and their water-proofing. The building of this structure is now well advanced, and it will be sheathed with $\frac{1}{2}$ in. thick alumply as designed.

A very large number and variety of requests for other structural designs have been received from all States. Latterly, the Timber Development Associations in the four States - New South Wales, Victoria, South Australia and Western Australia - have all independently asked us to provide detailed designs for them with a view to promoting engineering use of timber. At present we are not able to do this, but we have indicated that if these Associations are prepared to sponsor the work, we will endeavour to meet their requests.

It appears that the Timber Engineering Design Handbook, which you will recall was in course of preparation at the time of the previous Conference, has met with a very good reception and has been commended by authorities, both here and overseas. However, it does not meet all the needs of small builders and constructors, many of whom would like to have standard drawings from which they could produce either on request, or on a production line basis for selling "off-the-shelf".

Discussion

Mr. Huddleston asked if the Division of Forest Products work on engineering design fitted in with the work of the C.E.B.S.

Mr. Boyd said that there was very little overlap as his section concentrated on basic studies of design of timber structural units only, joint analysis and stress distribution, rather than the more general investigations of sufficiency of composite structures made by C.E.B.S.

ITEM 3. SEASONING

(a) SUMMARY OF RESEARCH ACTIVITIES*

This review of seasoning activities is somewhat limited in scope, as several of our projects are to be discussed as separate items immediately following this review. I shall, therefore, make only passing reference to these at the present time.

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*Presented by Mr. Wright.

Furthermore, I do not propose to review that part of our activities covering direct industry assistance. Most of you, as delegates to previous Forest Products Research Conferences, know that in this is included short-term, ad hoc studies to obtain more-or-less immediate answers to processing problems; seasoning plant design and layout work; consultant activities; kiln design; education work in the form of seasoning classes and correspondence courses, and aspects of wood waste disposal, and the like. I shall, therefore, limit my remarks to our work of more research interest.

Projects on hand at the time of the last Forest Products Research Conference, and still active, include -

(a) collapse, and its prevention or recovery,

(b) equilibrium moisture content in relation to wood usage,

(c) the prevention of log and pole drying degrade,

(d) studies on predrying, particularly to improve dried quality and rate of drying,

(e) kiln design studies,

(f) studies on yard drying and yard design,

(g) studies on the seasoning of young regrowth plantation eucalypts, and

(h) some limited work on chemical seasoning.

In addition to these, several projects have been commenced since the last Conference. These include -

(i) a basic study to determine the influence of meteorological conditions on the e.m.c. of wood,

(j) studies to determine the most suitable of possible accelerated drying methods for sleeper and pole timbers intended for preservation purposes, and

(k) work on the drying of radiata pine.

With respect to the above studies, the present position is as follows.

(a) Collapse

In this work we are trying to determine how recovery can be improved, collapse prevented or reduced, whether there is a collapse susceptibility pattern within trees warranting preferential sawmilling or other processing practices, what factors inhibit recovery and how these can be neutralized, and whether the present theory on collapse can be verified.

As this forms the subject of a separate paper I shall not summarize progress at the present.

(b) Equilibrium Moisture Content

This continues as a major project of the Section.

Since the last Conference, studies on the seasonal variations in moisture content in the components of timber and brick veneer houses have been continued, as have those on railway sleepers and other timber products. For example, we now know that in housing there is a marked variation in moisture content with height in the house. In Melbourne the range is about 5 per cent. of moisture content from sub-floor timbers to rafters, i.e. from about 14 to 9 per cent. in summer and from about 18 to 13 per cent. in winter, ranging slightly less in the case of timber houses and slightly more in brick veneer. Further, that the ridge timbers do not obey this rule but become much higher in moisture content than the rafters in winter.

The sleeper moisture content studies have shown that in the Melbourne metropolitan area, irrespective of age of sleeper, site, drainage conditions or season, the core moisture content does not drop below fibre saturation point.

We have also completed an e.m.c. exposure study in Antarctica since the last Conference: this has shown wood e.m.c. there to range from 10 to 14 per cent. in exposed outdoor sheltered conditions, but to be as low as 4 per cent. in personnel shelters.

(d) Yard Drying Studies and Yard Design

Over the past several years we have also been concerned with a gradual deterioration in the efficiency of air drying yards in industry. This deterioration is possibly partly due to the fact that in mechanising with fork lift and straddle trucks and the like, basic principles of stacking practice have been forgotten by industry. It is a fact, however, that for each 1 per cent. of loss of stock due to poor yard practice, the industry loss can be reckoned in hundreds of thousands of pounds. In addition, embarrassing and costly architectural and construction difficulties originate from this same source, quite a number of which often find their way to our laboratory, and probably organizations for help in resolution.

We have, therefore, continued, and are extending, yard studies with two objectives, (i) to find the best yard pattern for stacking with mechanized equipment, taking into account drying rate and uniformity, and (ii) to show industry how much this will pay off in material recovery and reduced costs.

(e) Studies on Predrying Conditions

Such extensive use has been made of predriers in Tasmania and Victoria that work on aspects of predrying operation has continued steadily since the last Conference, particularly in relation to schedule conditions, the effects of steam treatments before and during drying, the influence of time of reconditioning in relation to moisture content, and the effect of double reconditioning treatments in improving recovery. Some of this work is, of course, closely related to that on collapse.

There is also to be a brief separate report on this work so I shall not enlarge further at this stage.

Delegates may be interested to know that the Tasmanian industry has called a conference for later this year to discuss predrying conditions, determine what further research on predrying is required, and where and how this can best be done.

(f) The Drying of Young Eucalypt Material

Work has also been started to assess the drying behaviour of sawn material from young eucalypts in relation to the age and size class of the stock producing it. Apart from its intrinsic value, this information is of importance to those who must consider future silvicultural and conversion practices, an aspect thoroughly recognized by our friends in the Victorian Forests Commission who very kindly supplied us with the material to work with.

In brief, pilot work is in progress on $\frac{1}{2}$ in. to $1\frac{1}{2}$ in. thick material from two trees each of E. regnans (26 years old, GBHOB 3 ft 6 in. to 4 ft 3 in.); E. obliqua (26 years old, and GBHOB 3 ft); and E. sieberiana (26 years old, and GBHOB 2 ft 9 in. to 3 ft).

Results so far show good dried quality from the messmate stringybark after reconditioning: this material has showed up well with little checking and comparatively little collapse after reconditioning; good dried quality from one of the mountain ash trees, but poor dried quality from the other because of excessive collapse and checking; and somewhat mixed results from the silvertop ash because of pronounced collapse, although reasonably good recovery was generally obtained on reconditioning.

As might be expected, any board containing pith generally degraded markedly.

Work on this is proceeding.

(g) The Accelerated Drying of Poles and Sleeper Timbers

For the same reasons that the Tasmanian industry has turned to predriers for sawn timber, the rapidly developing preservation industry in Australia now recognizes it must turn to accelerated drying for partially drying the $\frac{1}{2}$ in. or so annulus around the outside of poles, sleepers and other large section timbers which require pressure preservation treatments. For example, at one pole preserving plant employing air drying methods the yard storage approximates 50,000 poles, the capital value of which approximates some £500,000. By accelerated methods this can be reduced to, perhaps, one-fifth, and at the same time ensure that immediate treatments can be given for urgently required products instead of there being a delay of some months.

With our Section of Wood Preservation we are shortly starting comparative studies to assess the relative advantages of steaming and cooling, steaming under vacuum, boiling-in-oil, boultonizing, and predrying for this material. It should then be possible to compare results with those obtained earlier with vapour drying.

(h) Radiata Pine

Work has been done on the drying of radiata pine since the last Conference. I shall, however, also defer comment on this as it will fit better into our discussions on this species later.

(i) Stabilizing Treatments for Wood

Work to assess the value of introducing stabilizing or bulking chemicals into wood has also been commenced. At this stage we are examining for comparisons the effects of - (i) polyethelene glycol; (ii) polyethelene glycol plus phenol formaldehyde resin; (iii) phenol-formaldehyde resins; (iv) silicones; (v) sodium chloride, and (vi) urea.

Some limited treatments with (i), (iii) and (iv) above on rifle furniture have been made with promising results. Work is proceeding with sawn timber.

Discussion

Mr. Orman asked what roofing material was used in the e.m.c. survey of structural members in housing, and whether studies were made under galvanized iron sheeted roofs. Mr. Finighan replied that as the survey was carried out at a Housing Commission estate, the choice of houses had to be restricted to those at a suitable stage of construction at the time. All those used had tiled roofs, as there were no houses being constructed with galvanized iron roofs.

Mr. Orman said that in New Zealand, with material up to 2 in. thick (for four species including P. radiata) commercial treatments (four preservatives) had little effect on e.m.c. With double retention treatments, an increase of only up to 0.3 per cent. occurred in $\frac{1}{2}$ in. material exposed outside. No significant increase was apparent in thicker material. With zinc chloride ($2\frac{1}{2}$ per cent. solution) increases in e.m.c. of up to 3 per cent. were obtained in the vicinity of the 20 per cent. e.m.c. for matched untreated material.

Mr. Huddleston said that in regard to log storage, particularly of radiata pine, but also of some hardwoods, they intended to study the effect of water sprays (on degrade) in the New Year and to carry the project on for a few years.

Mr. Cokley asked Mr. Orman what, in their experience, was the effect of preservatives on drying rates, and Mr. Orman replied that they cause a decrease in drying rate.

Mr. Cokley said that the Queensland trade has found that a definite increase in drying rate occurs with boron treated material.

Mr. Huddleston asked whether any controlled tests had been made, and mentioned that they have found that boron treated timbers have a lower drying rate. Mr. Cokely replied that certain commercial firms had done controlled tests. Some purposely treat first to obtain faster drying. The normal air drying time in one area for spotted gum is 6 months, whereas, after immunization, drying took 4 months as measured by sample boards.

Mr. Wright mentioned that work done by Mr. Campbell shows steaming before or during drying increases drying rate of the "ash" type eucalypts.

Mr. Reid said that they have found that sapwood, after immunization, dried unevenly rather than faster.

ITEM 3(b)

E.M.C. STUDIES - REVIEW OF PROGRESS TO DATE*

At the 1956 Forest Products Conference it was decided to commence an Australia-wide survey of equilibrium moisture contents for a number of timber species.

An attempt will be made to relate e.m.c. and meteorological conditions in a regression equation which will enable e.m.c.'s to be predicted for any locality where climatological readings are available.

A working plan was drawn up and an outline of this was forwarded to all the co-operating bodies.

Specimens of eight species were exposed at eleven localities throughout Australia and New Guinea. Suitable three specimen thicknesses were used, namely, $\frac{1}{4}$ in., $\frac{3}{4}$ in. and $1\frac{3}{4}$ in., with an overall specimen size of 9 in. x $3\frac{3}{4}$ in. A standard form of shelter was used which combined free air circulation with protection from sun and rain. Assistance was provided by the Forest Departments in all capital cities excepting Adelaide where the Division of Soils of C.S.I.R.O. is co-operating. Other co-operating bodies were the Bureau of Meteorology and the Zinc Corporation.

The temperature and humidity at each exposure site was measured daily and recorded with the corresponding weights and widths of the specimens. In addition, wind speed and rainfall were also measured at most stations.

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*Presented by Mr. Finighan.

All data was punched on to Hollerith cards to enable the rapid determination of the significant variables to be used in the regression equations.

Species

Brush box	Radiata pine
Jarrah	Queensland maple
Klinki pine	Spotted gum
Mountain ash	Tallowwood

Exposure Sites	Co-operator
Adelaide	Division of Soils
Alice Springs	Bureau of Meteorology
Brisbane	Department of Forestry
Broken Hill	Zinc Corporation
Cairns	Bureau of Meteorology
Dwellingup	Forests Department
Canberra	Forestry and Timber Bureau
Hobart	Forestry Commission
Lae	Department of Forests
Melbourne	Division of Forest Products
Sydney	Division of Wood Technology

Discussion

Mr. Blight asked what was the importance and ultimate use of the survey, and Mr. Wright replied that it was very necessary that the correct e.m.c. for particular uses in various parts of Australia should be known, as otherwise manufacturers and users ran the grave risk that timber products, fittings or equipment supplied would distort or become unserviceable in use. An important aspect of the study was that it would enable accurate prediction of e.m.c. values for areas on which information was not now held. Information on e.m.c. throughout Australia was also increasingly being required for specification and legislation purposes.

Mr. Huddleston agreed that it was of great importance to have a clear picture of the variations in e.m.c. throughout Australia, and mentioned particularly some of the difficulties associated with flooring in centrally heated buildings. He stressed the necessity of knowing the e.m.c. in all locations in a building, and using timber at the correct moisture content, but doubted whether any correlation between e.m.c. and meteorological conditions existed. He also said that the Sydney observations would be extended by exposing three species in indoor and outdoor locations.

Mr. Orman mentioned that a similar e.m.c. study was made in New Zealand 10 - 15 years ago and significant regression equations were found. He felt that it would certainly pay to carry out the present study as carefully as is planned.

Mr. Wright said that before commencing the study, the data of Elliot and Thomas were carefully examined. It was found that sufficiently good relationships were obtained to warrant proceeding with the work.

ITEM 3(c)

YARD DRYING STUDIES*

As mentioned in my review of seasoning activities, we have been somewhat concerned with what appears to be a general deterioration in drying yard design, and air drying control in industry.

This may have been due to a slackening of standards over what was, until comparatively recently, a long period of high timber demand; or it may be that timber standards which "got by" before the

*Presented by Mr. Wright.

wide adoption of fork lift trucks, etc., have proved woefully inadequate for high, multi-pack stacks, or it may be that the adoption of more mechanization has been thought automatically to eliminate the need for quality control methods, so that these have then been forgotten.

No doubt each of the above factors has contributed in some measure, but I believe another important factor has simply been ignorance of what should be done in air drying yards. My experience has been that management generally gives serious thought to yard design and the handling and stacking of drying stacks, and usually the stacks in the yards of the more reputable companies are well built, and the yards are clean, and a cursory impression is one of efficiency and well managed areas. Nevertheless, troubles due to unevenness in moisture content and similar factors flare up every now and then in material supplied from these apparently well controlled yards.

The fact is, however, that as recently as the last few months we have been asked by firms of some standing in at least three States to help them resolve difficulties which have arisen on a large scale because of poor behaviour of seasoned products marketed by them. This has led to losses for suppliers, agents and users. The latter, no doubt, have been left somewhat dissatisfied with the timber. These difficulties were not petty examples of minor carelessness. For example, whole floors in buildings or houses have had to be pulled out because of shrinkage and cupping.

The reason for this is that for all care and neatness of layout and sawing, the yards are inefficient drying units, with the lower parts of stacks and all but the most exposed stacks drying unevenly.

Besides causing the troubles mentioned, the timber in such yards has to be held drying perhaps 6 months longer than it should at an unnecessary additional cost of about 6/0d. per 100 super ft. Furthermore, such a plant, even a plant with a moderate output of, say, 50,000 super ft per week, because it is involved in holding 6 months more timber than it need, has to find another £60,000 capital for this extra stock. Obviously, some action on this situation is necessary.

With the co-operation of some five Melbourne yards we have now completed a study to demonstrate these factors.

The aim of the study was to determine the most effective spacing and yard conditions that would give fastest and most uniform and economic drying in high, multi-pack, yard stacks built up with fork lift trucks handling the usual 4 ft x 4 ft to 5 ft x 5 ft stickered packs. These are normally built into yard stacks from three to four packs high, i.e. up to 24 ft high.

The study material consisted of 180 stickered packs of normal commercial size in the five co-operating yards. Of the 36 packs used in each yard, 16 were sample (i.e. study) packs and the remaining 20 the necessary blanks to ensure required conditions around each test stack. As indicated, these packs were built into stacks each 4 packs high.

The study provided for stack side spacings of 1 ft, 2 ft, 4 ft and 6 ft on both sides of appropriate test stacks. The general layout in each of the co-operating yards is shown in the plan diagram of Yard C.

Spacings were randomized to ensure no consistent pattern error, and the blanks ensured no onverlap or interference by any spacing other than that provided for a given stack.

All material was green "ash" stock. That in Yard A (see Figures), Yard B and Yard D was 1 in. thick stock; that in Yard C $1\frac{1}{4}$ in. thick, and that in Yard E $1\frac{1}{2}$ in. thick.

It is clear from the study results that when stacks are built in a somewhat sheltered or congested yard, at right angles to the general wind direction, and with virtually no spacing between ends of adjacent stacks (see sketch) (the windward side stacks dry well irrespective of stack spacings, but with progress toward the leeward side of the yard) drying rate and uniformity are rapidly lost. For example, consider the most favourably placed packs in Yard A, i.e. the topmost ones: after 63 drying days, starting in spring, reasonably uniform drying was obtained in these irrespective of distance from the windward side, although drying gradients across the widths of the stacks are apparent.

In the lower parts of the stacks, however, this condition was obviously not maintained but rapidly deteriorated; this may be seen if the moisture contents of packs at the same elevation in successive stacks are compared. For example, a comparison of the avera moisture contents in the lowest packs after 63 days show that these range from 17 per cent. for the second stack from the windward side, to 31 per cent. for the sixth stack (6 ft spacing on each side), to 52 per cent. for the eighth stack (2 ft spacing on each side). The gradients across these packs are also pronounced. It is clear that only a few stacks on the windward side of this yard could have been removed at this stage before one would run into high moisture content material.

These results may be compared with those for Yard E, holding 1½ in. thick stock, after only 45 days. The general site condition for Yard E was much as for Yard A and the wind direction was also at right angles to stack length, but an open alleyway (up to 20 ft) was left between the rows as shown in the sketch of Yard E.

The material in this case, even though the range of spacings between stacks was the same as in Yard A, dried with far greater uniformity and at much faster rate, particularly on the leeward side of the yard.

Taking the least favourable positions again, i.e. the lowest packs in successive stacks, these show a range from 22 per cent. for the second stack from the windward side to 28 per cent. for the sixth stack from the windward side (6 ft spacing each side), to only 24 per cent. for the eighth stack from the windward side (2 ft spacing each side); and this, as mentioned, was for 1½ in. stock whereas that in Yard A was 1 in. and it was after only 45 days compared with 63 in Yard A. This Yard E, at this stage, could be almost entirely cleared without much risk of meeting high moisture content stock.

In this case it is obvious that the alleyways at the ends of each row of stacks enabled the prevailing wind to penetrate right through the yard. We think that equivalent results could be obtained with only 4 ft wide spaces between stacks if stacks were parallel to the prevailing wind, and if the ends of stacks were not butted close together but were spaced to give, say, a 6 ft to 8 ft gap forming a continuous air path.

In Yard C the stack lengths were parallel to the prevailing wind. This is also a fairly sheltered site holding 1¼ in. thick stock. The figure for Yard C shows the moisture distribution in stacks after 67 days drying, starting in spring. The uniformity in drying over the height of stacks is apparent (compare with Yard A) for all spacings other than 1 ft only, and even with this, results obtained were better than for some of the more open spacings in yards with cross wind air flow.

The study shows that good stacking methods can cut months off drying time compared with indifferent practice.

We are in the second phase of this study of model testing particularly yard layouts in wind tunnels.

A small tunnel has been made and stack models constructed to about one-twentieth scale for testing to ensure aerodynamic similarity with full scale stacks. Once we have determined model scale proportions to ensure this we shall then arrange them in selected yard designed patterns of stack spacings, foundation heights, end spacings, stack widths and roadways in relation to wind flow direction until we have determined optimum conditions. This pattern will then be tested in a full scale yard test.

With the technical and economic data these studies will give, we shall be in a very strong position to get yard design in Australia - and there is probably at least some 300 to 400 million super ft in Australia - again on a sound basis.

My experience is that industry is always ready to put into effect sound recommendations made and that it will readily do so once you are in a position to make them.

Discussion

Mr. Reid asked if the height of the stack above ground had been considered in the study to date. Mr. Wright replied that this had not yet been done since the yards tested were taken as they came. He advised, however, that scale model tests were planned to test variables in a wind tunnel. It was hoped to check effect of stack spacing, stack height, stack width, height above ground, etc., and thereby obtain an optimum combination which could be tested in a commercial yard.

Mr. Orman asked if the effect of variable flue widths had been investigated, and Mr. Wright replied that this effect had not been studied since flues are not generally considered necessary in Australian yards. Stack widths normally ranged from 4 ft to 6 ft.

ITEM 3(d)(i)

SUPERHEATED STEAM DRYING*

The question of the suitability of superheated steam drying for Australian species under commercial conditions has come up from time to time. It was thought, therefore, that some clarification of thought, or discussion on this might be of value.

First, what do we mean by superheated steam drying? Basically, it is simply the use of kiln drying temperatures greater than 212°F, using either air containing water vapour (as in an ordinary atmosphere) as the circulating atmosphere, or water vapour without air present. Water vapour in an atmosphere without air at temperatures over 212°F is, of course, conventionally called steam and if at atmospheric pressure, superheated steam. For the greater bulk of superheated steam drying, however, the air and water vapour mixture is used.

The type of kiln used is no different from the conventional internal fan type as used throughout Australia except that (i) more heating surface is provided, (ii) more care is taken in making it a "tight" structure, and (iii) much more care is taken in protecting it against corrosion hazards.

To dry a charge a superheated steam atmosphere is circulated in the kiln by conventional propeller type fans. To heat the kiln to superheated steam temperatures, the most common methods are by using steam heated pipes as in conventional kilns or electric elements.

Drying by superheated steam is not a new development. During World War I superheated steam kilns were used on the Pacific north-west coast of U.S.A. for softwoods such as Douglas fir and ponderosa pine, and fast drying rates were obtained, but despite this

*Presented by Mr. Wright.

it fell out of favour, mainly because of excessive corrosion in kiln structures. The idea was revived again in Germany subsequent to World War II and a number of German firms such as Schilde, Hildabrand and Keifer became very active with a world wide advertizing campaign for superheated steam drying, this coinciding with the marketing of packaged superheated steam drying units for export, and in the design of which considerable care had been given to anti-corrosion measures by the use of non-ferrous metals, etc. One English firm, Bachrich, also came into the picture a little later on an export basis.

What then, were the advertized advantages of superheated steam drying? There were much faster drying rates than obtainable at lower temperatures, and claims for reducing shrinkage, and improved stability.

Apparently the marketing campaign launched from Germany was also very active in Canada, so that the Canadian Forest Products Laboratories took up a study of the processing some 5 or 6 years ago. Their first results with softwoods were not very satisfactory, as although the fast drying rates claimed were substantiated, it was only at the cost of the charge finishing with an extremely wide range in moisture content of the order of 20 per cent. or so, i.e. was nominally dried to, say, 10 per cent. moisture content generally up to 25 per cent. and down to about 6 per cent. In other words, superheated steam conditions were simply emphasizing differences in the drying rates on different boards: furthermore, higher moisture gradients were present within boards. As a result of several years further work, however, the laboratory's report that by putting circulating rates up to an order of 900 ft/min or so, and by using very frequent reversals of circulation - say every 15 min or so - then drying times of the order of 36 to 40 hr can be obtained for fully green 1 in. softwoods.

In the meantime, five units were installed in Australia for drying radiata pine. One an English Bachrich kiln, three Australian designed units, and a small German Schilde. One Bachrich was also installed in New Zealand for drying radiata pine. Over the same period some fifty conventional kilns, also for drying radiata pine, have been installed in these countries so that comparisons could be made.

What then, is the present position on superheated steam drying and conventional drying for say, radiata pine?

This is that (a) despite the fact that many of the conventional kilns have been provided with sufficient heating surface to get up into the superheated steam range, none of them operate under these conditions, because by operating at high temperatures well under the superheated steam range, i.e. at 180°F or so instead of the superheated steam temperature of 230° to 240°F, they are getting drying times of the same order as under the superheated steam conditions, with drying times approximating 45 - 48 hr for 1 in. thick green radiata at moisture contents up to 150 per cent. and this with (b) far less corrosion or maintenance troubles in kilns, and (c) much less capital investment in the kiln construction.

Furthermore, (d) without the disability of superheated steam drying to darken the wood and so reduce its white appearance and sales appeal.

Superheated steam kilns constructed in Australia to an Australian design for one firm are now being altered for operation at lower temperatures because of sales resistance to the superheated steam dried radiata and the firm is now planning the installation of six conventional kilns.

Further, the firm operating the Bachrich steam kiln in Australia has since installed four conventional kilns for drying this species, and recently advised it would add another four conventional units.

The New Zealand firm which installed a Bachrich superheated steam kiln recently advised us as follows.

"You may possibly be interested to learn how the Bachrich S.H.S. kilns have fared at Putaruru. In general H.T. drying has been only satisfactory for predrying timber for the preservation plant, i.e. only down to an average 25 per cent. m.c. When we tried to go below this figure the variation in individual pieces was much too great. I think the air circulation rate is too low being less than 300 ft/min average. Also the rate of corrosion in the walls and ceiling plates were exceedingly rapid. We are therefore using them on conventional schedules not exceeding 180°F and getting more satisfactory results, with considerably less corrosion. The original kiln is at present being rebuilt."

Mr. W. G. Kauman, an officer of this Division at present in Europe, recently reported to us that not more than 10 per cent. of timber kiln dried in Germany itself is dried in superheated steam kilns, and that the quantity appeared to be falling.

ITEM 3(d)(ii)

FLUE GAS HEATING*

From time to time the question of flue gas heating for kilns or predriers is raised. There are, in fact, several kilns and predriers heated by this medium in Australia. While there is nothing to stop anybody building a kiln or other drying unit to operate on flue gases, it was thought some discussion on our general attitude to flue gas heating would be worth-while.

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*Presented by Mr. Wright.

Generally, those who turn to thinking in terms of flue gas heating as a possible heating medium for kilns do so with the idea that installation and operation by this method is cheaper than by other means.

There are, of course, no real problems in designing for the use of flue gases for this purpose. The design approach is exactly the same as that for steam, high pressure hot water, electricity, coal gas or any other heating medium, except that with flue gas we have a gas-to-gas heat exchange. So that although heat transfer coefficients are comparatively low, the total heat transfer rate obtained is high because of the large difference in temperature between that of the flue gas and that of most drier conditions.

At the same time, although designing for flue gas heating is not especially difficult, the operation and control of flue gas heated units is less flexible than for steam heated ones, and fire risk is far greater.

In practice, flue gas may be passed into a drier direct to become the hot circulating medium, or it may be passed through a heat exchanger within the drier - 3 to 6 in. diameter pipe may be used.

In either case, the general design of a predrier or kiln is practically the same as for a steam heated unit, except that in the one case a large flue gas duct is fitted adjacent to the drier fans with openings in it at the face positions so that these help draw the flue gases into the drier; and in the other case, flue gas heated tubes replace the more usual steam piping.

Using the heat exchanger method, a typical approach is to draw the hot flue gases from near the base of a furnace stack through steel ducting of suitable size and gauge, say, 24 in. x 18 in. This ducting continues to the drier where it connects into a rectangular inlet "header" from which a 4 to 6 in. diameter pipe runs the width (or length as required) of the upper part of the drier to another header at the other end of it, and from this similar pipes return back along the width (or length) of the drier to a discharge header above the previous inlet header. From here the header connects into suitable steel piping which, in turn, connects into a suitably sized exhaust fan. The pipe then extends back to the furnace stack, entering it above the take-off point. Suitable dampers are fitted in the stack, and the stack take-off, and return ducts to help control the flow of flue gases. A degree of comparatively simple automatic control can be fitted to control flue gas quantities passed into the heating pipes. The heating pipes in the drier can get very hot, so naturally the upper parts of the drier or parts adjacent to any of the hot pipes should be sheathed with an incombustible material.

At the same time, there is always the risk of fine dry sawdust or wood particles collecting on at least some parts of the pipe work. Since the pipe becomes extremely hot (the flue gas temperature would probably be not less than 500°F and could be considerably higher) one would expect that, sooner or later, the unit would pass from a "fire potential" stage to a "fire-actual" stage.

Passing the flue gasses into a drier chamber direct has disadvantages in that it becomes dangerous to enter the drier while it is working (lack of oxygen and the presence of carbon monoxide), fire risk is increased, the timber can get dirty from smut carried over with the flue gas, and heat distribution and control is more difficult than with the other method mentioned.

When we receive such enquiries, including comment concerning the high capital cost of a steam boiler and steam heated drier, and the savings which could be made with the installation of a flue gas heated kiln, our answer is that the anticipated cheapness of the flue gas unit is usually hypothetical. We argue that there would be little, if any, saving in installing a satisfactory and safe furnace for producing flue gas as compared with buying and installing a secondhand boiler (one which has, say, been derated in pressure for some other use: 30 to 40 lb/sq.in. steam pressure is adequate for most driers).

We point out that a flue gas furnace needs just as much attention as a boiler to be sure the fuel feed is not jammed, or overflowing, or on fire, etc., or that the stack is not overheating and burning.

Furthermore, with a boiler, one also has steam available for humidifying or steaming purposes.

So far as the installation cost of a kiln or predrier is concerned, for equivalent quality of construction, and for equivalent performance characteristics, I cannot see how a flue gas drier can cost any less than a steam heated unit - in fact, it could cost more. Furthermore, corrosion hazard is higher in the flue gas kiln. A steam heated unit has, in fact, many advantages - additional units can be added easily, and the steam heating and humidifying makes for simplicity in control, and for holding drying conditions. Its main disadvantage is that a certificated boiler attendant is needed.

Where the small operator wants to cut down on drying cost, our attitude is that he should think along the lines of one-shift heating (or for heating for as long as is practicable without having to put on an additional man for an additional shift) but to leave the drier fans running the full 24 hr. This requires a longer drying time, of course, than the 3-shift heating, but it does no harm to the timber and can cut down operating costs. Alternatively, operation with an oil fired flash type boiler of the Presha or Clayton type.

Discussion

Mr. Huddleston said that they received frequent requests for attachments to the McCashney incinerator to make use of the heat available, and asked what advice the Division of Forest Products gave to this query. Mr. Wright said he believed that the hot gases could be utilized, but could not suggest the best method by which this could be done. Possible interference to the operation of the McCashney must be considered, and at present he would advise to leave the McCashney alone and use a small wood fired boiler or packaged boiler if steam is required.

Mr. Huddleston mentioned that his Division was giving the same advice.

Mr. Wright then mentioned possible methods of utilizing heat from a McCashney as follows:

(i) By installing hot water coils around the inside of the barrel of the incinerator.

(ii) By placing coils between outside wall and firebrick lining.

(iii) By drawing off hot gases and using them as a secondary source of heat.

He concluded by saying that it is important to keep the burning area clear.

Mr. Huddleston asked how variations in burning loads are overcome in such a system. Mr. Wright replied that to cope with varying loads, a second hopper would be installed and waste fed in at a uniform rate.

ITEM 4. RADIATA PINE

ITEM 4(a)(i)

INCIDENCE OF DEFECTS*

The commercial supplies of radiata pine contain round knots, spike knots, clusters of knots, encased knots, cone holes, pith, etc. They affect appearance and strength and provision has to be made for them in specifications. Examples of their occurrence in flooring, weatherboards, boards, etc., have been brought to attention of parties interested in drafting or reviewing specifications and snap decisions made as to the size and number that should be allowed in main products. The incidence has not been studied systematically and no quantitative data are available. Consequently grades have been decided with an inadequate knowledge of the importance of various limits, and no forecasts have been possible of the yield of certain grades in various localities, from logs of certain ages or conditions of growth. The result is that some specifications have been difficult to meet in some respects and unduly generous in other respects.

Studies of quality can, however, be simplified in future as interim grades can be used as references. Field studies could show the percentage yield of individual grades from trees or logs of known character and establish the main reasons for pieces failing to comply with grades.

During the course of an investigation in South Australia last year, primarily intended to compare the merits of sawing scantling to final dimensions from (a) the log, or (b) seasoned flitches, pieces from 30 logs cut from 29 year, 35 year and 47 year old plantings were graded in accordance with S.A.A. Interim 376. The percentage complying with the standard was lower than expected in a sample that was above the average of the forest run of logs. The details were:-

*Presented by Mr. Turnbull.

	4 in. x 2 in.	3 in. x 2 in.
Source of piece	Butt logs	Top Logs
No. of pieces total	176	116
No. passing Int. 376	49	18
Per cent. passing	28	15½
Rejections % because of -		
Knots	31½	34
Holes	2	13½
Spike knots	26	30
Clusters	28	23½
Cross grain	32	13½
Combinations	6½	5

Subsequent revisions of Int. 376 allowed sawn pieces formerly rejected to be accepted, increased the 28 per cent. passed by former limits to be raised to 58 per cent. passed by the new limits.

Discussion

Mr. Huddleston said he believed the incidence of defects varied from State to State and from mill to mill, depending on the markets they were supplying and the plantation conditions. No detailed study has yet been made in New South Wales on the incidence of defects but it was intended to do so when radiata grading rules were finalized.

Mr. Reid said that New Zealand had made such studies but that the data obtained quickly became obsolete. Further, strength and appearance are not the only considerations; seasoning and machining characteristics should also be considered in relation to grade.

ITEM 4(a)(ii)

SCANTLING STRENGTH TESTS*

To date mechanical tests have been made on approximately 180 pieces of 4 x 2 in. and 3 x 2 in. These scantlings were part of the parcel used in the distortion study for the Woods and Forests Department. Each scantling was tested in third point bending on a span of 54 in. This allowed two and sometimes three tests to be made on each 10 ft length. Each test was arranged so that a defect was located in a position likely to have maximum effect on the strength of the piece under test. Tests on matched clear specimens were also conducted.

In analysing the data, to which has been added information on similar tests carried out by our New Zealand colleagues, it is convenient to relate the results to the working stresses as given in the Timber Engineering Design Handbook. On this basis it was found that -

25 per cent. of the total parcel of 832 pieces was suitable as equivalent to select grade dry Strength Group D timber.

30 per cent. of the total parcel of 832 pieces was suitable as equivalent to standard grade dry Strength Group D timber.

$42\frac{1}{2}$ per cent. of the total parcel of 832 pieces was suitable as equivalent to common grade dry Strength Group D timber.

and only $2\frac{1}{2}$ per cent. was completely unsuitable for structural purposes.

A very wide variation in modulus of elasticity was observed, values ranging from less than 0.4×10^6 to about 3×10^6 lb/sq.in. From our own results a very high correlation ($r = 0.87$) between the moduli of rupture and elasticity was observed. Thus separation of the material into strength grades also effectively separated it into

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*Presented by Mr. Kloot.

stiffness grades. This may be quite important as stiffness is frequently the criterion of design for house and other light frame construction.

The relationship between strength and visual grading was very carefully examined. Graded to S.A.A. Interim 376, 58 per cent. of the material was acceptable and 42 per cent. rejected. Of those accepted the individual strengths ranged from 34 to over 90 per cent. of the strengths of thin matched clear specimens. Of those rejected, the strengths ranged from 12 per cent. to 90 per cent. of the matched clear strength.

On a pure strength basis none of those acceptable on grading to the standard had a bending strength lower than equivalent to standard grade dry Group D. Of those rejected, the number with strength less than the stress for standard grade dry Group D was only 15 per cent. of the total parcel. The number with strength less than standard grade green Group D for which Interim 376 is considered to be equivalent, was only 9 per cent. compared with the 42 per cent. rejected visually to this standard. Of the total parcel $1\frac{1}{2}$ per cent. was weaker than common grade green Group D to which Interim 377 refers.

The results at this stage are interim only. A further parcel of 400 scantlings has been donated by the Woods and Forests Department and these will be tested as soon as possible.

Discussion

Mr. Jennings asked if any correlation had been found between the figures quoted and position along the length of the tree. Mr. Kloot replied that such work had not been done but could be done. In answer to Mr. Huddleston, Mr. Kloot said that all pieces containing pith were rejected in the grading work.

Mr. Brown said that the houses at Nangwarry were erected with green radiata framing with very little selection on the job. They have stood for 20 years without developing serious faults and he felt an inspection would be well worth-while. It was their experience when building these houses that the wastage on the job was very low, something of the order of $2\frac{1}{2}$ - 5 per cent. The material delivered on to the job was 20 ft lengths of 4 in. x 2 in. and was cut to length as required.

Mr. Orman asked if, in obtaining the correlation coefficient of 0.87 between strength and stiffness, the New Zealand strength figures had been taken into account. Mr. Kloot replied that due to a difference in testing techniques it was not possible to use the New Zealand figures.

Mr. Huddleston said that with increasing quantities of Pinus radiata becoming available and with decreasing use of Douglas fir in New South Wales, there was a growing interest in the use of Pinus radiata for building construction. Lending authorities were at present reviewing the position with a view to reducing the size of building members, e.g. 4 in. x 2 in. could be replaced by 4 in. x $1\frac{1}{2}$ in. New South Wales was at present not particularly interested in supplying scantling timbers as board production was a better proposition. However, quantities of scantling and engineering timbers were being supplied and it was essential that accurate strength data could be obtained. New Zealand was probably more interested in selling scantlings on the Sydney market.

Mr. Reid remarked that while 4 in. x $1\frac{1}{2}$ in. may replace 4 in. x 2 in. it should be realized that 4 in. x 2 in. was a better proposition as regards the influence of defects. Early New Zealand experience was with green radiata scantling and it was highly commendable that Australia was insisting on dry material right from the start. The figures quoted on strength testing of graded material seem to indicate that only one grade was required.

Mr. Jennings said that Mr. Kloot's figures indicated that visual grading was not as accurate as was at first thought, and work should be done to make it more reliable.

ITEM 4(b)

SEASONING*

In this discussion on the seasoning of radiata pine, I propose to outline present or preferred practice, indicate what work has been done, and then draw any appropriate conclusions from this.

In doing so, I propose to deal (i) first with the dressing or finishing grades, including 1 in. and other sizes for such purposes as flooring, weatherboards, lining, interior trim and mouldings, and (ii) then with the framing or scantling sizes.

I have assumed that the drying of case timbers, round timbers and sleepers is not appropriate to this discussion.

In general, the greatest problems in drying radiata pine are (i) to ensure uniformity of drying, i.e. uniform moisture content of the dried parcel, (ii) to control distortion, and (iii) to dry free of blue stain. In Australia, knot cracking and knot loosening are not generally pronounced, although the problem is recognized. Checking is generally of no consequence and, although some collapse has been seen in material from two areas, this is very much a minor problem.

Moisture content quality control varies widely between plants, and lack of sufficient control has been getting some plants into difficulties, so that either wet material has been going to the planer or excessively overdried material has passed out of plants, resulting in bad ridging in service later. This problem of moisture quality control, which largely simplifies to using proper sampling

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*Presented by Mr. Wright.

techniques, i.e. careful selection of the sample material, and its retention in a representative condition in stacks - if necessary by holding in polythene bags - is one that I feel will become self correcting in time, as management and kiln operators learn the hard way that the same liberties cannot be taken in kiln drying radiata pine from the green condition as could be taken even with hardwoods after partial air drying.

A complicating factor is the wide range in green moisture content between the sapwood and heartwood of radiata pine, averaging as it does about 140 per cent. in the sap and 47 per cent. in the heartwood in Australia.

(a) Dressing and Finishing Sizes

Turning now to dressing and finishing sizes, in the 1 in. and smaller thicknesses, present practice is, for the most part, to kiln dry green from the saw, although some partial air drying before kiln drying and some full air drying is done. In South Australia and Victoria, however, quantities marketed in the air dried condition are not great, and I would say are lessening.

Partial air drying before kiln drying can obviously only be successful with effective anti-stain dip control and a good air drying yard practice. Stacks badly built, cramped, without foundations, too wide, and not properly laid out - and these conditions have been happening in some recently set up plants of some magnitude - encourage non-uniform kiln drying and increased distortion. We have been active recently in helping re-organize yard design in such plants.

There are several reasons for the practice of kiln drying from the green: they include (a) a much diminished risk of blue stain, as this can occur during air drying despite the use, or possibly because of the mis-use, of anti-stain dips, (b) the fact that it needs far less capitalization in stock and yard facilities, and (c) the fact that it is economic and gives a rapid turnover. This is because the pervious nature of radiata pine permits it to be kiln dried very rapidly. Average kiln drying time for 1 in. thick stock from the green, at moisture contents of the order of 150 per cent. or so, is now no longer than about 48 hr.

To ensure uniform moisture content in a charge kiln dried from the green but yet ensure speed of drying, the first step is that the kiln provide a high air circulation rate - this should be generally in the 500 to 600 ft/min range through kiln stacks for pine.

The short kiln drying time mentioned is possible mainly because the species is very tolerant to high temperatures. General industry practice is now to kiln dry within the range 150°F to 200°F, with some plants using minimum temperatures of 170°F to 180°F. A considerable number of the more modern kilns in Australia now operating exclusively on radiata pine are equipped to go up into the superheated steam range, but only five of them have been so operated, and two of these are now being altered for lower temperature operation. I doubt the likelihood of superheated steam drying becoming common in Australia.

(i) Distortion Control

The problem of distortion in 1 in. thicknesses and less can only be handled by (i) careful stacking, and separating stickers fairly close together - not more than 18 in. - to reduce the possibility of localized buckling between stickers, (ii) by weighting stacks to the equivalent of some 40 to 60 lb/sq.ft. of top surface, or by otherwise restraining movement during drying, and (iii) by a final steaming treatment of about 3 or 4 hr at the end of drying. These measures are effective, even though pith is included.

The special value of weighting, or other restraint, is in reducing distortion in the material in the upper layers of stacks. Without weighting or restraint, boards in this position, particularly those containing pith, can bow and twist severely, affecting perhaps 20 to 30 per cent. of a parcel.

Various techniques may be used to avoid the problem of lifting on and taking off heavy weights, ranging from a simple mechanical hoist system to the use of a strong shelf in the stacking shed, built in at top-of-stack level, so that weights have only to be slid into position. A better development is the use of comparatively light, portable holding down rods in a lever system, so that a ten to twelve times weight advantage can be obtained and the necessary loading provided by using only comparatively light weights.

The special value of a short final steaming treatment at the end of drying, with stacks still under weights, followed by a holding period under cover in strips for about 2 days, cannot be over-emphasized. It helps reduce moisture gradients, reduces distortion, and reduces the hardness of knots so that they dress better, with less cracking, and less impact on cutter blades.

(ii) Knot Cracking

In Australia, as indicated, knot cracking and the loosening of encased knots in radiata pine during seasoning is far less of a problem than occurs elsewhere. That is, of course, the reward of the silvicultural treatments and plantation management programmes established here, ensuring a high proportion of comparatively small, live, tight intergrown knots that have not needed as yet the glue impregnation, plugging or masking techniques used elsewhere. No doubt they will be used sooner or later for special purposes.

Where knot cracking due to drying rather than machining occurs, it is probably accentuated by the use of large wet bulb depressions, i.e. low humidities, in an endeavour to accelerate drying rates.

I would like to emphasize that radiata pine dressing grade timbers are not a difficult seasoning problem if strict and conscientious plant and quality control are maintained, but that great difficulties in processing can be caused if these become indifferent.

(b) Building Frame and Scantling Timbers

Recently determined Australian Standards Association interim grading rules for radiata pine building frame timbers have laid down that it shall be seasoned to a moisture content not exceeding 15 per cent.

Clearly, the same considerations that have determined the practices described for dressing and finishing grades must dictate good practice for building frame timbers, due allowance being made for the fact that it offers more resistance to restraint applied to reduce drying distortion, simply because it is thicker. This applies particularly to pith containing material, and the low density, short fibred corewood adjacent to the pith. However, minor changes in moisture content, and hence dimension due to shrinkage, are not so important as in dressing grade timbers, so that the major problem in seasoning building frame timber is to do it with minimum drying distortion.

For the time being, at least, the interim grading rules also very wisely exclude pith-containing material. Chart 1 shows recent study results from 216-4 x 2 in. studs from some 25 to 30 trees from the widely separated Victorian areas of Dartmoor and Bright.

These 216 studs were received green and were sorted into parcels of (i) pith-containing studs only, (ii) studs cut from near the pith, but containing no pith, and (iii) studs not falling into either group (i) or (ii). These were then strip stacked, and half then kiln dried and the other half air dried, half under weights, approximating 70 lb/sq.ft. of stacked top surface, and the other half unweighted.

It was noticed that all material containing pith consistently twisted in the one direction, i.e. the far end twisted anti-clockwise when the near end was held flat and one looked along the length; that for the near pith material two-thirds only twisted in the same direction as the pith material, and about one-third twisted in the opposite direction; that of the remainder of the material, which we called the "sap material", three-quarters twisted about equally in both directions and about one-quarter did not twist.

The study results show that (1) although the green sawn studs were comparatively free from twist, those containing pith twisted badly during drying, the amount being three or four times more than studs cut from adjacent corewood, even though it was only just free of pith, and that it was five to six times more than in studs cut from the outer part of the log; (2) that spring and bow in the green material are not markedly influenced by the presence or absence of pith, but occurs about equally in studs from all parts of the tree, and (3) that weighting to the extent used (70 lb/sq.ft.) does not reduce twist in pith containing studs, but that it is helpful in reducing twist in other material under kiln conditions, and (4) but weighting to the extent used was generally effective in reducing spring and bow.

It is clear that the weighting used was only of limited value. It is believed, however, that very much improvement could be obtained with greater loadings, say at the equivalent of 140 lb/sq.ft. In fact, in a test with weighting at 140 lb/sq.ft. on pith containing material, kiln dried at high temperature, twist was reduced to about one-third of that in similar unweighted material. Russian reports tend to confirm this. The increased loading would probably be best obtained by using the portable rod and lever system already mentioned and, I understand, already in use commercially in Australia.

For comparative purposes some material was dried in block stacks without weights until the moisture content was 16 per cent. and then kiln dried to 12 per cent.: similar trends were apparent.

(i) Steaming

The value of steaming at the end of drying in reducing distortion is shown in Chart 2.

The results of studies to determine whether the improvement given by steaming is retained afterwards during storage are shown in Table 1.

In this case mean values are shown for twist in both weighted and unweighted studs in the green condition, after drying to 12 per cent. moisture content, after storage without restraint for periods ranging from 2 to 13 months, when the material was then steamed under weights, then re-measured 2 days after steaming, and then after a further 2 to 4 months further storage without restraint.

(ii) Drying in Multiple Sizes

On several occasions the question has been raised as to whether framing timbers such as 4 x 2 in. studs should be dried in multiple thicknesses and/or widths, or whether better results are obtained by drying in single pieces.

Multiple thickness cutting would so inordinately increase drying time, drying cost and the capital required for stock during seasoning, and it could induce such marked core moisture content effects that I believe this possibility can be ruled out.

In the case of multiple width material, however, I think the answer is that; providing pith is not included in any piece, multiple width cutting would probably help to reduce distortion due to twist, spring and bow, but that it could increase cup in some cases. In any case, of course, a lot of single width material must inevitably be sawn and seasoned in this form. Over the past 20 years a very considerable amount of 2 in. joinery quality pine has been seasoned so that the industry is not entirely lacking in experience in handling this material.

TABLE 1

TWIST IN RADIATA PINE AFTER DRYING AND AFTER STEAMING

(Corner lift in 6 ft length - values in 1/32 in.)

Type of Material	Restraint During Drying	Amount of Distortion Before and After Drying and After Holding but Before Steaming			Restraint During Subsequent Steaming	Amount of Distortion After Steaming and After Further Holding	
		In Green Condition	After Kiln Drying (12% m.c.)	After Standing 2 - 13 months Without Restraint (12% m.c.)		After 2 days Under Weights	After Further 2 - 4 months Without Restraint (12% m.c.)
Pith included	UNW W	0 0	18 18	20 19	W or C	12 11	14 13
Near pith	UNW W	0 0	4 5	4 4	W	2 3	- -
Near sap	UNW W	1 0	7 4	7 5	W	5 3	- -

An advantage of sawing in multiple widths would be a wider choice in the final selection after seasoning of material for construction (engineering) quality (which may frequently be required in wider widths than 4 in.) or for re-sawing into framing grade.

On the debit side against multiple width cutting are the added costs of the re-handling and re-sawing required and, probably, losses on re-sawing if twist or other distortions due to spiral grain or other causes occur. One Victorian plant executive, very experienced in the sawing and re-manufacturing of radiata pine, with whom I have discussed this matter, said he would not consider this practice as it would add another 3/0d. to 5/0d. a 100 super ft to cost. The extent to which this applies would, however, probably vary from plant to plant. Furthermore, should market consideration determine that seasoned framing timbers be machined to size before marketing, as is common with softwoods in other parts of the world, then the handling and re-sawing of multiple widths would add little to the cost of this operation.

It may be concluded, therefore, that (1) it is right that pith should be rigidly excluded from framing timbers until at least more effective means are developed to restrain distortion in pith containing material; (2) seasoning in multiple thicknesses would be uneconomic and unsatisfactory; (3) a considerable amount of material must be sawn in single sizes and seasoned in this form, and the extent to which sawing and seasoning some material in multiple widths becomes practised will largely be determined by the economics of re-sawing and may be influenced by the impact of sawing for construction grade; (4) stack weighting or restraint is of value, but loadings will need to be of a higher level than are effective for 1 in. thick timber; and (5) a final steaming treatment should be provided.

(c) Redrying After Preservative Treatment

One other aspect of the seasoning of radiata pine wants brief comment. This is the New Zealand experience that treatment with waterborne salts to refusal as is required for the solution strength and loading used, causes a marked increase in the time required for redrying compared with that for original drying. The New Zealand studies showed kiln redrying time ranges 25 - 70 per cent. longer for 1 in. stock, and some 150 per cent. longer for 2 in. stock. This cuts kiln output and can increase costs much more than might otherwise be expected.

Discussion

Mr. Huddleston said that *Pinus radiata* is very sensitive to moisture content changes and that care was needed to ensure protection of seasoned timber delivered on to the job. Complaints had been received of unseasoned timber being supplied, but on investigation it was found that in many cases seasoned timber had been left unprotected and had consequently picked up moisture. One favourite method of protecting timber was to place a couple of 4 in. x 2 in. on the ground, stack the seasoned timber on these, and then cover with a sheet of Visqueen which was then weighted down with stones. Under Sydney conditions this led to a rapid pick-up of moisture.

Mr. Jennings said experience in Queensland was such that it was necessary to anti-sap stain dip even though the material was kiln dried. He had seen blue stain develop overnight.

Mr. Huddleston reported complaints regarding dipped fruit cases used for unwrapped apples causing scald. However, a survey of the industry indicated a preference for dipped cases.

Mr. Jennings said that similar trouble had occurred in Queensland but he believed it was due to inadequate control of the dip solution strength and pH. They had found that with the addition of caustic soda or borax the solution could be kept alkaline and no trouble occurred.

Mr. Huddleston reported that New South Wales used 12 lb of borax per 100 gallons of water so that the solution must be alkaline.

Mr. Cokely said they used sodium pentachlorphenate and did spot checks against phenolphthalein for alkalinity.

Mr. Jennings said the main problem was to get the mills to keep a check on the solution strength.

Mr. Brown reported that South Australia had a problem due to the low summer e.m.c. conditions that occur in some northern areas to which radiata is supplied. These conditions caused severe distortion and he wondered if any work could be done on the problem.

Mr. Clarke said work could be done and a schedule could be provided for drying to these lower e.m.c.'s but the main problem might be one of plant control.

Mr. Foley remarked that concerning the need for careful handling of seasoned radiata, consideration might be given to adopting a code of practice for end uses similar to that in use in New Zealand.

Mr. Huddleston said that the New Zealand code of practice had been considered but that it did not cover all the end uses to which radiata was being put in New South Wales. He felt another difficulty would be getting people to read it.

Mr. Brown said that a radiata sales promotion organization was at present being established in South Australia and the problem of educating end users would be one of its first tasks.

Mr. Reid said that the New Zealand code of practice was prepared because of the long delay in the revision of the light building code. The revised light building code would eventually supersede the code of practice.

ITEM 4(c).

DISTORTION AND INSTABILITY*

At the request of the Woods and Forests Department, South Australia, a working plan was prepared for a study of distortion in radiata pine scantlings. The work as planned has now been completed and a draft report prepared. It is intended to mention here only a few of the highlights of this work.

A sample of 30 prime trees was chosen and these included 47, 35 and 29 year old material. From each tree, a 20 ft butt log and 20 ft top log were taken, the former for conversion into 4 x 2 in. scantlings and the latter into 3 x 2 in. scantlings. Each log was cross-cut into 10 ft lengths, and from one of these, scantlings were sawn according to one of several sawing patterns. From the other 10 ft length, flitches ranging in thickness from 2 in. to 5 in. were cut in such a way that eventually they would yield scantlings directly matched to those cut green to size from the other half of the log. All of the material was kiln dried, the flitches converted to scantlings and then the total parcel of some 600 scantlings measured for bow, spring, twist and moisture content.

The average distortions expressed in sixteenths of an inch measured on the scantlings originally cut green from the logs were:-

In 4 x 2 in. pieces - twist 4½, spring 10, bow 6.

In 3 x 2 in. pieces - twist 6½, spring 7 , bow 5.

In terms of S.A.A. Interim 376, 31 per cent. of the 4 x 2 in. pieces had twist greater than allowable, and 48 per cent. had excessive spring. In the 3 x 2 in. pieces, the corresponding figures were 48 per cent. for twist and 25 per cent. for spring. In neither size was any significant percentage rejected for bow. Making allowance for those pieces containing both excessive twist and excessive spring, the total

*Presented by Mr. Kloot.

rejects according to Interim 376 would have been 61 per cent. of the 4 x 2 in. and 56 per cent. of the 3 x 2 in. pieces. The average distortions (also in sixteenths of an inch) of the scantlings cut from the dry flitches were:-

In 4 x 2 in. pieces - twist $2\frac{1}{2}$, spring $4\frac{1}{4}$, bow 5.

In 3 x 2 in. pieces - twist 4 , spring 4 , bow 5.

The average values for twist and spring in this material were substantially lower than those for the first parcel of scantlings. In this material, the total rejections for distortions would have been 21 per cent. of the 4 x 2 in. and 36 per cent. of the 3 x 2 in. pieces.

All of the scantlings were stacked under various conditions from block-stacking indoors to open-stacking outdoors without cover. After 3 months, the scantlings cut from the dry flitches were re-measured. The distortions showed some levelling up, and at this stage, twist in both sizes was 60 per cent., spring 50 per cent. and bow 70 per cent. of the distortion measured in the scantlings cut to size directly from the logs.

Following this measurement, all the material was block-stacked indoors for a further 9 months and then re-measured. It was found that the scantlings originally cut green from the logs had recovered 30 per cent. in twist, 40 per cent. in spring and 50 per cent. in bow. At this stage the average distortions in the two parcels of scantlings were as follows:-

4 x 2 in. scantlings cut to size from logs and dried	Twist 2.85	Spring 5.60	Bow 2.51
4 x 2 in. scantlings cut from dry flitches	Twist 2.37	Spring 3.97	Bow 3.34

An analysis of the effect of distance from pith was made on the three types of distortion. In twist there was found to be a very distinct trend, the distortion falling very rapidly from the pith to a point

2 in. away, after which it fell at a much slower rate towards the outside of the tree. For spring, the trend was found to be very distinctly linear from pith to bark. The results for bow were rather more scattered but distinct trends were observable.

Before conversion of the dry flitches into scantlings in the early stages of the investigation, each flitch was measured for twist and a very decided trend of distortion with flitch thickness was observed, flitches 2 in. thick having the least amount of distortion. An analysis of the distortions of the scantlings cut from the 2 in. flitches showed that they had less than average twist, spring and bow.

In conclusion, it is necessary to point out the limitations of the sample - the fact that they were rather better than average size trees from only one area. However, some positive conclusions can be drawn. One such is that the cutting of scantlings from dry 2 in. flitches yields pieces with substantially less distortion than scantlings cut to size from the log and then dried.

Discussion

Mr. Jennings said that any board containing pith, in his experience, is completely unstable. No matter how well it is restrained during seasoning it will subsequently move with manufacture, and their work indicates that it is very wise to segregate the pith material. The results quoted on spring and bow are probably a reflection of the sawing pattern. In all their investigations they found that there is an unstable core surrounding the pith, the diameter of this core varying with the tree, but in the case of hoop pine, *elliottii* and *taeda*, is generally around about 4 in. to 5 in. diameter, and appears to taper towards the top of the tree.

Mr. Jennings then explained the sawing pattern used in their investigations, in which it was found that a greater recovery of stable boards was made by taper sawing, and rejecting the unstable core. He recommended that to reduce overall distortion, through and through sawing should not be used, as the best quality wood is converted to shorter lengths.

Mr. Kloot agreed with Mr. Jennings' comments on the instability of the very centre of the tree, but felt that his first comment that nothing can be done about it was not strictly correct. The results of work at the Division of Forest Products indicate that a considerable permanent improvement can be effected.

Mr. Huddleston said they also find that the central core is unstable. If that core is put into boards particularly and, in some cases, into scantlings, it can be restrained in drying and used satisfactorily.

In the case of scantlings they have found that the majority twist in the one direction, a small percentage will not twist at all, and a smaller percentage still twist in the opposite direction. Because of the predominant twist in the material in an anti-clockwise direction, a whole stack will twist in that direction. For restraining the stack the original recommendation was for fairly heavy loading, uniformly distributed over the whole of the top of the stack. One miller in New South Wales found that it is far better to put the weights at each end of the stack and leave the centre free. It appears that some worth-while advantage could be obtained by sorting out on the green chain material which is going to twist, that which will not twist, and that which will twist in the opposite direction. A grain detector was used initially, but after experience with this, spiral grain could be picked visually.

Mr. Huddleston also mentioned that the pith containing material which does not distort, is material which does not show any spiral grain, and emphasized that the degree of spiral grain stipulated in Interim Specification No.376 should be strictly adhered to.

Mr. Wright agreed with Mr. Huddleston and said that pith included 1 in. thick material is used satisfactorily in South Australia particularly. Examination of any parcel of flooring will show quite a high percentage of pith which, with good seasoning practice, can be restrained and used. This is demonstrated by the fact that that material is at present marketed with satisfaction. He agreed that pith should be excluded from framing timber. If pith and spiral grain were sorted off the green sorting chain and segregated, there is a good chance of getting good results from the remainder of the tree. He agreed with Mr. Huddleston that twist in one direction (anti-clockwise) occurs in a stack as a whole.

Mr. Turnbull said he noticed in New Zealand a sawmiller who was stacking 4 x 2 in. on the narrow face while drying to make it straight.

Mr. Wright said that stacking on edge would reduce spring but the main problem would be whether the stack would remain stable during handling or whether there would be a tendency for the material to roll, so finishing up with a stack in which the material was mixed up. That practice is worth investigating and it could well reduce spring in studs.

Mr. Huddleston said that Mr. Wright referred to the sizing of studs in overseas practice. In New South Wales an additional charge of 5/0d. per 100 super ft is made for the larger size.

Mr. Reid asked Mr. Wright whether he had included kinking as well as spring in the full length of the piece, and secondly, if he had found any internal checking resulting from mechanical restraint. Mr. Wright replied that the values given were the total spring over the full 6 ft length. He had never heard of internal checking resulting from weighting the stacks.

Mr. Turnbull asked Mr. Kloot whether he had related the amount of twist to the width of the boards.

Mr. Kloot said that the analysis of the distortion in the flitches had been made and was of interest. The following values were quoted in terms of the twist per inch of width and were for the butt logs only.

Width of board (in.)	2	3	4	5
Twist (per in. of width)	0.44	0.82	1.05	1.26

Mr. Orman asked what was meant by prime trees, how they represented material from the plantation and whether they included only dominant and co-dominant crown classes.

Mr. Kloot said that, as he recalled, they were very large trees, amongst the biggest of the particular class in the plantation, and much better than average.

Mr. Turnbull mentioned that big trees were selected in order to be able to cut 4 x 2 in. and 3 x 2 in. from the centre and well away from the centre of the tree. There was no reason for difference in quality, only for size.

ITEM 4(d)

PREPARATION OF GRADING RULES*

These have been under development for some years. The large producers have been marketing branded lines of flooring and other milled items and distinguishing qualities in sawn boards and flitches. Such grades have not been described formally and there have been no means of indicating to users what they might expect in normal supplies, or no means of ensuring consistency. After several semi-official attempts to establish some basis for recognition of quality followed by discussions in some State sectional committees on Wood Technology of the Standards Association, it was decided that representatives of the States concerned in the growing, production and marketing of radiata pine should meet to exchange views. They met in Adelaide in 1953 and

*Presented by Mr. Turnbull.

drafted a series of grades for sawn and milled products. After being processed through the usual channels for discussion and review under the usual procedure of Standards Association of Australia, the grades were issued as Interim 371-5. At that time the quantities of clear and joinery qualities were regarded as too small to justify the issue of grade descriptions for them. Scantling was not available either and was not described.

About 2 years after the publication of Interim 371-5 interest in scantling developed in both Australia and New Zealand. The Standards Association invited the States who had contributed to the preparation of Interim 371-5 to meet with New Zealand interests and discuss the preparation of a specification for scantling. This was duly drafted, reviewed and issued in 1958 as S.A.A. Interim 376. These established a basis for grading radiata pine and New South Wales began to organize the implementation of the Standards. A Monterey Pine Inspection Association was formed. When training men who desired a licence from the Association as commercial graders, they found that little scantling being produced and sold would meet the requirements of Interim 376. A request was made for another lower grade.

Early this year the Standards Association constituted a technical committee on radiata pine to deal with matters concerning the grading of all radiata pine products. All States of Australia and New Zealand nominated representatives to the committee, which held its inaugural meeting in Mt. Gambier in August, 1958. The committee discussed a range of topics, revised the scope of grades for sawn and milled products, and drafted the necessary grades, except scantling, which was referred to a special sub-committee.

(a) <u>Scantling</u>

Scantling grades have now been drafted by the sub-committee of the technical committee on radiata pine. Two grades - No.1

Construction, an amended form of Interim 376 and No.2 Construction, similar to New Zealand export construction quality have been drafted, but sub-committee members are evenly divided in their support for and opposition to two grades. The question of number of grades has been submitted to the main committee, and a postal ballot discloses 19 favouring amendments to Interim 376 and 6 opposing the amendments; and 15 supporting two specifications, while 10 oppose one or the other.

(b) Other Grades

The scope of specifications decided by the technical committee on radiata pine includes No.1 and No.2 Clear; No.1 and No.2 Dressing Quality and an economy grade of sawn timber; one grade each for milled flooring, weatherboards, lining and mouldings. A postal ballot is being undertaken.

Field experience is needed to determine the applicability of the rules to commercial timber.

Discussion

Mr. Huddleston said that he felt the preparation of grading rules was the business of the Standards Association; however, there is an obligation on all delegates to organize the field experience to which Mr. Turnbull referred. The present grading rules are interim only, but it is the intention of the Standards Association to issue the rules covering sawn and dressed lines as full Australian Standards. However, because of the indecision regarding the construction grades, these will remain as interim. When the revised construction grades are issued the public review documents will be taken into the field and proof tests conducted to ascertain the effect of the various limits on mill run production.

Mr. Clarke asked what the other States were doing or intended to do in regard to field testing of grading rules.

Mr. Jennings and Mr. Brown both said they had results from limited tests.

Mr. Boyd said that a parcel of radiata flooring received from South Australia had been tested. Material graded to the new specification had proved to be somewhat better generally than was required according to proof load tests developed by the C.E.B.S.

Mr. Turnbull said that in addition to the grading rules mentioned during his talk, rules had been prepared for dressed lines such as flooring, lining, weatherboards and mouldings, and these were consistent with the rules for sawn boards.

ITEM 4(c)

PRESERVATIVE TREATMENT, INCLUDING DIP-DIFFUSION FOR SAWN TIMBER*

The purpose of this paper is to survey information on various aspects relating to treatment of radiata pine building timber in South Australia as a basis for discussion on future policy on this matter.

(a) Durability

Radiata pine building timber today probably averages 90 per cent. sapwood which has low durability to decay fungi and to most termites. The sapwood is susceptible to *Anobium* and almost certainly also to *Hylotrupes*. While the heartwood is immune to these borers, the decay resistance of the material we have so far tested has been no better than that of sapwood.

In timber such as weatherboards, window joinery, laundry floors, etc., subject to rain or other occasional wetting, we now know that the decay resistance of relatively non-durable species is very dependent on water absorption. Since radiata pine sapwood is very absorbent, this factor should be added to its known low durability and

*Presented by Mr. Tamblyn.

kept in mind when making comparisons with other timbers - particularly those resistant to absorption such as spruce sapwood, Douglas fir heartwood, etc.

Apart from these general considerations, we have very little statistical evidence on performance of radiata pine houses in Australia. Some evidence on Anobium attack in the Mount Gambier area is not reassuring, but mostly it is too indefinite to be of much value yet when considered against the fact that a life of 50 - 80 years or more is required for most houses.

(b) Treatment of Building Timber Abroad

That many countries give little or no preservative treatment to building timbers has sometimes been quoted as a reason for not treating radiata pine in Australia. The best comment on this reasoning is to review present trends in New Zealand, U.S.A., England and South Africa.

In New Zealand, according to 1956-57 statistics, there were about 80 plants treating some 90 million super ft of sawn timber of which about 60 per cent. was radiata pine building timber. The main object of treatment in New Zealand is to control Anobium attack.

In U.S.A., treatment of house timbers is still on a small scale. However, a survey of several thousand houses in the Southern States made by the American Wood Preservers' Institute at the request of the Federal Housing Administration has been published recently* and some rather startling claims made of which two quoted below are a fair sample.

(i) "There is plenty of documental evidence to show that decay and termite damage have provoked buyer resistance to lumber in buildings."

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*Forest Products Research Journal, June, July 1957, March 1958.

(ii) "In Los Angeles, houses built in 1934-49 with pressure treated sub-floor timbers were compared with similar untreated houses. Only 1 per cent. of treated houses had been attacked by decay or termites compared with 78 per cent. of untreated houses attacked by termites and 30 per cent. by decay. Average repair bills exceed $300 per untreated damaged house. By comparison, cost of treatment had been about $30."

The survey also concluded that termite shields were 95 per cent. ineffective in U.S.A. and that soil poisons should be considered a temporary expedient only. The American Wood Preservers' Institute is now recommending use of treated timber to the extent of about 2 per cent. additional home cost.

In England it is claimed that the market for non-decorative wooden floors has been lost to concrete slab and tile construction because of the combined effect of dry rot and timber shortage after the last war. Because of frequent trouble with rotting floors in the past, buyer resistance has prevented recapture of this timber market despite the strongest propaganda for treated wood. It is understood that the Marley Tile Co., which has been the most powerful opponent of wooden floors in England, is setting up a factory in South Australia.

In South Africa, legislation to compel treatment of building timber has been necessary in coastal areas following introduction of Hylotrupes and the dry wood termite Cryptotermes brevis. In these prescribed areas, which stretch from Durban to Capetown, all softwood timbers must be treated.

(c) The Position in South Australia

In the Adelaide area and over most of South Australia, the main building hazard is termite attack. With untreated radiata pine some Anobium damage and some decay will also occur and could prejudice the use of untreated pine for some purposes. Thus in the floor and sub-floor timbers of brick houses, where conditions are fairly cool and damp, Anobium damage is a real danger. Also in shops, factories and other similar buildings, where a large floor area is kept typically low to the ground and is covered with lino or rubber, floor decay would probably prohibit completely the use of untreated pine. To what extent decay will develop in untreated weatherboards is not yet clear as its occurrence becomes progressively more likely as the building ages. Thus freedom from decay in the first 20 years does not guarantee freedom in the next 20 years. At present we cannot rule out decay in pine weatherboards as a possible danger which could affect future sales in a State where wooden cladding has never been very popular. No prophesy can be made regarding Hylotrupes except that its establishment in South Australia would almost certainly necessitate treatment of all pine building timber.

On our present judgment, the combined hazard from Anobium attack and decay would seem barely sufficient justification for treatment of pine flooring timbers and weatherboards. Any difficulty in sub-floor access would tend to tip the scales in favour of flooring treatments for brick and brick veneer houses. However, any doubt of the need for treatment in the Adelaide area can be dismissed on the grounds that termite attack is the main hazard and is almost inevitable some time in the life of an unprotected pine house. In support of this statement, it should be mentioned that in 1956 Mr. Gay and I tried to assess the termite hazard in Adelaide and suburbs and reached the conclusion that probably 4 per cent. of all houses were being attacked each year*. On this figure an unprotected house would have only an even chance of missing attack in any 12½ year period. This high hazard is considerably

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*"A Survey of Termite Problems in Housing Trust Dwellings in the Adelaide Area (March 1956)". Confidential Report No.1, Project P.22-9, N. Tamblyn and F. Gay.

increased by traditional building practices in South Australia which preclude a sub-floor access door in the foundation wall of brick and brick veneer houses and which use dwarf wall construction in brick houses to obviate the need for bearers. In these houses, sub-floor access can be obtained only by cutting traps in the floor. A dozen or more traps may be necessary in a brick house.

(d) Costs of Termite Control

Costs of termite eradication are high and for a 12 square house range upwards from about £30 with a guarantee of 1 - 3 years after which an annual payment of about £6 is required to extend the guarantee. In a house where no attack has occurred "protection" can usually be bought for about the same annual premium. This "protection" means that if termite attack does occur it will be treated at no cost. Repairs are the responsibility of the owner, the obligation of the pest controller being only to cause attack to cease.

This is an insurance at high premium with very limited benefit, with not guarantee that the premium will not increase, that the eradicative treatment will avoid costly repairs or that the company accepting the premium will remain in business long enough for any benefit to accrue. It is not a capital investment, it does not increase the resale value of the property and it must always tend to discredit the use of wood. For a house continuously insured for 60 years, at least £360 would be paid out, plus the cost of any repairs necessary. Since most termite eradication treatments give little or no protection against Anobium or decay it is quite likely that total payments for all pest control and related repairs would be of the order of £500 for an untreated brick or brick veneer house over a minimum life period of 50 - 70 years. Economically this is a most unattractive proposition.

The first alternative to consider is installation of metal termite shields during construction of the house. This is practicable and desirable with a wooden house, and, provided the whole sub-floor area is accessible for regular inspection of capped piers we would recommend it as still the cheapest and simplest form of termite protection. Metal shielding is much more difficult with brick and brick veneer construction and for such houses in South Australia, where regular sub-floor inspection is impracticable, we can now no longer recommend it.

The second alternative is the use of soil poisons and though we recommend this, it is always with the limitation that such treatment may have a life of only 10 - 15 years. Initially it would cost about £40 for soil poisoning of a 12 square house before laying the floor, but in Adelaide any subsequent treatment would be so much more difficult and costly that with retreatment every 12 years, soil poisoning, plus any necessary Anobium control and repairs would probably cost upwards to £400 over a period of 60 years. It would thus have no great advantage in cost over annual insurance, though the danger of a high termite repair bill should be greatly reduced.

The third alternative is the use of preservative treated pine in all new buildings at a cost varying from as low as 10/0d. per 100 super ft for diffusion treatment to the firmly quoted 20/0d. for pressure treatment with proprietary salts. In a 12 square house, flooring accounts for about 1,100 super ft of timber before machining, and bearers and joists for another 1,000 super ft with a 10 per cent. allowance for building waste. Pressure treatment with proprietary salt would therefore cost about £21 for floor and supporting timbers and this figure would reduce to about £18 with dwarf wall construction.

In a brick house, if roof timbers are left untreated, the only additional cost would be for treatment of door jambs, architraves, skirtings and window joinery amounting to about another 700 super ft. The total cost would therefore be about £25 - £28 for protection of an average small brick home and being a capital charge would be financed on the relatively attractive terms for property investment. Thus the home purchaser would require about £7 extra deposit and would repay the remaining loan at 6 per cent. interest for 35/0d. annually over 25 years. For this outlay the householder would have complete protection against decay, termites and borers for the full life of the house which could well exceed the 60 years used in previous calculations. The alternative of outlaying £400 - £500 in dubious insurance protection or soil poisoning is ridiculous and once the facts are known no home owner, builder, architect or finance organization could reasonably deny the benefit of treated pine, unless it could be shown that no treatment of any sort was alternatively a cheaper proposition. With the possible exception of Melbourne and Hobart, it is most unlikely that this could be shown for radiata pine in any capital city in Australia.

For a brick veneer house, the same charges would apply except that we would recommend the additional treatment of bottom plate, wall studs, noggings and braces. For a 12 square house this would involve an extra 2,000 super ft of timber and would raise the total cost to somewhat less than £50. This would require a deposit of about £12.10. 0d. and annual repayments of about £2.14. 0d. over 25 years.

With a wooden house, treatment of weatherboards would be the only cost increase over brick veneer construction. For a 12 square house slightly less than 1,000 super ft of treated timber would cut the necessary weatherboards, at an additional cost of about £10. Despite the fact that metal shielding of most wooden houses is cheap and practicable, that _Anobium_ attack is unlikely because of warmer, drier conditions and that serious decay in pine weatherboards has not been proved to occur, it is quite possible that treatment costing less than £60 would receive strong support from banks and loan organizations.

Summarizing, it would cost, in round figures, £30, £50 and £60 respectively for pressure treatment of all except roof timbers of a 12 square brick, brick veneer and timber house using a proprietary waterborne salt. If a dip-diffusion treatment were used as later discussed these costs would be approximately halved. If it can now be decided that preservative treatment is desirable, it is then necessary to decide further whether dip-diffusion treatments are to be encouraged or whether proprietary salt pressure treatments should proceed without any opposition.

(e) Dip-Diffusion Treatment

We have now patented (Australian Patent 213,697) the dip-diffusion treatment for green building timber mentioned at the previous Conference, using a range of preservatives based on a 4 : 1 weight mixture of boric acid and sodium fluoride which can be used either with or without addition of varying amounts of sodium arsenate and dichromate. Very concentrated cold solutions of the 4-component preservative can be made containing more than 45 lb of dry salt dissolved in 1 gallon of water. Any concentration up to this strength can be used to obtain a given overall salt retention in the wood. Depth of penetration is controlled by the block stacking period.

In addition to this borofluoride mixture, diffusion treatment can be made with other non-patented highly soluble boron compounds such as sodium pentaborate or sodium octaborate to which sodium arsenite can be added to give high termite resistance. We have formulated at least one alternative to our patented mixtures.

Our development and testing of dip-diffusion is still proceeding and the present position may be summarized as follows:-

(i) The process is simple, practicable and requires very small capital expenditure on equipment. It is commercially used in New Zealand and New Guinea.

(ii) The preservative is cheap and would cost about 11d. per lb for the simple boric acid : sodium fluoride mixture rising to about 1/3d. per lb for the 4-component mixture. The non-patented formula would be just as cheap.

(iii) We are reasonably satisfied that the process can be controlled on solution strength, block stacking period and colorimetric test for depth of penetration. No routine analysis should be necessary either of solutions or treated wood.

(iv) In the simplest practice, all radiata pine would be dipped in the same solution and then block stacked for 2 - 6 weeks depending on cross-section. The object would be to obtain substantially complete penetration of 1 in. boards and about $\frac{3}{8}$ - $\frac{1}{2}$ in. in larger sections as determined by simple colorimetric test. Overall retention of preservative would probably be 0.3 - 0.4 lb/cu.ft.

(v) With 1 in. material, covering of stacks with tarpaulins appears to be unnecessary, provided there is protection from rain. If the maximum thickness can be limited to 2 in., it is possible that covering could be dispensed with for all sizes. Further work is necessary on this point.

(vi) Based on laboratory decay and termite tests of treated 4 in. x 1 in. and 4 in. x 2 in. radiata pine boards, the above requirements appear to be reasonably safe. Tests are still proceeding and results are given in the next section.

(f) Tests of Dip-Diffusion Treatment

Since dip-diffusion treatment of radiata pine building timber is already a commercial practice in New Zealand, there should be no need to justify the method or the use of boron for controlling *Anobium*. Our results, summarized below, are intended to show what specific treatments are suitable for use in Australia, where control of termites is one of the main objectives.

(i) Use in New Guinea

The borofluoride-chrome-arsenic mixture has been used with apparent success for treatment of klinki pine in New Guinea since about May, 1955. We understand that about 2 million super ft has been treated, with the object of obtaining ½ in. penetration but with cuts made after treatment dressed with copper naphthenate.

(ii) Laboratory Decay and Termite Tests

Specimens cut from 4 in. x 1 in. radiata pine boards which had been block stacked for 14 and 28 days before air drying, were tested by the soil jar method using five test fungi. There was little difference in decay resistance between the diffusion periods and, except where noted in Table 1, the results refer only to the 14 day period.

TABLE 1

DECAY RESISTANCE TESTS (4 IN. x 1 IN. RADIATA PINE)

Preservative Solution	Dry Salt Retention lb/cu.ft.	Per Cent. Weight Loss		
		Maximum	Minimum	Mean
34% boric acid - borax	0.28	4.2	0	1.6
41% borofluoride	0.43	2.7	1.6	2.1
52% borofluoride-Cr-As	0.68	2.3	0.6	1.8
35% sodium arsenite (28 days)	0.33	5.0	0	1.9
"Tanalith C" - pressure treatment	0.35	49.1	0.6	*1.5
Untreated controls	-	42.5	13.6	30.9

*Excluding maximum figure.

Further tests on 4 in. x 2 in. boards diffused for 28 and 56 days are in progress. These include leached and unleached boards from covered and uncovered stacks.

Termite resistance tests have been made by Mr. Gay using the laboratory colony method with specimens cut from 4 in. x 1 in. and 4 in. x 2 in. boards, the latter being both unleached and leached. The leaching consisted of exposure on the roof of the Division for 6 months during which period about 14 in. of rain fell. Also included in these tests were boards from covered and uncovered block stacks, the latter being subject to fairly severe dry conditions - i.e. summer temperatures in a kiln with the fan operating. In all cases, with 4 in. x 2 in. material penetration was incomplete and the specimens used for test deliberately exposed untreated wood. The following tables (2 and 3) summarize results obtained with C. lacteus. Further tests with C. frenchi or C. acinaciformis are in progress.

TABLE 2

COPTOTERMES LACTEUS TESTS (4 IN. x 1 IN. RADIATA PINE, UNLEACHED)

Preservative Solution	Dry Salt Retention lb/cu.ft.	Covered Stack*		Uncovered Stack*	
		% Colony Survival‡	% Wood Eaten	% Colony Survival‡	% Wood Eaten
34% boric acid - borax	0.28	0 (20)	4.7	0 (28)	3.4
41% borofluoride	0.43	0 (17)	2.7	0 (20)	2.3
52% borofluoride-Cr-As	0.68	0 (15)	1.2	0 (14)	0.4
35% sodium arsenite (28 days only)	0.33	0 (11)	0.1	NOT TESTED	
"Tanalith C" - pressure treatment	0.35	0 (30)	1.9	NOT TESTED	
Untreated controls	-	74	88	37	38
E. regnans controls	-	74	99	38	81
Unfed colony	-	5	-	47	-

*Since there was no significant difference between 14 and 28 day diffusion periods, the above are average results for both periods.

TABLE 3

COPTOTERMES LACTEUS TESTS (4 IN. x 2 IN. RADIATA PINE, UNLEACHED AND LEACHED)

Preservative Solution	Dry Salt Retention	Unleached				Leached	
		28 Days Covered Stack		56 Days Uncovered Stack		56 Days Covered Stack	
	lb/cu.ft.	% Colony Survival[+]	% Wood Eaten	% Colony Survival[+]	% Wood Eaten	% Colony Survival[+]	% Wood Eaten
34% boric acid - borax	0.18	0 (26)	6.2	0 (26)	6.2	0 (30)	5.9
41% borofluoride	0.26	0 (23)	5.4	0 (20)	3.0	0 (25)	3.8
52% borofluoride-Cr-As	0.38	0 (17)	2.6	0 (17)	1.0	0 (14)	0.4
35% sodium arsenite (56 days only)	0.24	0 (16)	1.2	NOT TESTED		NOT TESTED	
"Tanalith C" - pressure treatment	0.37	0 (32)	1.8	NOT TESTED		0 (24)	0.7
Untreated controls	-	44	59	37	38	37	38
E. regnans controls	-	46	93	38	81	38	81
Unfed colony	-	41	-	47	-	47	-

[+]Survival periods of less than 84 days are shown in brackets.

From these decay and termite tests several very important conclusions can be drawn, though care is necessary in their complete acceptance pending results of field tests to be discussed later. Conclusions are -

1. Boron-arsenic mixtures have very satisfactory toxicity to building decay fungi and termites and compare favourably with proprietary copper-chrome-arsenic salts. Their high toxicity to Anobium is already known.
2. Incomplete penetration (as little as $\frac{3}{8}$ in. in material of 4 in. x 2 in. cross-section) with exposure of untreated wood has given the same high degree of termite control as complete penetration with a preservative of known reliability such as "Tanalith C". It is believed that this result is related to the establishment of a concentration gradient of preservative in diffusion treated material which prevents termites from distinguishing treated and untreated wood.
3. Roof exposure of 4 in. x 2 in. boards for 6 months in Melbourne caused insufficient leaching of any diffusion preservative used to significantly reduce termite protection.
4. 4 in. x 2 in. material from uncovered stacks exposed to summer conditions has so far given the same satisfactory results as similar material from covered stacks.
5. Diffusion periods of 14 days for 4 in. x 1 in. boards and 28 days for 4 in. x 2 in. boards appear to be adequate for termite control. Longer periods for 4 in. x 2 in. material may be desirable for Anobium or decay protection.

(iii) Field Tests

Field tests to confirm the results of the laboratory termite tests are in progress at Heathcote, Victoria. In all we have established about 80 tests each in contact with a separate colony of *Coptotermes* spp. All treated specimens are incompletely penetrated and have been cut to expose untreated wood. Unfortunately the test is not yet at a stage where we can be sure of the results. It can, however, be said that there is no evidence yet that the borofluoride-Cr-As preservative will not be effective.

(g) Commercial Application of Diffusion Treatments

It cannot be said yet that diffusion treatment giving incomplete penetration has been fully proved as satisfactory for radiata pine interior building timber, but it now seems most probable that results will finally dictate this conclusion. In anticipation of this, consideration should now be given to the conditions under which diffusion treatment of radiata pine should be permitted. Several difficulties immediately arise which can be discussed as follows.

(i) Control of Treatment

This Division cannot accept the responsibility for technical guidance and control of dip-diffusion treatments in Australia. Also we could not recommend general use of the treatment unless machinery for this guidance and control were available. Dip-diffusion is a treatment which, because of low equipment cost, must appeal to small operators who, as a class, are often technically more inept, less efficient or more careless of their reputation than larger organizations. Without technical control, there is a strong chance that introduction of dip-diffusion treatments would damage our reputation and retard or even stop the establishment of pressure plants using proprietary or other salt preservatives. We should not be responsible for this development unless the alternative can be guaranteed to be completely satisfactory at less cost. Minimum safe requirements would seem to be -

1. Completion of all tests necessary to prove the effectiveness of the treatment.
2. Legislative control of the treatment in South Australia or alternatively control by C.S.I.R.O. licence, revocable at our discretion.
3. Availability of permanent technical personnel to assist industry in establishing the treatment and in controlling it.

(ii) Cost of Treatment

There is no doubt that pressure treatment to obtain complete penetration with a fixed salt such as "Tanalith C", "Celcure A" or "Boliden S.25" is generally more reliable and more versatile than incomplete penetration with a leachable diffusion preservative. Introduction of dip-diffusion would be justified only if the cost to the consumer were substantially less than the cost of the alternative pressure treatment. Historical evidence points to the strong possibility that the price of both treatments as offered to the public would not be very different. Unless this profiteering could be avoided there would be little advantage in releasing dip-diffusion treatments except possibly as a means of holding pressure treatment costs to a minimum.

(iii) Future of the Preservation Industry

Four pressure plants which will use three different proprietary salt preservatives are already under construction for treatment of radiata pine in South Australia and several more plants are probable before dip-diffusion could be safely released. These plants will rely for "bread and butter" on treatment of interior building timber but will also provide a valuable service in treating pine for various other uses where a fixed salt is needed - i.e. cooling towers, external decking and cladding, fascia boards, round and sawn fence posts, palings, refrigeration rooms, boat building, concrete form work, etc. It is believed that introduction of dip-diffusion will prevent these plants from operating profitably and will hence retard to some extent desirable preservation developments.

The alternatives are for the establishment of a self-controlled versatile industry using proprietary salts, or an industry which must be policed, based on diffusion treatment suitable only for interior building timbers. If both treatments are to be made simultaneously then approximately the same selling price is highly probable except in periods of building recession, with little advantage to the consumer.

Discussion

Mr. Gay said that he could give more details on the dip-diffusion tests. Normally these laboratory tests include *Nasutitermes* and *Coptotermes*, but this time *Coptotermes* only was used. *Pinus radiata* is not susceptible to *Nasutitermes*. Six tests were done, three with *C. lacteus* and three with *C. acinaciformis*. *C. acinaciformis* results already given closely paralleled *C. lacteus* results, therefore any remarks made regarding *C. lacteus* will apply to *C. acinaciformis* which is the main species in Adelaide.

Using 4 in. x 1 in. timber, all treatments, both dip-diffusion and pressure, were toxic. The order of toxicity was arsenites, chromated borofluoride plus arsenic, Tanalith C, fluoborate, pentaborate. Tanalith C gave slightly inferior results to chromated borofluoride plus arsenic, but was superior to other treatments. There was no appreciable superiority of 28 days block stacking over 14 days block stacking.

Using scantling sizes 4 in. x 2 in., all treatments were again toxic and the order of toxicity of diffusion treatments was as before. Tanalith C was not as toxic as any dip-diffusion treatment. As regards prevention of attack, the arsenite, chromated borofluoride plus arsenic and Tanalith C treatments were approximately equal.

The treatments were still very toxic after leaching. Pressure treated Tanalith C was inferior to chromated borofluoride plus arsenic which was better than fluoborate and pentaborate.

In the uncovered tests good results were still obtained.

General conclusions based on laboratory tests were as follows:-

(i) Best of dip-diffusion treatments are better than pressure treatment with Tanalith C against C. lacteus and C. acinaciformis.

(ii) No evident advantages in increasing stacking time from 14 to 28 days.

(iii) No need to cover stacks after treatment.

(iv) Both pressure and dip-diffusion treatments show considerable resistance to leaching.

Mr. Huddleston asked whether this treatment was only being advocated for Adelaide, and Mr. Tamblyn replied that it could form a pattern for recommendations to other States later on.

Mr. Reid said that in New Zealand, the prices for dip-diffusion treated material are slightly lower than for pressure treated, but they should be much lower. Mr. Reid also made these points.

(i) The time elapsing between sawing and final use is important.

(ii) The necessity for two seasonings for pressure treatments gives more risk of degrade.

(iii) The policing of the industry by the industry itself is not impossible and could be facilitated if we required a minimum standard of plant for diffusion treatments.

(iv) The arguments relating to incomplete penetration often apply to pressure treatments as well as to dip-diffusion.

Mr. Jennings said that they are not particularly interested in treatment against termites, but more in treatment against decay of above ground line structures. He felt that sawmillers could be interested in dip-diffusion treatment because it can be used as a small unit. Capital investment and location of plant is important, e.g. in northern Queensland two pressure plants could probably handle all the requirements but large transport costs would have to be considered. The set-up is different from South Australia's where there is a high concentration of milling plants and where treatment could be confined to one plant. If control is introduced it is likely to incur Legislative action.

Mr. Bednall asked whether Mr. Tamblyn was 100 per cent. happy about dip-diffusion treatments.

Mr. Tamblyn replied that he was 100 per cent. happy with tests made so far but not on economic and psychological aspects. He felt it would be undesirable for every small mill to treat by dip-diffusion "to C.S.I.R.O. specifications". In South Australia he thought it would be desirable to have technical personnel to assist plants to start operating and to exercise the control necessary.

Mr. Jennings said that the cost of Lyctus immunization treatment in Queensland is nominally 12/9d. - 14/3d. per 100 super ft, but often the treatment operator does not get this price. For example, spotted gum with sapwood needing immunization very often cannot be sold at any higher price than untreated material not needing immunization.

Mr. Clarke asked whether treated radiata would compete with jarrah, and Mr. Brown replied that it would compete with karri rather than jarrah, but especially it would compete with baltic.

Mr. Tamblyn said that radiata carrying a 20/0d. per 100 super ft treatment cost would still be much cheaper than the alternatives.

Mr. Bednall commented that short end matched jarrah flooring sells at about the same price as radiata.

Mr. Huddleston said that he does not agree with recommendations regarding treated Pinus radiata because if the treating of timber for houses is started, everything will have to be treated, not only flooring and wall frames. He felt that this could not be justified, since their building regulations give scope for regular sub-floor inspection and, together with correctly fitted ant caps, do a great deal to reduce termite activity in Sydney. He believed that various pressure treating firms are looking to Pinus radiata to establish their treatments, since there is likely to be a £2 to £3 million turnover potential in radiata in New South Wales during the next 10 years or so. In New South Wales pressure treatments could only be justified for external cladding and external joinery. Dip-diffusion treatments are satisfactory if adequately policed, provided they are not subject to leaching, as tests in Sydney have shown that boron will be leached out in about 2 years. Any recommendations should be on the basis that timber be treated only where treatment is required.

Mr. Jennings said that they felt as Mr. Huddleston did. The problem in Queensland is external decay in cladding, etc. There is no Anobium problem in Queensland, only Calymmaderis and the Queensland Department would not be prepared to make a general recommendation for pressure treatment.

Mr. Brown said that the South Australian Woods and Forests Department was putting in a pressure treating plant for poles and sleepers, etc., and he understood that private firms propose to handle building timbers. Most termite attack in South Australia is in floors.

The Housing Trust dip radiata flooring in an arsenic bath and have had no case of attack in 12 years. Cost would probably be less than £12 - £15 per house.

Mr. Gay mentioned that during the South Australian termite survey it was evident that attack would not have been expected on Housing Trust Estates as they had been completely cleared, but the problem will arise in future when colonies of *C. acinaciformis* develop.

Mr. Brown replied that the Housing Trust has built in a large number of localities and he could not imagine that all are free of termites.

Mr. Irvine said that all evidence seems to be that dip-diffusion is satisfactory and cheaper. He would take a lot of convincing that a cheaper treatment should be withheld from the consumer purely because pressure treatment has been recommended.

Mr. Huddleston said that if proper exterior painting was maintained then preservative treatment was not needed.

Mr. Jennings pointed out that the further north the less durable is paint, since paint coats are very difficult to maintain in the tropics. A paint coat will not last much more than 3 years in Brisbane or 1 - 2 years in Cairns or Townsville. Therefore, a timber with better durability than hoop pine is required in cladding and external joinery.

ITEM 4(f)

RECOMMENDED USES

Mr. Turnbull said that all officers who undertake advisory work need to know what lines the industry can readily produce, as recommendations for uses are ineffective if material cannot be supplied. Some system is desired for keeping the Division informed as to the availability of different qualities and sizes, including high qualities, wide boards and scantling.

Mr. Huddleston said that there was a small percentage of high-grade material available. Occasionally millers produced clear material up to 16 in. wide and 20 ft in length. Material 4 in. x 1 in. for flooring was over-supplied at present.

Mr. Reid stated that they hoped to develop radiata for sash stock, panelling and mouldings, but he felt they had to give careful consideration to both seasoning and preservation to achieve this goal.

Mr. Brown said that South Australia concentrated at present on producing material for cases, flooring and furniture. It is already being used for joinery and scantling. A wider trade was becoming possible in wide boards and shelving. The entire output was being disposed of without trouble at present.

Mr. Jennings commented that Queensland has no problem at present. He said that imports of radiata from New Zealand, used mostly for corestock and cases, were dropping.

Mr. Foley said that in the past 8 months New Zealand exports to Australia had increased, most interest being in construction grade.

Mr. Turnbull asked whether high quality treated radiata would be available for cooling tower fill. A requirement of about 300,000 super ft per tower should make this an attractive proposition. Although a high quality is required, it need not be clear. Slats are only small size so that required quality should not be a problem.

Mr. Huddleston stated that radiata had been specified for a tower at Newcastle. The timber was available but the price asked was too close to redwood for it to be acceptable.

Mr. Foley commented that New Zealand could supply this material at a very attractive price.

Mr. Brown mentioned that there had been enquiries for such material in South Australia but at present producers were not in a position to supply.

ITEM 5. PRESERVATION

(a) SUMMARY OF RESEARCH ACTIVITIES*

This review will be as brief as possible as we have about 15 agenda items to discuss which cover much of our field in some detail. I propose only to fill in the gaps and to make general comments which may help to give perspective in later discussion.

(a) General Developments

In my review at the 1956 Conference mention was made of "the imminent birth of a conventional preservation industry". That industry has been born and there are already some twenty commercial or semi-commercial plants either in operation or being made. We must now begin to adjust our thinking and our work to this change. The objective in the past has been to get the industry started, it is now increasingly our job to keep it in control by setting high standards and thinking forward as far as possible. On this latter point it may soon be opportune for New South Wales and Queensland to revise their respective Acts to make easy control by other methods than core loading.

(b) Rail Sleeper Tests

We are at present treating sleepers for tests in New South Wales and Queensland and when these are completed there will be tests in six States all established since about 1954. We do not propose to set up any more extensive service tests, but may make some small tests of those timbers which proved most difficult to treat even at high pressure. Brush box has been probably the most untreatable in its density class and because of its economic importance further work is desirable. In such timbers, which we cannot penetrate with water when once dry, a diffusion treatment of the green material might prove reasonably permanent, and by adding a polyethylene glycol we might obtain some mechanical benefit. Tests of this sort are in our mind for the future.

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*Presented by Mr. Tamblyn.

On the subject of rail sleepers, mention should be made of one of our test sections of creosoted radiata pine sleepers at Heyfield, Victoria, which failed in about 2 years because the spikes would not hold. These sleepers were adjacent to similar pine sleepers treated with "Greensalt" which have not given the same trouble. We have set up a new test recently to obtain further information on this trouble.

(c) Poles

We have no statistics yet available but it is likely that about 80,000 poles are now being pressure treated annually. There have been no serious difficulties but the method we initially recommended of basing retention figures on sapwood volume has come in for some criticism. It should now be possible to set overall figures for each pole size and species subject to some adjustment at the plant on the basis of occasional measurements.

Cleanliness of oil treated poles is a matter of some concern and we are doing some work on this aspect. However, an oil treated pole can never be as clean as a salt treated pole and it is quite possible that waterborne treatments will slowly oust creosote, particularly in urban areas. At present we are watching large scale tests of salt treated poles in Tasmania and expect to arrange similar tests of several thousand poles in Victoria.

Our own pole tests, set up in 1932-1936 in co-operation with the State Forest Services have now largely served their purpose. Although there was a good attendance of pole engineers at the inspections during the last few weeks, we should now consider setting up new tests with the object of retaining the interest and answering the questions of pole engineers over the next 25 years. On this we would like comments and suggestions from the States.

(d) Crossarms

Crossarms treated at high pressure with petroleum-pentachlorphenol will soon be in general use by the Postmaster-General's Department. There should be no difficulty in treatment and there should be benefit in use. The main problem is the cleanliness of the arm at the period of its erection. Our work on crossarms is at present confined to this.

(e) Cooling Towers

This is the subject of an agenda item and the only comment to be made here is that if clear radiata pine is to be imported at premium price from New Zealand for slats or drip bars, we should also look at the possibility of using Queensland hoop pine thinnings or perhaps klinki pine from New Guinea. This is not a matter for small tray tests such as we are now installing but for a semi-commercial scale test in which twisting, splitting, machinability and treatability of the timber would all be considered. I think we could now arrange such tests in Melbourne if required.

(f) Mining Timber

Last year, in co-operation with the Division of Wood Technology, we made an inspection of a colliery at Port Kembla and finally recommended treatment at about 50 lb/sq.in. with a copper-chrome-boron preservative. The plant has been awaiting installation for some time but should be starting soon. We had hoped that this plant would stimulate interest in treatments in both the Port Kembla area and in the northern field.

Unfortunately, in the northern field it now appears likely that pressure treatment with a fixed copper-chrome-arsenic preservative will be made despite the results of tests (not made by us) which seem to show that Lyctus is the main hazard in the northern field and that cheap boron or sodium fluoride treatments give good results. We had thought that low pressure treatment with these cheap preservatives or even a dip-diffusion treatment might be satisfactory and are hence a little perturbed at the present situation where the most important coal field in Australia may be adopting an unnecessarily costly treatment because of failure to seek professional advice.

In connection with treatment of mining timber there is some controversy as to whether the use of an arsenical preservative is desirable. We have been endeavouring to develop a fixed copper borate preservative which would be suitable for wet conditions in mines and also for general purpose treatment of building timbers.

(g) Fence Posts

The work we had planned on treatment of fence posts has been almost completed, though we have not yet investigated double-diffusion treatments. A new field test of fence post treatments is desirable preferably in co-operation with one or more of the State Forest Services.

In such a test we would include different methods of treatment as well as a range of preservatives likely to be still important 20 or 30 years hence.

Our fence post bulletin is running out of print and we propose to revise it and include treatment with waterborne preservatives, including sap-replacement. Any criticisms of the first edition would be welcome.

(h) Marine Tests

For some years we have done very little work on testing of preservatives for piling, etc., but have very recently discussed a small specimen test with the New South Wales Maritime Services Board. It may be desirable to duplicate this test in the Brisbane river and we would be glad to have comments on the basis that we would supply only the treated specimens.

(i) Diffusion Treatments

Although we have patented the dip-diffusion treatment using a specified range of preservatives, it is not C.S.I.R.O. policy to charge royalty on the patent in Australia, and even if such royalty were charged, the money would be paid into consolidated revenue and hence would not be available to us even for administration of the patent. The purpose of the patent is thus very truly to prevent mis-use of the treatment and to enable us to revoke its use if necessary without giving a reason.

While we regard dip-diffusion as already very promising, there is room for much development in this field. A highly soluble, slow fixing preservative would be useful for treatment of weatherboards and other timbers subject to occasional wetting, and the incorporation of a bulking agent could open up other possibilities. A treatment for the future on which we have done a little work might be called "pressure diffusion" being simply the pressure treatment of green timber with a fairly strong solution of a diffusible salt. We believe this could be the pattern for the future, particularly with building timbers.

Under diffusion treatments, mention might be made of preservatives suitable for treatment of green veneer to be used for marine grade plywood. We have recently spent a little time trying to develop a copper-chrome-fluoride preservative for this purpose but at present feel that the copper-chrome-arsenates are the best available, provided arsenic is considered tolerable in plywood production.

(j) Tolerance of Fungi to Preservatives

Mycological work has included some studies on the tolerance of fungi to preservatives. So far we have not found any Basidiomycete fungus highly tolerant to boron compounds. A fungus (*Poria vaillantii*) which we isolated from Celcure-treated timber attacked in New Zealand has proved to be extremely tolerant of copper-chrome-arsenic preservatives and probably could not be stopped by any commercially possible treatment with these preservatives. At present we cannot judge the practical significance of this but do not view it with great alarm.

(k) Reasons for Durability of Timber

This subject will be discussed fully in a later item. The purpose of raising it here is to remind you that it could have useful bearing on the selection of seed trees of durable species and we would like the States to give some consideration to whether work of this sort might be desirable for any particular species. This work is possible now but once the investigation has been concluded it would be difficult to re-open it.

Discussion

Mr. Cokley said that it would be very difficult to do away with core loadings in Queensland and New South Wales, as the Legislation is based on them. In many cases the sample cannot be related to the charge, and it is impossible to determine the loading in a sample as so many lb/cu.ft. unless it is known from what charge the sample originated. A second factor is that from legal aspect it is necessary to be able to quote an analytical figure. From the control point of view no sufficiently accurate relationship between analytical results and consumption of materials has been found from results of tests made over 12 years; the only exception is in case of veneers and even then there is only a very approximate relationship. That, primarily, is the reason why a change from core loading could not be considered. When the idea of core loading was proposed at the 1956 Conference it was to avoid the fact that overall pick-up could be obtained with incomplete penetration, a factor that is particularly vital with North Queensland "scrubwood", where in many cases sapwood occurs in pockets, e.g. as in yellow walnut, rather than in bands.

Mr. Tamblyn said that the alternative is to institute a system of control based on plant records and determine how much preservative is used for a certain amount of timber on a monthly basis, coupled with occasional examination made to see that the specified amount of penetration is obtained.

Mr. Huddleston said that they also have this problem of control. They are currently issuing permits to a firm for pressure treatment of poles and other products. The basis of approval is that there shall be penetration to the complete extent of sapwood or where no sapwood exists to $\frac{3}{8}$ in. at not less than 8 lb/cu.ft. of creosote. The same specification has been applied in the case of water soluble preservatives used by the same firm. The same pattern is followed in each approval. With Tanalith approval has been given for a loading of 0.35 lb/cu.ft., to be described as Tanalith for ground line contact and a third approval allows timber to be treated at any concentration agreed upon by treating firm and buyer. The invoice must specify the concentration, which shall be the minimum concentration. There are restrictions on the approval in that, as part of approval, all work shall be done before timber is treated and that a note shall be attached to invoice of sale giving a statement to the effect that the timber has been treated with a superficial treatment and that any subsequent cutting, boring or planing of timber will expose untreated timber and such timber should be treated before use.

In New South Wales there are two plants treating poles with creosote. The specification requires that poles shall have at least $\frac{1}{2}$ in. sapwood and that that sapwood shall be treated with 12 lb of creosote per cubic foot. This has had a somewhat detrimental effect on the supply of poles in the areas in which pole plants are in operation, so much so that in Grafton no poles are being taken from State Forest as foresters will not sell them. Sapwood of more than $\frac{1}{2}$ in. takes too much creosote. In case of timbers like white mahogany, which is one of our best pole timbers, the sapwood is very narrow, so these are left in the bush rather than risk rejection on account of too narrow sapwood. In both Grafton yard and Wauchope yard there are large supplies of poles which have been rejected for treatment because either the sapwood is too wide or too narrow, and these poles have been dumped and allowed to rot. In both yards there is insect attack in the poles and in some which are being seasoned, particularly spotted gum with starchy sapwood, the sapwood is rotting before treatment takes place. Mr. Huddleston felt that an effort should be made to avoid mistakes being made in New South Wales and said that all concerned should endeavour to help each other to overcome these problems.

Mr. Irvine said that in Victoria the absurd condition was developing of pressure treated messmate pole lines running through box and ironbark forests from which 10,000 poles could be obtained, and yet pole using authorities will not buy them. They prefer to transport treated messmate poles up to 100 miles and use them there rather than poles which could be cut alongside the holes. The pole using authorities should be kept fully informed, by everybody concerned in pole usage and production, that the durable poles are still an economic proposition for them.

Mr. Jennings felt that even with durable species such as grey ironbark, it would pay pole using authorities to forget about desapping and treat the sapwood with creosote, because a very large percentage of the grey ironbark poles that are being supplied now are quite fast grown material, and it is doubtful whether it is as durable as old growth material. The future recommendation to pole using authorities in Queensland will probably be that they should leave sapwood on and treat, irrespective of durability rating. This will improve the supply position, as with desapping, a larger tree than otherwise necessary must be used. This would be important in Queensland with only a limited supply of durable timber left.

Mr. Huddleston asked whether Mr. Jennings was aware of the cost of treatment, viz. 8/6d. per cu.ft. true volume in one case to his knowledge.

Mr. Jennings replied that to maintain a pole line, the economics should be based not on replacement cost of the pole, but complete cost of the erected pole. A new pole on site in Queensland which costs about £15 or £20 costs about £150 to erect and put into service, hence it does not take many years to amortise cost of treatment.

Mr. Tamblyn said there were many questions still to be answered, such as use of creosote, new preservatives, the effect of knots in the butt section of the pole. Some evidence is also desirable as to whether splits, which go well up into heartwood at the time of treatment, are a bad risk.

Mr. Clarke suggested that another outstanding question is the effect of using fixed water solubles in species which tend to crack deeply.

Mr. Huddleston said that it has generally been stated that heart rot in a growing tree does not continue after the tree has been made into a pole. From some inspections in New South Wales, he believed that some of the heart rots do continue under service conditions. He asked whether this could be checked in collaboration with the Division of Wood Technology.

Mr. Tamblyn said that the need for some new pole tests was apparent and he would draw up the outline of a test and circulate it to the States to see what further suggestions they have to make.

Mr. Tamblyn said that he had recently discussed with Mr. Moore of the Maritime Services Board the possibility of installing a marine borer test in Sydney Harbour. If a test in Sydney Harbour were started, a similar test in the Brisbane River would be desirable if it could be installed on the basis that the Division of Forest Products supplied treated test material only.

Mr. Jennings said they would co-operate. They are currently making observations under a number of wharves in Brisbane River and new specimens could be hung there. The distribution of Nausitoria is a great problem in Queensland, and he suggested that the population of various organisms should be determined at each site. This was particularly important since the Somerset Dam now controls the flow of the river, and they are now getting a fresh water stream with lower alkalinity further down river.

Mr. Wickett said that Western Australia would be interested in taking part in a marine borer test.

Mr. Tamblyn doubted whether there would be any different hazards in Western Australian harbours from those existing in Sydney and Brisbane, but he would be glad to consider Mr. Wickett's offer.

Note: Further discussion on Marine Borers under Item 5(p).

ITEM 5(b)

DIP-DIFFUSION TREATMENTS FOR SAWN TIMBER*

As is now well known, the dip-diffusion process is a simple one, consisting of dipping green timber for a few seconds in a preservative solution, then allowing the dipped timber to drain for a few minutes and block stacking it for 1, 2 or 3 weeks, or longer if necessary. At present it is thought desirable that the outer layers of block stacks be protected from rain and rapid drying; however, it has not been established that coverings are indispensable and, in fact, there is evidence that under humid conditions the rate of diffusion in

*Presented by Mr. Johanson.

uncovered stacks proceeds in the outer layers as satisfactorily as in timber from the middle of the stack. This aspect will be the subject of further work if necessary.

When applying this dip-diffusion treatment to hardwoods on an experimental scale, some interesting results were obtained. The experimental work was carried out in co-operation with the Division of Wood Technology of New South Wales. Using flooring boards (4 in. x 1 in. x 2 ft) of brown tulip oak (Argyrodendron trifoliatum) and rose maple (Cryptocarya erythroxylon) it was found that 2 weeks of diffusion was sufficient to obtain 0.2 per cent. of boric acid in the cores. The mean core loading varied from 0.21 to 0.57 per cent. and, as time progressed, higher loadings in the cores were obtained.

The test was carried out during the winter months when the temperature was less conducive to diffusion than it would have been in the summer. Three different logs were used for each species to ensure some degree of variation in the two timbers. The analytical values obtained suggest that there is little difference in ease of treatment between rose maple and brown tulip oak, although there is a tendency for brown tulip oak to attain higher boron content in the cores than rose maple.

Another experiment on dip-diffusion was carried out at a commercial mill in Queensland. This time spotted gum (Eucalyptus maculata) was cut to obtain flooring boards (4 in. x 1 in. x 2 ft) with as much sapwood as possible. In this test, as in the New South Wales experiment, three different logs were used to supply both quarter-cut and backsawn boards. The block stacking was divided into four periods, 1, 2, 3 and 4 weeks. From the treated samples, cores were obtained from sapwood only (cores were about 3/16 in. thick). The analysis of the cores indicates that adequate penetration could be obtained in 2 weeks of diffusion, and as the length of the diffusion period extended much higher core retentions were obtained. At 4 weeks there was as much as 0.7 per cent. of boric acid by weight on oven dry basis. The experience with this eucalypt suggests that its sapwood is particularly easy to treat against Lyctus.

We should also mention here the ease with which taua (or basswood) from New Guinea may be treated by diffusion. At Lae samples of 1 in. and 2 in. boards (6 and 7 in. wide) were dipped and stored in uncovered wired bundles with the idea that the humidity in that area would be sufficiently high to enable adequate diffusion to take place before the surface dried out. The 1 in. thick boards showed complete penetration in 2 weeks and complete penetration appears to be possible in 4 to 5 weeks in 2 in. boards.

Although we have established that a minimum concentration in cores can be easily achieved in the timber mentioned, it is advisable to bear in mind that no particularly great merit should be attached to complete core penetration. We have already considered incomplete penetration in P. radiata for control of decay, Anobium and termites, and it may be envisaged that incomplete penetration in treated timber need not be looked upon as a disadvantage. In fact, as far as control of termites is concerned, it could be of distinct value by providing infinite gradation in concentration of preservative, thereby providing the termites with indistinguishable but toxic doses.

By the same token, one could consider that the surface treatment and incomplete penetration are not as inadequate in control of decay as may appear at first. It is possible that in places where timber becomes sufficiently wet to be attacked by wood destroying fungi, easily diffusible salts, or slowly fixing salts, will continue to diffuse and thereby impede the onset or progress of decay. The damp micro environments often encountered in sub-floor timbers would be particularly conducive to such diffusion, and here it would be advisable not to forget boron compounds which seem to be so effective against decay.

Discussion

Mr. Cokley said they had made tests of a dip diffusion treatment using fluoride-boron-arsenic mixture for rose maple at Ipswich. Within an hour a gelatinous precipitate had formed in the solution and the solution had such a bad effect on the operators that they could not carry on, one developing severe dermatitis. Mechanical dips are not the complete answer, as in the case of small country sawmills hand dipping will still be employed.

With regard to analytical control, they were concerned at the comparatively high analytical figures for boron. At the moment the validity of the analytical results using the normal method and the colorimetric spot tests is in doubt. Overseas workers have found it necessary to go to the extent of ion exchange separation of boron and fluorides. It is vital to have a method that will stand up in court.

He felt that diffusion treatments were satisfactory provided complete penetration was obtained. It cannot be used for less than complete penetration, particularly in the case of the North Queensland scrubwoods. Large stocks of logs are carried and in many of them the moisture content is going to be very low, particularly in the outer zones. In the case of the Ipswich material, penetration into the core was obtained with roughly 30 per cent. moisture content. He felt that the limit would be about 20 - 25 per cent. and that this would vary with species.

Mr. Cokley suggested that investigation of the analytical methods be treated as a matter of urgency.

Mr. Edwards said their experience had been only on an experimental scale, but they had almost exactly the same experience as Mr. Cokley. He thought that the problem is most important and warrants further attention.

Mr. Huddleston said he felt that boron had been so successful it could stand a few failures due to mismanagement of plants. It is rather a feather in our cap to realize that there has not been one recorded failure of boron in the preservative treatment of timber against *Lyctus*. As far as dip diffusion is concerned, there are obviously defects to overcome in chemicals, method of handling, etc. He could also see the possibility of overcoming treatment problems with timber which cannot be treated by pressure. It is a means of obtaining preservative treatment at comparatively low cost and he felt sure that New South Wales would be prepared to approve of it if application for approval were received.

ITEM 5(c)

SAP REPLACEMENT

Mr. Dale said that the Newsletter article gives our latest ideas on sap replacement and defines the fields for which it is suitable. Leaflet 12 is still a very useful background but few people are using the methods outlined therein.

Sap replacement is proving very useful for the small user and serves the main purpose of preventing waste of small round material now often cleared and burnt. There is little difficulty in preventing its mis-use, i.e. commercial exploitation, as the process is economically unsuitable for such. He mentioned that the Creswick students are doing useful work on the treatment of *Pinus radiata* by this process, and indications are that the concentration must be below 2½ per cent. for this timber.

Mr. Edwards said he understood that Tanalith C and Celcure had been used for this treatment and asked what the position is regarding initial toxicity hazard to cattle, especially where freshly treated posts are used for paddocks.

Mr. Dale said that cattle would have to eat a lot to get a fatal dose. This is borne out by the New Zealand Animal Health Research Station. Not only is surface of timber treated with arsenical waterbornes safe, but the cattle would have to ingest a very large amount of the actual timber to suffer any serious effects.

Mr. Bednall asked whether there is any information available on fire hazard of creosote treated material.

Mr. Dale replied that this question is often raised. The Western Australian test has had several fires through it but there has been no appreciable damage to posts, and overseas practice shows that creosote treatment certainly improves fire resistance of round timbers because it keeps sapwood intact. Commercial treaters carried out tests and bored a hole right through a treated pole with an oxy-acetylene torch without it igniting.

Mr. Reid asked if Mr. Dale had any comment on the checking in service of non-durable species treated by sap replacement.

Mr. Dale replied that this does seem an obvious defect. At present it is the user's responsibility to choose posts which do not split. Results would indicate that a certain amount of checking can be allowed in a post or pole which has been treated in the sapwood without danger that infection would occur, but this is not desirable.

Mr. Tamblyn said that the average treated round eucalypt fence post is about 4 or 5 in. in diameter. If the heartwood rots out completely there is still 50 per cent. of the post left.

ITEM 5(d)

TERMITE CONTROL IN BUILDINGS*

The title of this section suggests that it is our intention to consider both the prevention and the eradication of termite attack from buildings. In fact, I have only two observations to make on the

*Presented by Mr. Beesley.

subject of termite eradication, and both relate to treatment with white arsenic dust. In some of our contacts with the public we do find a certain amount of opposition to the use of arsenicals, and would like to know if the States have had the same experience. If so, does the Conference consider that there is sufficient demand for a less lethal powder to justify a search being made?

The second observation is to do with the cost of eradication which, in Melbourne, is commonly of the order of £30 - £40, but may be as high as £100 in the country. This seems a lot of money to have to spend on eradication when, with the leaflets and advice available free from ourselves, from the State Forest Departments and from Agricultural Extension Services, the job can be done at a cost of only a few shillings. Perhaps the Conference would like to express an opinion on what can or should be done to bring these Departmental leaflets and services to the notice of the public? How can the publication of articles such as those appearing in "Australian Country", May, 1958, and "Australian House and Garden Practical Planning Series No.5" be stimulated?

Our main purpose of including this item on the agenda was to get the views of the States on the relative values of several different methods of preventing termite attack in buildings - both old and new.

As a general rule, our present recommendations are along the following lines.

(a) Stumps and Piers

Properly made and fitted ant caps offer the most economical form of protection for free-standing stumps and piers - provided that they project at least 9 in. out of the ground. We do, however, point out that 9 in. is the minimum clearance and that 15 - 18 in. is preferable, and that regular (and frequent) inspection of the shields is an essential part of the protection.

(b) Continuous Foundation Walls

We strongly advise a minimum clearance of 12 in. beneath the bearers in brick and brick-veneer buildings, emphasizing that this helps sub-floor ventilation and facilitates inspection of shields, etc.

Given adequate sub-floor ventilation and ease of access we tend to recommend metal shields and treated soil barriers about equally beneath buildings of this type. Without doubt, shields offer the more permanent form of protection, but the difficulties of obtaining satisfactory shielding gives the treated-soil barriers an initial advantage. In Victoria, at least, professional eradicators will contract to form a treated soil barrier, and usually do a satisfactory job. Almost any plumber or sheet-metal worker will claim to be able to make and fit a satisfactory termite shield but the result is not always as good as it is supposed to be.

The fact that the life of treated soil barriers is limited, perhaps to only 10 or 15 years, is their biggest drawback, and points to the necessity for some other form of protection which is both permanent and free from any inherent defects - even in the hands of unskilled users.

(c) Treated Timber

Whenever maintenance is liable to be irregular or unreliable, either through lack of sub-floor clearance, tenancy, or for some other reason, the form of termite protection used must be permanent and automatic. Under such circumstances a termite resistant timber appears to offer the most satisfactory method of protection. It appears to be immaterial whether this timber is naturally resistant to termite attack or has been treated (e.g. with Tanalith, Celcure or a similar salt) to give it immunity, provided the resistance is permanent.

We are not yet certain that termites will build over timber treated with an arsenical salt in order to reach susceptible materials.

If they do not, then it is probable that only the flooring and sub-floor timbers will have to be treated. If they do, then all the timber in the structure of a building will have to be treated and, even then, the contents may not be safe from attack.

(d) Protection Service by Pest Eradicators

The essential of this method of protection is an annual payment of about £6 - with limited liability. For obvious reasons we do not regard this as good "insurance" on new buildings, but are sometimes inclined to recommend it for buildings occupied by people who are unwilling or unable to undertake treatment work themselves.

(e) Concrete Slabs

We usually consider a perimeter apron or other structural device as offering the best form of protection for dwellings on a concrete slab foundation. We have noticed, however, that (in Victoria) there is a tendency for the framing to be brought to the edge of the slab and for the sheathing to cover the joint between wall and slab. Grass or garden soon obliterate the joint and the termites then have easy access to the timber.

Discussion

Mr. Huddleston pointed out that there was another approach to termite control which had not been mentioned, viz. the total eradication of termites from the area, as was done with arsenic dust treatment. He stated that use of bait stakes soaked in arsenate solution had been known to arrest termite attack on garden stakes in Sydney and recalled that when the Benalla pole test was installed termites had been eliminated from the whole area for some time by one of the arsenical treatments and had to be re-imported.

Mr. Beesley replied that termites were now abundant again at Benalla and that baits used in Western Australia, in the form of arsenic dust sandwiched between pieces of susceptible wood, had been a complete failure.

Mr. Harris said that one pest eradicator in Western Australia had claimed considerable success by the use of karri bait stakes soaked in sodium arsenite.

Mr. Gay, at the request of Mr. Wickett, outlined laboratory tests aimed at protection of concrete slab floors against termites, especially "no fines" concrete, which offered ample avenues for termite penetration. Laboratory termite colonies were capped with a cylinder containing a tightly-fitting 3 in. thick plug of "no fines" concrete, with susceptible wood laid on top. The termites penetrated untreated concrete and reached the wood in 24 hr, but when 0.5 per cent. dieldrin was added to the water used in making the concrete, no penetration occurred and, with one termite species, the colonies died out. To assess the likely permanence of protection in service, the treated concrete plugs were immersed for 14 days in running water at 25 - 30°C, then dried in an oven at 45°C for 7 days, and a 26 in. vacuum applied by 8 hr each day. Repeat tests were being made on the weathered blocks and no penetration had occurred so far in 4 months. Standard compression strength tests showed that treated concrete was not weakened in any way.

Normal concrete had also been treated with dieldrin in the same way as the "no fines" and had been shown to be toxic to termites walking over it, but no artificial aging had been attempted. It was expected to be even more permanent within the concrete slab than with "no fines" concrete and so should protect any fine cracks opening up.

In reply to a question by Mr. Cokley, Mr. Gay said that the possibility of chemical changes in the dieldrin following incorporation into the concrete had not been investigated. The required analysis was very complicated and could be performed only in London. A parallel investigation had shown that no such changes occurred when dieldrin was incorporated in lacquers. It had been found that aldrin changed quite readily to dieldrin but dieldrin itself was very stable.

ITEM 5(e)

TERMITE INVESTIGATIONS*

Those aspects of the termite investigations of the Division of Entomology which are of interest to the Conference will be discussed briefly under five headings.

(a) Natural Durability

The survey of the range and variation in durability of commercial hardwoods from eastern Australia is now virtually complete with the testing of the third group of timbers, which comprised the following species:- *E. rostrata*, *E. propinqua*, *E. punctata*, *E. eugenioides*, *E. saligna* and *E. sieberiana*. In all, samples from twenty tree species have been studied, and the results can now be prepared for publication.

A similar survery of Western Australian timbers has been started. The following species are being tested, both in the field and laboratory: *Acacia acuminata*, *E. astringens*, *E. calophylla*, *E. diversicolor*, *E. gomphocephala*, *E. guilfoylei*, *E. jacksoni*, *E. marginata*, *E. patens* and *E. redunca*.

(b) The Nature of Natural Durability

Two separate studies are in progress in this field, one in co-operation with the Division of Forest Products on tallowwood, in which the ether soluble material shows anti-termitic activity, and a second study in co-operation with the School of Applied Chemistry, University of New South Wales, on black bean, in which the activity appears to lie in the methanol extractives. The next stage in each investigation is further fractionation of the active extracts in an attempt to characterize the toxic material(s) more precisely.

(c) Preservative Tests

These fall in two groups, pressure treatments and surface treatments. Work in the former field has been confined to exposure

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*Presented by Mr. Gay.

tests of samples treated with a creosote from petroleum. Regarding surface treatments, the only materials still giving complete protection after 2 years' exposure are 5 per cent. pentachlorphenol, and "Termiten-Basileum", a proprietary product.

(d) Wall Boards, Building Boards

An extensive test of hardboards and softboards on behalf of Bolidens Ltd. of Sweden showed that low loadings of zinc arsenate (0.20 to 0.65 per cent. calculated as As_2O_3) gave a high degree of protection to termite susceptible board stock.

Tests of a wide range of English plaster boards made from varying gypsum sources showed that all were susceptible to severe termite attack. The general pattern was destruction of the paper facing followed by extensive boring or holing of the gypsum cores.

A co-operative investigation with the Division of Forest Products on the effects of termites of toxic additives to the glue line of karri plywood is still in progress. Interim observations indicate that loadings of 5, 10 or 25 parts of As_2O_3, or 5, 10 or 20 parts of chlordane in the glue line are rapidly lethal to the termites, and prevent significant attack on the plywood.

(e) Soil Tests

These tests are continuing at three different sites. The best record of materials currently in test is of chlordane, which at 2 per cent. strength (0.5 gallons/cu.ft.) is still giving complete protection after 6 years' exposure.

Discussion

Mr. Edwards asked what was the effect of NaPCP on termite resistance of hardboards.

Mr. Gay said ¾ per cent. in hardboards gives high resistance. The present trend is to include aldrin and dieldrin in termite resistance tests.

Mr. Huddleston suggested there may be some danger with treated boards in contact with food stuffs.

Mr. Cokley asked what happens to sodium pentachlorphenate at the high temperatures met with in hardboard manufacture.

Mr. Gay replied that sufficient is added to give a final retention of 0.75 per cent.

ITEM 5(f)

MASTOTERMES TEST IN QUEENSLAND*

(a) General

This test was undertaken in co-operation with the Postmaster-General's Department to study the behaviour of various preservatives in the tropical areas of Australia where severe hazard from the termite Mastotermes darwiniensis exists.

Briefly the test will examine and compare the efficacy of nine full-length pressure impregnation treatments which totally penetrated the sapwood of non-durable free splitting E. goniocalyx poles. In addition, it will also compare their performance with that of in situ maintenance treatments - applied initially to green poles of the durable species E. crebra - as currently practised in North Queensland by the Postmaster-General's Department.

(b) Treatment

Twenty poles - comprising 10 end matched pairs - were treated per preservative, and all full length pressure treatments were carried out in the high pressure cylinder at the Division of Forest Products. The in situ maintenance treatments were -

(i) Arsenic collar.

(ii) Creosote butt brush and soil puddle.

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*Presented by Mr. Barnacle.

The preservatives used in this test, the average retentions obtained in each case and the procedures used in applying the in situ maintenance treatments are listed on the data sheet.

The range of preservatives used will be of interest and the performance of dieldrin and also the arsenite type preservative will be of added interest. Also, it should be noted that as far as is known, this is the first time copper pentachlorphenate has been used in pole field tests.

(c) Installation

The test poles were installed in June - July, 1958, at two sites, namely Breddon and Millaroo, and details pertaining to these sites are also provided on the data sheet.

A total of 120 poles, with equal representation of each treatment and untreated controls, were installed in one long line at each of the two sites. Each pole was fitted with a metal cap and a dummy silky oak untreated crossarm at the time of installation. The reason an untreated crossarm was fitted was to determine whether Mastotermes - even if deterred from attacking the treated wood - would build galleries over it to attack the untreated crossarm.

Since the nature of this test requires the continued presence of Mastotermes throughout its duration, a small round ironbark trap stake was placed adjacent to every pole to provide a means of continuous check on Mastotermes activity without unduly disturbing the main test. Each stake will be lifted and inspected after 12 months' exposure by local P.M.G. officers and if there is no termite attack this will be noted and the stake replaced. If, however, any attack has occurred, the extent of the attack will be recorded and a fresh stake will be located adjacent the pole but displaced 90° from the position of the attacked stake. These minor inspections will be repeated annually and if Mastotermes activity ceases the test will be moved to another site.

(d) First Inspection

The first full inspection of this test will be carried out about June 1960.

From the results of the test, we anticipate the following information, relative to the particular conditions of exposure:-

(i) The most effective preservative commensurate with economy and ease of procurement.

(ii) Whether waterborne preservatives can afford satisfactory protection for eucalypt poles. This, of course, refers to the possibility of heart rot or termite attack in the heart should poles split after treatment to expose untreated heartwood.

(iii) Whether the economic advantages of preservative treated poles, either transported or treated locally, could justify their replacing steel poles in general practice.

(iv) From the nature and extent of attack on the treated test material, whether totally treated softwood poles would generally be more serviceable than treated eucalypt poles.

Discussion

Mr. Cokley said that they are particularly interested in this experiment, as Mastotermes is a problem in North Queensland. In one area, Collinsville, first class ironbark poles have an extremely short life - only a few years - primarily because of Mastotermes. Up to date the only treatment that has been used is a semi-maintenance treatment of drilling and pouring in creosote or arsenic.

DATA SHEET FOR MASTOTERMES TEST IN QUEENSLAND

Preservatives Used and Average Retentions Obtained

Oil and Oil-Borne Preservatives

(a)	Creosote (A.S.S.K.55)	-	12.0 lb/cu.ft. sapwood
(b)	Creosote (A.S.S.K.55) plus ½ per cent. dieldrin	-	13.8 lb/cu.ft. sapwood
(c)	5 per cent. pentachlorphenol in furnace oil	-	12.3 lb/cu.ft. sapwood
(d)	2½ per cent. pentachlorphenol plus ½ per cent. dieldrin in furnace oil	-	12.8 lb/cu.ft. sapwood

Waterborne Preservatives

Copper and copper-zinc-chrome arsenates

(a)	2½ per cent. Tanalith C	-	0.73 lb dry hydrous (commercial) salt/cu.ft. sapwood
(b)	2½ per cent. Boliden S.25	-	0.78 lb dry hydrous salt/cu.ft. sapwood
(c)	2½ per cent. Celcure A	-	0.78 lb dry hydrous (commercial) salt/cu.ft. sapwood

Ammoniacal preservatives

(a)	1½ per cent. copper arsenite (similar to Chemonite)	-	0.47 lb dry salt*/cu.ft. sapwood
(b)	1⅛ per cent. copper pentachlorphenate	-	0.37 lb dry anhydrous $Cu(PCP)_2$ salt/cu.ft. sapwood

*As expressed in A.W.P.A. Specification P5-56.

N.B. All oil-borne and waterborne preservatives were mixed on a weight/weight basis.

In situ Maintenance Treatments - Procedure

(i) Arsenic Collar. 2 lb of white arsenic powder (As_2O_3) placed in bottom of hole. The pole was then placed in position and the hole backfilled to within 2 ft of groundline.

Another 2 lb of arsenic was used to form a collar around the pole at this point and a further 2 lb of arsenic used to form a second collar 1 ft below groundline.

The top 6 in. of backfilling was mixed with 1 lb of arsenic and the mixture used to fill the hole. The treated soil was then covered with a layer of untreated earth.

(ii) Creosote Butt Brush and Soil Puddle. Creosote oil was brushed over the whole of the butt of each pole to a point 2 ft above groundline. Approximately 1 quart of creosote was then poured on to the soil at the bottom of the hole. The pole was then placed in position and the hole backfilled. Finally, one-half gallon of creosote was puddled into the top 18 in. of backfilling.

Site Location, Rainfall and Soil Conditions

(a) Breddon near Charters Towers in a 25 in. rainfall area.
Soil: ironstone clay.

(b) Millaroo 42 miles west of Ayr in a 50 in. rainfall area.
Soil: heavy loam.

ITEM 5(g)

ASSESSMENT OF INSECT AND DECAY HAZARD IN BUILDINGS*

At each of the last several Conferences there has been an item on the Agenda relating to a "Statistical Survey of Damage by Borers, Termites and Decay in Buildings". Such information as was obtained from these surveys came almost entirely from reports prepared by the Department of Works. At the last Conference, New South Wales expressed an intention to investigate reports that Anobium was on the increase in the Sydney area, and stated that tests had been commenced to determine the effectiveness of anti-sapstain dips (borax and sodium pentachlorphenate) in preventing Ernobius attack in P. radiata.

During the last couple of years this Division has been involved in numerous discussions on the need for preservative treatment in building timbers. In many cases the arguments have centred around the increasing use of P. radiata in situations where it might be exposed to a decay hazard and to attack by Anobium, Ernobius and termites.

On the one hand it is claimed that the cost of treating P. radiata sub-floor timbers, framing and flooring is small in comparison to the benefits received, and that with much evidence pointing to an increased hazard from Anobium, Ernobius and, perhaps, even Hylotrupes during the next half-century (a reasonable life expectancy for a dwelling) treatment before erection is sound common sense and good insurance. Those who oppose this view point out that the incidence of damage from these pests is not sufficient to justify all building being loaded with the extra cost of treatment, and some have adopted the view that to insist on treating P. radiata for building purposes would add just enough to its cost so as to price it out of the building field.

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*Presented by Mr. Beesley.

We are of the opinion that surveys of decay and insect damage in buildings will have to be made. Past experience has shown that general surveys do not give information of the sort we require. As an alternative, we would like to suggest that a series of specific surveys should be made. For example, a few years ago we made an assessment of the incidence of decay in window sills for the Victorian Housing Commission. As a result of this survey, faulty building practices were pinpointed, specifications were slightly altered and the position appears to have improved.

A second example of these "specific purpose" surveys is one we did on the service life of timber house stumps. The prime purpose of the survey was to obtain an estimate of the average age of replacement of red gum house stumps - and, incidentally, of jarrah, which has been fairly extensively used in the Melbourne area. The survey was limited to about 100 houses, of which about half were actually being re-stumped at the time of the survey, whilst the remainder were selected at random. Without going into details, we can summarize the results of the survey by saying that about 16 per cent. of the houses with timber stumps will require re-stumping by the time they are 30 years old, that another 34 per cent. will require re-stumping during the next decade, and that re-stumping will have occurred at least once in 90 per cent. of all houses over 60 years of age. Stated differently, timber stumps can be expected to fail any time after a house is 25 years old, and about 50 per cent. of the houses with timber stumps will require re-stumping before they are 40 years old.

Whilst surveys of this nature require very careful planning, they do not take very long to perform and they do yield very useful information. In view of the current interest in the use of <u>P. radiata</u> we would like to suggest that some figures be obtained on the incidence of decay in softwood weatherboards, e.g. hoop pine in Queensland, *P. radiata* in New South Wales and South Australia, and perhaps red baltic in Victoria. Alternatively, how common is *Anobium* attack in *P. radiata* flooring. The timber has been extensively used in Canberra and South Australia for this purpose: Will *Anobium* cause as much damage in *P. radiata* as it has in New Zealand white pine?

How often do termites build over termite-resistant flooring and sub-floor timbers in order to attack studs and lining? Is it necessary to treat all the framing timbers of a house (including the rafters) to prevent termite attack in a house which has no other form of protection? Does decay occur more often in exterior joinery in North Queensland than it does in similar situations in Victoria and Tasmania? What is the effect of the age of the building on these and other similar questions?

Most of us will have opinions on each of these questions - but is the evidence on which these opinions are based good enough to influence the policy of, say, a State Housing Authority, a Committee drafting the Uniform Building Regulations or a financing authority?

Discussion

Mr. Huddleston said that to determine the effect of sap stain dips on *Ernobius*, a working plan has been drawn up and the work is in hand. He agreed that a survey on decay in houses is most urgent to counter treating propaganda. What is wanted is a house to house inspection in districts or streets chosen at random; this would mean a lot of work but he could find the staff to do it. To be of full value, the survey should be extended throughout Australia.

Mr. Jennings said that they have recommendations on uses, species and need for treating or otherwise summarized in Pamphlets 1 and 2 which are now being revised and combined. He said their official policy re preservation was for treatment for specific use. They were against wholesale treatment.

They have found Ernobius in material from New Zealand. Calomaderus is the greatest hazard in southern Queensland, but enough is known about it to render further survey useless. There is no Anobium in Queensland.

The decay hazard is largely due to lack of sub-floor ventilation and in exterior cladding in North Queensland. Lyctus immunization has got rid of 95 per cent. of borer trouble. They are not experiencing any major trouble with other insect attack except perhaps dry wood termites. Mastotermes is covered in building practice by the normal practice of pier construction and suspended floors. He said they would co-operate in surveys, particularly in detection of introduced pests and of extension by native pests.

Mr. Huddleston agreed with Mr. Jennings that general timber preservation is not necessary, but he felt that a survey would give facts to answer exaggerated statements made by pest control and timber preservation firms.

Mr. Colwell said that a survey had started in New Guinea. The Commonwealth Department of Works quote £400 per annum maintenance cost on each house, therefore all maintenance replacements are being treated. The main hazard is decay.

Mr. Beesley asked if Mr. Jennings was confident that dry wood termites would not increase to become a major pest in 30 - 50 years.

Mr. Jennings said that they make inspections regularly. An officer in the district investigates all complaints. Past performance of dry wood termites is the only criterion, and indicates no real hazard.

Mr. Reid suggested that New Zealand could help on the question of Ernobius as they have done work in this field.

Mr. Tamblyn said that opinions were valueless in this field, and statistical evidence was vital.

Mr. Huddleston asked if Mr. Tamblyn would undertake to draw up a draft working plan and circulate to the States and discuss collaboration.

Mr. Tamblyn agreed to do this.

ITEM 5(h)

CONTROL OF *HYLOTRUPES**

VICTORIAN REPORT

Following the European House Borer Conference in Canberra in August, 1958, the European House Borer Survey Committee was formed to organize inspections of imported pre-fabricated buildings. The committee consists of representatives of -

Department of Agriculture (Plant Quarantine Service)
Division of Forest Products, C.S.I.R.O.
Forests Commission
Hospital and Charities Commission
Housing Commission
Public Works Department
State Electricity Commission
State Rivers and Water Supply Commission
Victorian Railways
Masonite Corporation and A.C.I.
(These two associated companies had purchased 200 houses at Eildon from the State Rivers and Water Supply Commission).

The committee accepted a sampling plan prepared by the Division of Mathematical Statistics, C.S.I.R.O. In the sampling method adopted all the houses of a particular type were considered as

*Presented by Mr. Irvine.

a single group. The number of houses to be inspected was then calculated for each type so that there would be only a 1 per cent. risk of not detecting infestation if it was present in 3 per cent. of all the houses.

The Division of Forest Products conducted two and subsequently a third training school for inspectors and inspections were made as follows.

Authority	Total Houses, etc.	Number Inspected
Housing Commission (Two types excluding 500 Thermo type)	2,200	260
State Electricity Commission	962	50
Victorian Railways	1,462	80
Eildon houses, including State Electricity Commission, State Rivers and Water Supply Commission and Masonite and A.C.I.	301	20
Public Works Department	Schools	29
Hospital and Charities Commission	Hospitals	4

No cases of infestation were found but two cases in Housing Commission houses have been reported by tenants. One at Norlane, a suburb of Geelong, was reported during the survey, and one at East Reservoir, a Melbourne suburb, following the completion of inspections. At Norlane a live beetle emerging from a door stile was caught and a dead beetle recovered on dissection of the door. At East Reservoir at least two live grubs were found in portion of a kitchen cupboard. In both cases the damaged timber was replaced and the whole house closely inspected.

The East Reservoir Estate, of Thermo type houses, had been excluded from the survey because the 500 houses of this type had been fumigated at the time of entry with methyl bromide against Sirex wood wasps.

Eight private houses within a 100 yard radius of the East Reservoir house were inspected but no signs of damage were found.

Following the East Reservoir case of infestation the Survey Committee recommended that every occupier of an imported building should be fully informed about this insect and be asked to assist in detecting it. The Division of Forest Products drafted a proposed leaflet and it was submitted to the Government for approval. The Government was not in favour of the leaflet but ordered that all imported buildings be inspected. The Housing Commission has refused to do this and there is no power under present State Legislation to force inspection of privately owned homes. All other authorities aim at completing 100 per cent. inspection by the end of June, 1959.

A revised leaflet has been prepared.

Discussion

Mr. Jennings said that *Hylotrupes* was first found in a collapsed floor board, and a house to house inspection was started at once. Ninety per cent. of the attack is in 1 in. boards (roof trusses and floors). As the inspection was unable to cover all possibilities of attack with certainty, the only possible recourse was to test each house by fumigating with methyl bromide. Tenders were accepted for 2,600 houses; 1,150 had been treated to 14th November, 1958. Spot sample checks showed no failures and up to 3 in. penetration in pine, also a high concentration in ply doors enamelled both sides. Hardboard partitions are very well penetrated. A concentration of 4 lb/1000 cu.ft. appears to be quite satisfactory. Mr. Jennings said that the job must be done thoroughly, and he was disturbed at Victorian reports which, he felt, indicated the borer may not be under control. He also said that safety during fumigation was vital, and the tenants of treated houses are kept out for 4 days and only allowed in again after a thorough check.

Mr. Huddleston said that the New South Wales fumigation gave the lead to Queensland. The Collaroy test showed that the necessary concentration was obtainable under cover, with lethal results to live *Hylotrupes* in blocks put in the house. They had inspected all imported houses, and while there was plenty evidence of attack, fumigation for *Sirex* had killed any borers present. All Port Kembla houses and large amounts of European timber were fumigated. A South African report on New South Wales plantation material indicates attack on *Pinus radiata* but no attack on *Callitris glauca*.

In reply to a question, Mr. Jennings said that the cost of treatment was £100 per house excluding Commission overhead (£40), and tenants' shifting costs. Inspection cost per house is one man-day, *i.e.* £4 per house. Some timber has drifted outside Commission areas and must also be inspected. A survey of older houses built with hoop pine was proposed over a radius of approximately 1 mile from the housing project.

Mr. Orman said that in New Zealand *Hylotrupes* had been identified in brandy cases, mostly ex France. It was not detected in Dutch (1951) or Austrian (1953) imported pre-cut houses, and recent inspections show no indication of infestation. There is no evidence of establishment in exotic forests and no cases of infestation of housing or other buildings have been reported.

ITEM 5(j)

PRESSURE TREATMENT - COMMERCIAL DEVELOPMENTS

Mr. Dale. Commercial pressure treatment has become firmly established since the last Conference and at least £400,000 has been spent on plant alone. The plants comprise the following.

(a) 200 lb/sq.in. Treatment

1. Hickson's - 4 pole plants and 4 waterborne plants in New South Wales, Victoria, Tasmania and Port Moresby.
2. Celcure - 1 plant in Victoria capable of treating whole stripped charges 6 - 8,000 super ft per charge. Two buildings in South Australia, one of same size as Victorian plant.
3. Boliden's - 1 large plant building in Victoria.
4. Saxton's - 1 pole plant.
5. Woods and Forests Department, South Australia. - 1 plant building for poles and sleepers.

The activities of these plants to date have been:-

Hickson's. Creosote treatment of P.M.G. poles in New South Wales and Victoria. Some electricity poles. Tanalith C treatment of poles for P.M.G. and H.E.C. in Tasmania.

Tanalith C plants. New South Wales, sawn timber; Port Moresby, sawn timber about 100,000 super ft per month; Tasmania, treatment of hop poles and fence posts just commenced; Victoria, cooling tower timber and other sawn timber.

Celcure. Victoria, cooling tower timbers.

Saxton's. Hardwood poles. Up to 1,100 treated in 1 week. Also sawn alpine ash and *Pinus radiata*. Saxton's plan to install a plant at

Moe to treat 150,000 posts per annum at 200 lb/sq.in. and also a cylinder for the high pressure treatment of crossarms.

(b) Low Pressure Treatment

Plants are treating posts at Meadows (South Australia), Caramut (Victoria), Ranelagh (Tasmania) (hop poles), King Island, and a portable plant has been sent to Noumea. There is considerable interest in the Murray Valley (vine posts), northern and eastern Victoria, South Australia and Tasmania, most being interested in waterborne preservatives. The facts on preservation, particularly post strengths, are now widely accepted, and at least one genuine enquiry for plant each week and up to 150 general enquiries on fence post treatment are received. There is no conflict with 200 lb/sq.in. treatment as yet, and there appears to be plenty of room for both. The plant at Kembla No.2 Colliery for the treatment of spotted gum mine timbers, designed in conjunction with the Division of Wood Technology, is now being assembled.

(c) High Pressure Treatment

There is considerable interest from Western Australia, Victoria and Tasmania in crossarm treatment following calling of tenders by the P.M.G. and in Tasmania in sleeper treatment following the recent inspection of the test installed there 4 years ago. No high pressure plant is actually under construction but we expect to see one within the next 12 months.

(d) Achievements of the Industry to Date

The P.M.G. are very satisfied with preservative treatment on the whole. They have received -

18,000 poles in Grafton

25,000 poles from Wauchope

15,000 poles from Trentham

3,000 poles from Longford (Tasmania) (most recently started).

In New South Wales 1,700 spotted gum poles have been rejected because of Lyctus attack, largely as a result of the pole suppliers' neglect to take recommended precautions. The P.M.G. have expressed their willingness to discuss the question of minimum sapwood thickness. Steaming experiments to improve cleanliness of poles at Hickson's Trentham plant appear very promising. In 16 months Saxton's have turned out 42,000 poles for the S.E.C., 6,000 poles for the P.M.G., 20,000 ft of sawn timber and 12,000 posts, and they cannot meet the demand for treated posts. Treatment is giving the State a much greater return than was previously obtained from the sale of durable poles and at least 50 per cent. of the timber used would otherwise have stayed in the bush. It is also a most valuable thinning operation.

(e) Pressure Treatment of Sawn Timber

Mr. Tamblyn gave a scrupulously fair case for dip diffusion treatment, but I, personally, would be most unhappy at sawmill control of even the best such treatment, as I believe it would be very difficult to police and nothing but the best is good enough for ground line protection. It is no good offering timber for sale with all these conditions as to its use. It must be improved to compete with other materials and to suit modern architectural practice. People will not go under their houses to inspect for termites these days any more than they will climb underneath their motor cars.

Mr. Reid, summarizing the commercial field in New Zealand as at 15th November, 1958, said there were 100 plants in operation of which 57 were pressure plants and 44 non-pressure plants. Fifty-five pressure plants and 41 non-pressure plants treat with waterborne preservatives and 13 pressure plants are fitted to treat with two or more preservatives. Much work remains to be done re optimum treating schedules for exotic and indigenous species. Recently a brochure was issued by the Timber Preservation Authority in New Zealand called Timber Preservation in New Zealand, which gives bases for acceptable retentions for various preservatives, etc. The whole field is not yet covered, but the brochure gives retentions for building timbers and ground line contact. Not much attention has been given to intermediate retention requirements. In addition, tests have been conducted with various preservatives to determine suitable loadings for marine exposures.

Mr. Cokley said he felt that some thought is necessary regarding the question of preservative retention. He is concerned with two aspects, the practice of firms using creosote working only to a retention, and the practice of controlling treatments only on a liquid absorption, the latter being most important as it is necessary to depend on an operator making up the correct solution concentration. The treatment people are working on the assumption that if they get an overall retention for the charge, each individual piece will be within the required limits. He felt that a closer control system was necessary. There is, apparently, a tendency overseas to prefer sample control. The main point is that the pressure plant treatment position does not get too far ahead before the weaknesses are discovered, particularly in control.

Mr. Dale thought that Mr. Cokley's proposal was a very desirable ideal, but practice overseas and here has shown that at the present time quantity control, i.e. control of absorption by amount of preservative for a given quantity of timber, is the only practical one, more particularly in poles. While it would be very desirable to be able to analyse creosote treated sapwood, it is not yet a practicable proposition, since it would considerably increase cost of treatment particularly as a given charge must be controlled from the amount of preservative put in from storage tank. In actual practice you have to allow for a certain amount of material lying above and below average. While the idea of every piece of timber being treated to perfection is ideal, it is not practically possible. In the case of waterborne preservative treatments, the control of preservative absorption based on a weekly or even monthly check of timber and chemicals used gives an accurate average preservative retention.

Mr. Reid substantiated Mr. Dale's final comment on control, and made the point that he thought it was possible to relate timber on a job back to a charge. A number of supervizing authorities have been doing so.

ITEM 5(k)

RECOMMENDED TYPES OF PRESERVATIVES AND THEIR RETENTIONS

Mr. Tamblyn said that at the last Forest Products Conference the need for agreement between the Division of Forest Products and the States in making recommendations for the use of new preservatives and for the loadings of preservative necessary for new uses was discussed. At that time, the opinion of the meeting was that since any recommendation for a new preservative, or for a new use for it, was generally referred to the Division of Forest Products, such recommendations as the States might make were, in fact, practically those of the Division of Forest Products. However, in practice, this did not always happen and even within the Preservation Section of the Division, it was difficult to prevent different recommendations from being made. He proposed that he should prepare a list of types of preservatives and suggested loadings for different purposes and circulate it to the States to see if agreement on acceptable loadings can be obtained. Both the method of estimation and the required retentions should be defined.

Mr. Huddleston had no objection to such a document being passed around between departments. It would be very helpful, but it must be remembered that in both Queensland and New South Wales there is a statutory obligation thrown upon the Forest Department in administering the Timber Marketing Acts, and the Forests Departments must accept full responsibility for any approvals given. They can be guided by outside recommendations but ultimately the approval given is their own. When approval is given for a preservative for a particular application, the department concerned must remain free to impose any conditions considered necessary.

Mr. Clarke pointed out that there will soon be a Preservation Committee working for the Standards Association. He thought it would be necessary for that committee to recommend retentions. Such recommendations are not binding in any way. It would be desirable for the technical people to get maximum agreement on treatment methods, acceptable retentions, methods of estimation and so on.

Mr. Tamblyn stressed that the document would be unofficial. If anyone found occasion to change it they could do so provided the Division of Forest Products and the other States were kept informed.

Mr. Huddleston said he could see no difficulty in that.

Mr. Jennings agreed with Mr. Huddleston.

Mr. Clarke said that the position would be covered by Mr. Tamblyn getting out a statement and circulating it to the States. If they have any objections or comments they can raise them with him.

Mr. Huddleston said that the concentrations of preservative approved by them are affected by many conditions. Some are political, some are practical. They have found that in issuing approvals where plant control is liable to be poor they are inclined to increase concentrations to make sure that all treatments meet the minimum requirements. They would come nearer the threshold if there were good plant control.

ITEM 5(1)

SOFT ROT IN COOLING TOWERS AND OTHER TIMBERS*

This item on soft rot has been included as a report of research in progress because, since the last Forest Products Conference, the study of this type of deterioration in timber has come to occupy an increasing amount of our time and will do so in future, and because we may be seeking the co-operation of the various State Forest Services in our investigations on cooling towers in different parts of Australia.

Soft rot is a name now becoming widely used in England and other countries for a particular type of fungal deterioration caused by Ascomycetes and imperfect fungi and not by the Basidiomycetes responsible for ordinary decay. As may be seen from the specimens exhibited, severely affected cooling tower slats show a soft structureless deterioration of the outer layers, which may readily be scraped off or eroded by falling water and which develops fine cubical cracking on drying. Less severe cases may show little macroscopic change but the microscopic appearance is very distinctive. Whereas with normal decay hyphae are present in the lumen of the cell and perforate the cell walls horizontally, the soft rot fungi operate entirely within the secondary wall of the cell making vertical bore holes which are readily seen in sections of affected wood. Although soft rot has been known for many years and was recognized as able to cause serious deterioration in wood by Mr. Tamblyn in investigations on jarrah before 1938, it is only in the last 10 years or so that it has been identified as the principal cause of the failure of cooling tower filling. Previous to this many cases of soft rot were wrongly regarded as examples of purely chemical break-down of filling.

As regards the economic importance of soft rot attack, it should be pointed out that in individual cooling towers it may cause

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*Presented by Mr. Da Costa.

very serious losses. For example, the severely affected slats exhibited came from a tower only 4 years old and it appears possible that the filling in this tower may have to be replaced after 7 - 10 years service at a cost which would probably exceed £20,000. Only a few towers have been shown to be affected as rapidly as this but most towers do show some signs of soft rot attack. We do not know as yet what factors decide whether soft rot in the tower shall remain only a very slight superficial deterioration or shall cause deep seated softening and eventual failure of the fill.

In view of the present rapid industrial development in Australia and the consequent increase in the use of water for cooling, many new high efficiency cooling towers are being and will be erected. Wood is the ideal filling material for this type of tower except for its susceptibility to soft rot, which has led overseas manufacturers to experiment with more expensive substitute fillings such as plastics, glass and asbestos cement. If, therefore, wood is to be satisfactorily used in this application, some means of controlling soft rot must be developed.

A number of such control measures have been suggested. In the first place it has been recommended that the pH of the circulating water should be maintained below 7.5, but with many water supplies this would be an expensive measure and might give additional problems in corrosion control, and in any case, it is not entirely certain that it will always control soft rot. The use of durable timbers for cooling tower construction is another control method. It has been shown that the order of durability to soft rot is generally the same as that to Basidiomycete attack except that conifers are very much more resistant than hardwoods in laboratory tests and that the differences between timbers seem to be less with soft rot than with Basidiomycete attack. In the present state of our knowledge we would not recommend the use of any untreated timber, no matter how durable, for cooling tower fill of small cross-section, although as soft rot in cooling towers is mainly superficial, we would regard the use of the dense durable Australian eucalypts as satisfactory for large structural members, e.g. those of 2 in. minimum dimension.

Preservative treatment of the cooling tower filling before erection with a high loading, e.g. 1.25 lb/cu.ft., of a highly fixed waterborne preservative such as copper-chrome-arsenate, would appear to be the most effective means of controlling soft rot. Experience in the United Kingdom is that timber treated in this way shows no deterioration after 4 - 5 years in service and should give a life of 15 - 20 years, which is often all that is required of a cooling tower owing to obsolescence of the plant, etc. The treatment of existing cooling towers is a more difficult problem and two methods have been suggested; the addition of fungicides to the circulating water, and the treatment of the cooling tower fill in situ with a fixed preservative. Laboratory tests have indicated that it would probably be possible to control soft rot in cooling towers by the addition of sodium pentachlorphenate to the circulating water, but the process would be rather costly and would possibly create problems in the disposal of treated effluent water. Treatment of the cooling tower filling in situ by double diffusion either with copper-chromate or with zinc-chrome-arsenate has been developed in the United States by the Marley cooling tower organization and is expected to be commercially available in Australia from the Australian Marley representatives shortly. We would expect it to be fairly effective and of considerable use in existing towers showing incipient soft rot.

Our research work on soft rot follows two main lines. We are carrying out laboratory investigations aimed at isolating and identifying fungi causing soft rot in various towers throughout Australia, at estimating the relative soft rotting ability of the fungi isolated, and at studying the preservative tolerance of the more important fungi. We are also setting up a number of exposure tests in which small trays of treated and untreated slats are exposed in different cooling towers and are returned to this laboratory at intervals of 3 - 12 months for examination before being returned to the towers for further exposure. The first of these tests is now almost ready for distribution and will consist of eighty trays each 2 ft square by 2 in. high and each containing one slat 10 in. x 1 in. x $\frac{1}{2}$ in. of each of twenty-four untreated timbers. These trays will be exposed in duplicate in 30 - 40 towers throughout Australia in an endeavour to determine the relative durability of the timbers, variations in fungal population in different localities, the variation in soft rot hazard in different towers as related to operating conditions, and the best selection of towers showing severe soft rot hazard but different operating conditions in which we may at a later date carry out accelerated tests of preservatives. The first of these preservative tests will be to compare a number of commercially available highly fixed waterborne preservatives in an endeavour to find out whether the loadings recommended overseas will be effective and whether they will be necessary under all conditions. Other tests later will deal with other types of preservative treatment such as surface coating of the slats. We would appreciate co-operation of the State Forest Services in locating suitable towers for these tests and possibly in setting up the tests themselves.

Discussion

Mr. Edwards asked what the recommended concentrations are for prevention of soft rot in towers in service.

Mr. Da Costa said that if applied as continuous treatment, control could probably be detained with 20 p.p.m., but he would not like to use continuous treatment as it gives the fungi a chance to build up resistance; he preferred to use a shock treatment as it prevents this. He felt that 300 p.p.m. for 3 or 4 weeks would keep out soft rot infestation from a tower, but did not know how often this shock dose would have to be repeated.

Mr. Edwards asked what would be the consequences on the use of 50 p.p.m. at monthly intervals, which has actually been used.

Mr. Da Costa said that it probably would not work. From most of the towers there is a certain loss from drift, and if all the water in a tower were treated, it would all be lost in 10 - 15 days; after 7 days the concentration would be halved. On these figures, it does not look as though 50 p.p.m. would be adequate.

Mr. Beesley mentioned that at the recent inspection of pole tests certain poles treated with creosote, zinc chloride and arsenic and Cuprinol had failed, and samples were brought back to the laboratory. In each instance break-down was attributed to soft rot, the depth of attack varying from $\frac{1}{4}$ in. - $\frac{3}{8}$ in. after 30 years. Soft rot can be detrimental to poles as well as cooling towers.

Mr. Da Costa pointed out that soft rot can, on occasions and when conditions are suitable, penetrate quite deeply into timber. Soft rot causes a lowering of impact resistance of timber. Recent work has shown that attack of marine fungi is a contributing factor to a great deal of marine borer infestation. Soft rot is a far more serious problem than has previously been recognized.

Dr. Liese said that they have done some work with soft rot in Germany, and have found attack in poles to be quite severe. Soft rot can go quite deep into both sapwood and heartwood. Soft rot can also occur in sleepers and they are investigating the importance of this occurrence. Similarly, they find very bad soft rot attack in mining timbers and in cooling towers, and have just established a

Commission to investigate the cooling tower occurrence following very severe break-down during the last 3 years. They have also started natural durability investigations of timbers against soft rot fungi.

ITEM 5(m)

LYCTUS SUSCEPTIBILITY TESTS OF QUEENSLAND TIMBERS*

This test was first proposed in 1949 by the Queensland Department of Forestry and this Division was requested to determine the *Lyctus* susceptibility of approximately eighty Queensland timber species upon which information was lacking.

After subsequent discussion it was decided that the test should be carried out by at least two independent investigators. Mr. Gay offered to co-operate with the Division in this test. In 1952 a master list of species to be tested was forwarded to the Division. This list contained the names of 170 timbers and with subsequent additions now totals 181. Upon arrival of the first consignment of 44 species from Queensland in October, 1952, two duplicate sets of specimens were cut for testing, one of which was forwarded to Mr. Gay. In 1954, a second parcel of approximately 58 species was despatched from Queensland.

At the present time 102 different timber species have been received and tested. The pattern of attack obtained by Mr. Gay is in close agreement with that recorded at the Division. Of these 102 species, 49 have shown attack to a greater or lesser degree. Of the species showing attack 67 per cent. exhibited it in 50 per cent. or more of the number of trees tested per species.

Of the remaining 53 species which gave a completely negative result, 37 only were represented by three or more different trees.

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*Presented by Mr. Rosel.

There has been no further despatch of samples since July, 1954. However the following suggestions are offered for discussion.

1. Should these interim results be published and, if so, could the Queensland Forestry Department furnish information on the approximate size and commercial availability of as many of the timbers as possible?

2. Is there any information available on the average sapwood widths of the various timbers? (We could obtain enough information to have a fair indication of this by measuring the sapwood widths of the test specimens held at the Division).

3. Future consignments of timber species. (There are still approximately 80 species on the master list which have not yet been tested).

4. Supplies of further trees of the species which are at present partially tested but upon which insufficient information is available for assessment of a susceptibility rating.

Discussion

Mr. Cokley said that his Department would obtain as much of the required information as possible, and expressed thanks to the Division of Forest Products for the tests being carried out.

ITEM 5(n)

REASONS FOR AND VARIATION IN DECAY RESISTANCE*

Preliminary work on *Eucalyptus* heartwoods indicated that the extractives were probably responsible for the decay resistance. In order to study these substances, it was necessary to devise a scheme which would satisfactorily remove the extractives from the wood and, at the same time, fractionate them.

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*Presented by Dr. Rudman.

The general scheme adopted for the extraction of tallowwood, the first eucalypt studied, was ether followed by methanol followed by acetone then water and finally alkali. At each stage during this extraction procedure representative samples of the extracted sawdust and of the extractives were taken. The extractives were added to the decay susceptible mountain ash. The extracted tallowwood sawdust and the mountain ash containing extractives were then subjected to decay by a number of wood rotting fungi in pure culture using a new technique. This technique was an adaptation of the soil jar technique used with wood blocks. Study of the results indicated that ether extracted tallowwood was as decay resistant as unextracted tallowwood but methanol extracted tallowwood was as decay susceptible as mountain ash. No further loss in decay resistance was caused by the remaining extractions. Only the mountain ash containing the methanol extractives from tallowwood was decay resistant, the other extractives being non-toxic to the wood rotting fungi. This illustrates that it is the methanol extractives which are responsible for the natural decay resistance of tallowwood.

Dosage-response curves using the methanol extractives from tallowwood in mountain ash and in an agar-carboxymethylcellulose medium confirmed the previous findings and indicated that tallowwood has just sufficient toxic extractives to render it highly decay resistant.

The preceding extraction procedure was used in a study of silvertop ash. In this species the same general results were obtained but tree to tree variations were evident. Silvertop ash is a species of variable decay resistance and it was shown that those trees having a high methanol extractive content were more decay resistant than those trees having a low methanol extractive content.

A similar study using thirteen trees of karri again showed that the methanol soluble extractives were responsible for the decay resistance in this species. Some samples of light karri were found to be quite decay resistant whilst some samples of very dark karri were non-decay resistant, indicating that colour is of no value in assessing the decay resistance of karri. It would appear that the dark coloured karri contains a lot of extractives which are non-toxic and only soluble in alkali. The best correlation was obtained with the amount of methanol soluble extractives, no consistent correlation being found with density or with colour.

A study is now being made of grey ironbark, river red gum, grey box, grey gum, yellow gum, wandoo, jarrah, white mahogany and red bloodwood, to see if the methanol soluble extractives in these species are also responsible for their natural decay resistance. It is possible that the structure of the wood may play some part in the decay resistance.

The variability in decay resistance within a species is clearly illustrated by the work of Clarke using softwoods and Lenzites trabea. In the decay susceptible species all trees were decay susceptible, there being little variation in the susceptibility, whilst in the more decay resistant species there is often a marked variability, some trees being virtually decay susceptible.

A study of the radial variation in decay resistance in teak has confirmed the general finding that outer heartwood is more decay resistant than inner heartwood. This in itself was subject to tree to tree variation, some trees having decay susceptible wood up to 10 or 15 growth rings from the pith, whilst an exceptional tree exhibited decay susceptible wood at 40 growth rings from the pith. This becomes more important in fast grown material such as is obtained from plantations where the amount of absolute wood contained in the first 10 growth rings may be quite large. The present grading rules do not take decay resistance into consideration, and it is therefore possible that large squares of relatively decay susceptible material may be obtained. Evidence to date indicates that fast grown heartwood may contain a lower amount of extractives than slow grown heartwood and this could become of importance if genetically poor quality trees are involved. The decay resistance of teak would appear to depend upon two factors; firstly, the most important, the genetical composition of the tree, and secondly, the rate of growth to which it is subjected, this latter becoming of importance in genetically poor trees, whilst being of no importance in first class trees. Examples of fast grown teak were illustrated by colour photographs, one tree being apprxoimately 17 years old and 2 ft in diameter at breast height.

Discussion

Mr. Huddleston said that he would send all the material that he could, and mentioned that white cypress is better than black cypress and both are better than coast cypress. Grey ironbark could be supplied from their plantations.

Mr. Boetle asked whether the variation across the pith was due to aging.

Dr. Rudman replied that it was not known to what extent. Some young teak heart is relatively decay susceptible, and aging would have had to take place in only a few years in this case. In general 5 - 10 rings from the pith is susceptible, but even then it is in durability class 2 or 3.

ITEM 5(o)

RAILWAY SLEEPER CLASSIFICATION*

It is not possible to give a precise life for all timbers used as rail sleepers in Australia. The main timbers thus used have therefore been classified into three groups as defined below. The "service life" referred to in these groupings is the approximate average life of the timber when used as a rail sleeper of good quality under normal conditions and without preservative treatment. "Good quality" means compliance with a relevant specification similar to those used by Australian rail systems. "Normal conditions" can be regarded as service in well maintained, stone ballasted track in temperate to sub-tropical Australian areas.

Within a group, species are listed alphabetically and not in any order indicating relative performance or the suitability of the trees of a particular species to produce such sleepers. They are referred to by their Standard Trade Reference Name and Common Name in accordance with Australian Standard Specification No. 0.2-1940 "Nomenclature of Australian Timbers".

It should be noted that eucalypt heartwood is generally difficult to penetrate with wood preservatives and sleepers should not be purchased as preservative treated or with the intention of subsequent treatment, unless favourable advice has been obtained from Australian Government authorities.

GROUP 1

Hard, heavy or interlocked species of the highest natural durability, regarded as our best sleeper timbers. A service life of 30 years or more may be expected under normal conditions.

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*Presented for consideration by Mr. Tamblyn.

GROUP 2

Good sleeper timbers which give a service life of not less than 15 years under normal conditions. Some timbers in this group approach the performance of timbers in Group 1 and may give a service life of upwards to 30 years. With most species a life of about 20 years may be expected.

GROUP 3

Timbers used in Australia as rail sleepers without preservative treatment, but which are less durable or more free splitting or for other reasons are not as satisfactory for this purpose as species in Groups 1 and 2. Under favourable conditions (i.e. Mediterranean type climate and stone ballasted tracks) a life of up to 20 years may be obtained without treatment for some species. Under normal conditions a life of about 10-15 years may be expected.

GROUP 1

Eucalyptus bosistoana	-	Coast grey box
E. cloeziana	-	Gympie messmate
E. crebra	-	Narrow leaved red ironbark
E. hemiphloia	-	Grey box
E. leucoxylon	-	Yellow gum
E. longifolia	-	Woollybutt
E. microcorys	-	Tallowwood
E. paniculata	-	Grey ironbark
E. polyanthemos	-	Red box
E. punctata	-	Grey gum
E. rummeryi	-	Steel box
E. siderophloia	-	Broad leaved red ironbark
E. sideroxylon	-	Red ironbark
E. redunca	-	Wandoo

GROUP 2

E. acmenioides	-	White mahogany
E. albens	-	White box
E. botryoides	-	Southern mahogany
E. consideniana	-	Yertchuk
E. corymbosa	-	Red bloodwood
E. eugenioides	-	White stringybark
E. guilfoylei	-	Yellow tingle
E. jacksoni	-	Red tingle
E. maculata	-	Spotted gum
E. marginata	-	Jarrah
E. melliodora	-	Yellow box
E. muelleriana	-	Yellow stringybark
E. patens	-	W. A. blackbutt
E. pilularis	-	Blackbutt
E. planchoniana	-	Planchon's stringybark
E. quadrangulata	-	White topped box
E. resinifera	-	Red mahogany
E. rostrata	-	River red gum
E. tereticornis	-	Forest red gum
Syncarpia longifolia	-	Turpentine

GROUP 3

E. amygdalina	-	Black peppermint
E. calophylla	-	Marri
E. capitellata	-	Brown stringybark
E. diversicolor	-	Karri
E. globulus	-	Southern blue gum
E. goniocalyx	-	Mountain grey gum
E. macrorrhyncha	-	Red stringybark
E. obliqua	-	Messmate stringybark
E. saligna	-	Sydney blue gum
E. sieberiana	-	Silvertop ash

Discussion

Mr. Huddleston said that the classification is based very largely on an expression of opinion rather than on experimental data. He felt that the classification is not all it should be, but was not prepared to suggest any alteration at the present time. His Division proposed to keep certain sections of railway track under observation and at some time in the future would make proposals for the alteration of the classification. He suggested that other people in a position to do so collect factual data so that the classification would be based on actual observed figures rather than an expression of opinion.

Mr. Blight said that it has been suggested that sleepers cut from mature blackbutt are more durable than sleepers cut from immature blackbutt and that this is supported by evidence in New South Wales railway systems. He asked whether this is a fact and, if so, is it to be expected with other species.

Mr. Huddleston did not think there was any doubt that timbers cut away from the heart in big logs are giving better service. On the observations which they can make, he felt that they would never be in a situation to say whether timber cut from immature trees is worse than that cut from mature trees.

Mr. Tamblyn mentioned a test in Western Australia in which jarrah sleepers cut fairly close to the heart had rotted prematurely in the track. There is no doubt that the jarrah used in that test was relatively non-durable for 6 in. or so from the pith. He had noticed in many of his observations of other eucalypts, that wood close to the pith is less durable.

Mr. Huddleston thought that the observation they made recently in New South Wales tended to show greater life from railway sleepers than anyone has expected. Blackbutt in New South Wales has shown 20 years plus which was never anticipated.

Mr. Tamblyn said that one reason for putting this rail sleeper classification forward at the meeting was to enquire whether there was any objection to publishing it as a tentative classification in the Division's Newsletter.

Mr. Huddleston said he felt it was too incomplete to publish yet. Foresters in New South Wales would object to white mahogany in Group 2 instead of Group 1.

Mr. Blight said in view of the variation between trees of the same species and in view of the fact that anything published is taken as reasonably certain, he though it would be inadvisable to publish it as yet.

Mr. Tamblyn then suggested that this matter be brought up at the next Conference.

ITEM 5(p)

MARINE BORERS

Mr. Wickett said he wished to ascertain what work was proposed in this field. Bankia is coming into Western Australian waters and he would like to know how serious this pest might be and whether anything more should be done about it. It is attacking untreated jarrah in boats: sheet piling is going out in a matter of months. Previously jarrah piles in the Fremantle area have had a life of anything up to 15 years against teredo attack, but it appears as though Bankia might be more serious. It has apparently been brought in on ships from northern waters.

Mr. Tamblyn said he thought tests should be installed to show that treated jarrah piling is much more resistant than the untreated material in Western Australia. Some years ago the Division of Forest Products made a survey on the use of wooden piling throughout Australia, and the Fremantle authorities were dissatisfied even then with untreated jarrah and in future proposed to use concrete. In the past there has been a tendency to over-rate the marine borer resistance of jarrah, and the answer in the future might be jarrah heavily treated with creosote.

ITEM 6. VENEER, PLYWOOD, ADHESIVES

(a) SUMMARY OF RESEARCH ACTIVITIES*

In May, 1956, the Australian Plywood Board made a contribution towards plywood research and following this Plywood Investigations work was reorganized. Staff has been trained, laboratory equipment is being improved, and both field and laboratory work has been developed in such a way as to give maximum assistance to industry.

It is interesting to note that in the last few years there has been a tremendous increase in reports on aspects of plywood technology. This applies not only to the well-known Forest Products Research Society Journal, but also to German, French, Russian and Japanese publications. It seems, therefore, that the special properties of cross laminated veneers in developing the most desirable strength and decorative properties of wood are being increasingly accepted. This is probably due in part at least to the relatively low capital cost of equipment for the basic process and improvement in quality of adhesives available. Application of the materials is, I think, well illustrated in this Division's Lecture Room in which the stressed walls have a decorative interior and a waterproof plywood exterior which is being used to test exterior finishes. The roof trusses are of extremely light construction, plywood gusseted for maximum strength with the lower chord curved to accommodate the multiple curved ceiling which was specially designed for decorative and acoustical effects.

The Australian plywood industry has a number of rather special problems which include:-

1. Use of a large number of hardwood species available in relatively small volume.

*Presented by Mr. Gottstein.

2. Extending use of species which presents special problems in application as the more popular species become scarce.
3. The increasing use of imported species and plantation-grown softwoods.
4. The changing market conditions.

Our research programme has been to some extent at least directed towards problems arising from the above.

Work on veneer peeling and the associated preparation of peeler blocks has received special attention. Better control of both billet temperature and soaking time has now been applied in industry to obtain better colour and to improve dried quality. Total shrinkage of veneers has been reduced by several per cent. Laboratory work has also shown this thermal effect to be present to a lesser extent in species of relatively low collapse susceptibility, such as karri from Western Australia, and also in red Cryptocarya from New Guinea. A check on this type of thermal sensitivity is now being made whenever new species are being studied in the laboratory.

Our work on the setting up of knife and nosebar, and the use of measuring stations, referred to at the previous Conference, has been developed, and the difficulties of implementation of laboratory work in commercial peeling have been largely overcome by this method. Many commercial lathes have adopted the use of measuring stations to a greater or lesser extent and control of veneer quality has been greatly improved. In addition, many firms have now adopted the knife and nosebar gauging techniques as applicable to Australian conditions and lathes. A very considerable amount of field research has been carried out on different types of commercial lathes to analyse factors affecting peeling control, stability of settings and performance.

A number of species have been peeled, including native, plantation, New Guinea, Solomon Island, Borneo and Philippine species.

In species peeling trials, extensive changes have been made recently in laboratory peeling techniques in order to evaluate peeling factors, such as lathe settings and knife wedge angles more rapidly and accurately. In particular, a four-section knife has been used which allows the study of four factors simultaneously in the peeling of a single 40 in. peeler block. The length of the face grind is held constant to maintain uniform pitch while, for example, different angles of back bevelling may be used to obtain desired bevels or wedge angles. This laboratory technique has been adopted now on several species and peeling requirements and setting limits are known with considerably greater accuracy.

A serious problem encountered in this work is the accurate evaluation of veneer quality. Methods of improving the accuracy of quality measurements have been examined. This work has been primarily based on examination of peeling check depth and frequency, transverse tensile strength and surface smoothness. Statistical analysis has shown that transverse tensile strengths are roughly proportional to maximum depth of peeling check. This is, of course, not unexpected but it has been further found that extrapolation of the graphed values to zero check depth gives good agreement with values obtained with backsawn and dressed to 1/16 in. thickness. This result indicates that under certain circumstances peeler checks may be the only significant damage unless excessive nosebar pressure leads to picking out and shear at or near the surface.

Studies have also been made on knife sharpness. Previous work has been hampered by lack of available technique for measuring knife edge profile. We have now developed a technique consisting of taking an impression of the knife edge with a modified epoxylene casting resin and cutting microtome sections of the impression. This method has been found effective up to 1,000 or so magnifications. This appears to be quite sufficient for the usual practical orders of sharpness, though not for extremely sharp edges. On this basis we have now been examining effects of micro-bevelling with different angles and different bevel widths. We are also studying the effects of knife wear and profile and effect of wear on bevel angle.

Considerable attention has been devoted to veneer drying and, in particular, to drying problems and the development of appropriate drying control under accelerated drying conditions. Several studies have been made of commercial mechanical driers and recommendations have been made in respect of operation and modification for improved efficiency. A new technique has been developed for prediction or estimation of final veneer moisture content in several types of drier and this will be covered later.

A laboratory veneer drier is being built to study veneer drying under a wide range of conditions.

Field studies have been made with the several types of moisture meter available and the success of the needle electrode has been demonstrated by the Timber Physics Section.

Some laboratory studies have also been made on the rates of moisture sorption by over-dried veneers under ambient and somewhat accelerated conditions. Very recently attention has been drawn to buckling of panels in which end shrinkage of veneers has apparently been involved. Initial studies have shown that many apparently straight-grained species have surprisingly large end shrinkage components and that considerable care in selection was therefore necessary in apparently balanced constructions to avoid warping with changes of moisture content. This work is continuing and is being extended.

Our main work on adhesives has been directed towards a low cost waterproof formulation and we have made considerable progress with work on tannins.

Results of work on gluing of veneers treated with waterborne preservatives will be given in a later item.

We have also been concerned about a number of the physical variables associated with gluing processes, particularly those of pressure, temperature, time and species in the thermo-setting adhesives. Casual observations have indicated the presence of considerable differences in glue line temperatures of different species and now that suitable multi-point electrical recording equipment is available, work on glue line temperatures at various moisture contents, species and thicknesses has been initiated. The results help to explain the number of unexpected failures and relatively low waterproofness of some joints in plants dealing with different species and densities. It is hoped by integrating results of studies of this type with information on curing rate of a particular adhesive over the appropriate range of curing temperature that minimum times for full cure will become determinable with improved accuracy. This should permit a higher degree of reliability in commercial gluing without overall increase in pressing time.

Some progress on the phenolic gluing of boron treated veneers will be discussed later.

Studies of the effects of elevated temperatures and humidities on inactivation or case hardening, as it is sometimes called, have been carried out on several species as opportunity offered. Two factors appear to be of importance in surface inactivation and loss of joint strength through case hardening:

1. Actual mechanical damage through heat, usually with temperatures in excess of 300°F.
2. Some "inactivation" of the surface which results in reducing specific adhesion of the glue.

Our most recent results indicate that for coachwood reduction in strength is not significant until 100°C has been exceeded for protracted periods (24 hr), provided gluing factors are under proper control. With such factors under poor control some species could perhaps give some indication of reductions in strength at lower temperatures. This effect seems similar but quite independent of the poor wetting of surface obtained for low moisture contents.

Some studies have been made on difficulties arising with particular species. In long assembly operations using urea resins, low pH with the high buffering offered by a particular species can lead to resin advancement and poor adhesion. One method of reducing this difficulty was clearly the use of an alkaline buffer such as borax, but the use of high spreads and pre-pressing was also very effective. Moisture content has proved remarkably critical in the phenolic gluing of several species.

Work has also been initiated on glue spreading in the laboratory in an endeavour to determine which factors must be brought under control to maintain adhesive spreading tolerances. Initial work on the laboratory spreader has shown that relative positions of doctor and spreader rolls are quite remarkably critical and should be held to less than 0.001 in. to hold spreads within 10 lb/1,000 sq.ft. of double glue line.

Some work has also been carried out on preparation of surfaces for finishing treatments and one point of some importance is the correct laying up of veneers. If veneer is laid with the loose side exposed a large number of species will not sand smoothly.

Some work has also been carried out in conjunction with Timber Mechanics Section towards grouping of species and veneer qualities to allow a simplified classification for application of plywood to engineering structural grades.

ITEM 6(b)

TANNIN FORMALDEHYDE ADHESIVES*

At the last Forest Products Conference a report was made on the first few months work done on this project following its transfer from D.I.C. In that period, working with unsulphited mangrove tannin extract (cutch), adhesives had been prepared which under test had satisfactory dry shear and would withstand 6 hr boil without delaminating. However, wood failure of specimens tested dry and after boiling was low.

Following this, we sought to improve strength and wood failure especially by varying the conditions under which the adhesive was prepared and used, e.g., by varying pH of the adhesive over the range 2 - 7, by the use of different kinds of filler, etc., but little improvement was achieved.

It became obvious that we could not expect much progress without some chemical investigations, first of all to check the variability of the mangrove tannin supplied, and secondly, to obtain information on the tannin formaldehyde reaction and the differences between tannins of different origin. For checking variability the Stiasny test was adopted. This test gives a measure of the proportion of the tannin extract reacting with formaldehyde. The cutch samples received were found to contain a fairly large amount of material not precipitated by formaldehyde.

We developed a second test aimed at revealing the number of potentially reactive groups in the tannin molecule. In preliminary tests this information was obtained very approximately by determining the minimum amount of formaldehyde required to gel a tannin solution under standard conditions, but afterwards a method of determining formaldehyde uptake was developed. Both methods pointed to cutch having comparatively few reactive sites.

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*Presented by Mr. Plomley.

Thus far our experiences pointed to the need for fortifying cutch in order to make a satisfactory adhesive, and so the effect of adding varying amounts of different synthetic resins was tried. The resins used included P.V.A., U.F., P.F., R.F. and melamine resins generally in amounts up to 30 per cent. The resins were commercial ones and many, particularly U.F. and P.F., were not compatible with cutch; of the compatible ones R.F. was by far the best, giving fairly satisfactory results with 20 per cent. fortification and good results with 30 per cent. It was not possible to produce a low cost adhesive containing this quantity of R.F. so we turned our attention to trying to produce a P.F. which would be compatible and also cheap enough to be used commercially in blends. In this part of the work we had the co-operation of Dr. Fitzgerald of D.I.C. and with his help we prepared a suitable resin. Using varying amounts of this resin up to 30 per cent. the effect on shear strength and W.F. was additive and at 30 per cent. with pine veneers shear strength and wood failure both dry and after 6 hr boil were fully satisfactory.

These laboratory results were confirmed by a small factory trial in Sydney, carried out in May, 1957. However, the setting time obtained with this resin was rather too slow for the requirements of the main potential user of this adhesive (12 min at 140°C for 2 x 3/16 in. panels), and as we were unable to speed up the setting time of the P.F. any further without taking away its dispersibility in the adhesive, no other field tests have been carried out with it.

In our investigations we had observed that wattle tannin gave higher results in both Stiasny test and formaldehyde uptake. We therefore carried out some gluing tests with it using varying amounts of R.F. fortifier up to 30 per cent., and with a wattle tannin adhesive containing 10 per cent. fortifier obtained results as good as we had had with cutch containing 30 per cent. fortifier.

With such a low rate of fortification, it was now possible to use a resorcinol based resin which would give a faster setting time than we had been able to obtain with our P.F. With a view to reducing costs further, we investigated the setting times of various P.R. co-polymers. Under the conditions used we were able to reduce the resorcinol content to 19 per cent. and still retain R.F. characteristics. At 15 per cent. phenolic properties predominated and the resin did not set at room temperature in 24 hr.

The resin containing 19 per cent. R. has been offered in commercial quantities by an adhesive manufacturer at about 3/0d. per lb and at 10 per cent. fortification we calculate that we can produce a waterproof adhesive at about the cost of an H.M.R. one.

We have investigated the effect of pH on rate of gelation of wattle tannin and have speeded up setting time by adjusting pH to about 7.0 where it is more reactive than at the natural pH.

A glue mix containing 10 per cent. R.P.F. has given good results with klinki, hoop pine, coachwood and ramin, and with karri does not appear inferior to some commercial liquid phenolics. It has a tendency to penetrate veneers, but this has been overcome largely by using a suitable filler and by adding a small amount of formalin which reacts quickly with the tannin and increases the viscosity of the mix. Work now in progress is aimed at investigating adhesion in a range of species and testing low cost additives which might accelerate setting and improve adhesion. We hope to carry out some small scale commercial tests in the near future.

Discussion

Mr. Cokley said that the Plywood Investigations Section is to be congratulated for the excellent work on tannin formaldehyde adhesives. He asked about adhesion with different species, particularly the effect of species with low pH, and also enquired if tannin-formaldehyde adhesives are now ready for commercial use.

Mr. Plomley said a tannin formaldehyde formulation with a pH of about 7 was generally used, but satisfactory results have been obtained at pH's below this. Setting time becomes longer as pH of adhesive decreases from 7 to about 4. Only the few species mentioned have been tested and as most mills use more than one kind of veneer tannin-formaldehyde is not being recommended for commercial use before adequate tests have been made of a range of species.

Mr. Jennings asked whether it was intended to patent the adhesive.

Mr. Clarke said no, but the Division will publish results as soon as possible in order to make the work available to those interested. It is intended to test the adhesive thoroughly before recommending its commercial use.

Mr. Jennings said that he could see difficulties in introducing it.

Mr. Huddleston felt that no more trouble should be experienced with tannin adhesives than with some of the adhesives already in commercial use. The Division of Wood Technology has been working on glues made from P. radiata tannin extracted from the bark with cold water and have found this tannin very reactive. Shear strength and wood failure with coachwood have been so consistently high that now grey myrtle is being used since it provides a more exacting test of the adhesive.

ITEM 6(c)

EFFECT OF CURING TIME AND ADDITIVES ON BOND STRENGTH OF PHENOLICS IN THE PRESENCE OF BORON*

Work on gluing of boron treated veneers with phenolic glues was restarted in August, 1955. From earlier laboratory work and commercial experience, it was well known that boron decreased the wet

*Presented by Mr. Hirst.

strength of phenol formaldehyde adhesives and that generally results with liquid glues were better than with film glues. From earlier discussions, too, it seemed likely that boron formed a water soluble salt with the phenol formaldehyde causing inferior water resistance of the adhesive and characterized by extremely poor wood failure in boil tests.

Initially it was hoped to improve gluing properties of the veneers by decrease of the amount of boron on the surface of the veneer, but no great improvement was obtained.

The next step was to try to pre-react the boron before gluing by coating of the plywood with some reagent. Lime, tannin, phenol, formaldehyde and phenol formaldehyde solutions were brushed on the veneers previous to gluing. Brushing with phenol formaldehyde was found beneficial and the effects were examined by U. Yin Pe (a Colombo Plan Student). It proved to be possible to obtain full strength, but the process was not economical and the work was discontinued.

In most experiments results were characterized by variability of results. Some batches of borax treated plywood showed bad wet strength while others were excellent. It was therefore possible that some small changes in gluing procedure have an influence on the results. Experiments were carried out to find whether reliable waterproof plywood could be produced from boron impregnated veneers by controlling gluing variables. Variables investigated included method and quantity of spreading, method of impregnating, sanding of surface, assembly time, pressing time, glue spread, and moisture content of veneers.

The most marked differences found were those caused by varying setting time, as can be seen from graph 1. Normal setting time of about 5 min for a single 3/16 in. panel gives optimum dry strength, while wet strength increases up to 8 min, though dry strength shows a tendency to decrease slightly with this pressing time.

Subsequently, further work was carried out in conjunction with R. Johanson. It was thought that selected compounds added to the glue might react with the boron preferentially and thus prevent the formation of water soluble phenol formaldehyde compounds. Zinc powder, manganese dioxide did not improve shear strength but molybdenum trioxide and vanadium oxide appeared to improve wet and dry strength to a small degree and further investigations will be made with additives of this type. Simultaneously arsenic trioxide which had been found to improve bond strength of phenolic glues on unimmunized veneers was added to glue mixes. Results, which are shown in graph 2, show a distinct improvement of shear strength and also of wood failure with wet specimens.

The results of findings so far indicate that borax impregnated veneers may be glued successfully if optimum conditions are applied. Those involve an increased setting time and possibly the use of a suitable additive. This work was largely carried out with one species and one make of glue. Experiments are now in progress to check results with three further phenolic adhesives. Weatherometer tests and exposure tests are at present being carried out with panels glued with extended pressing time using veneers dried to low moisture content. These will be extended to panels glued under similar conditions, including arsenic trioxide in the glue.

ITEM 6(c) - (cont'd.)*

It is generally believed that, during gluing, boron forms water soluble linkages which break up when coming in contact with moisture. One author has suggested that the formation of ester linkages between phenol formaldehyde and hydroxy groups on boron atoms could be responsible for the low wet strengths of plywood containing boron.

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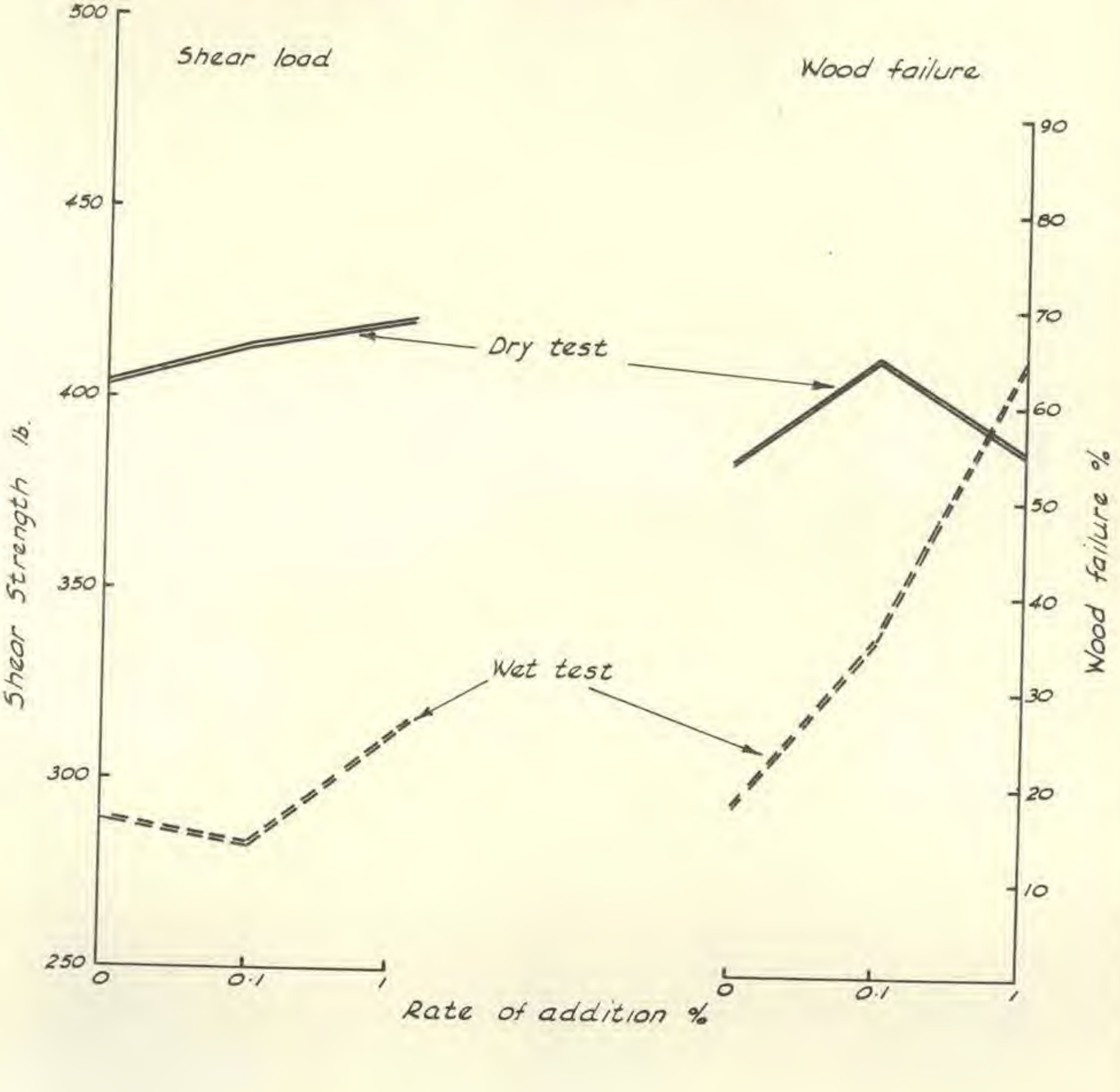
*Presented by Mr. Johanson.

Influence of addition of As_2O_3 on Bond of Phenolic Glue with Boron Immunized Coachwood



For good reasons, anticipation of ester linkage formation under alkaline conditions and subsequent hydrolysis is unsatisfactory, and we preferred to test out a different hypothesis. From the literature, we know that boron forms, under favourable conditions, boron-hydrogen, -carbon and -oxyalkyl linkages, and we do know that these could be very susceptible to moisture. We have no evidence that reactions of these types do occur to any great extent during heat setting of plywood, but still the possibility should not be overlooked.

We were interested to test the effect of reducing and oxidizing environments during gluing; we would expect reducing conditions to favour undesirable boron linkage formation, i.e. that they would tend to lower the wet strengths. On the other hand, carefully controlled oxidizing conditions should improve wet strengths in plywood.

To produce a reducing environment zinc metal powder was selected, and the result was very definite. Whether it is in conformity with our assumptions or because of some other side reactions, the addition of zinc to phenol formaldehyde reduced glue line strengths greatly.

The next step was to try an oxidizing medium; however, conditions here are not so straightforward. The possible effects of excessive oxidation had to be considered, but it was felt that if we could provide, through some medium, not additional but exchangeable oxygen which is already in the system, we may stop boron interference. In other words, the right type of catalyst with suitable electronic configuration was required. For this purpose two elements capable of high oxidative state were selected and the compounds used were vanadium pentoxide and molybdenum trioxide; manganese dioxide was used as a control.

Preliminary tests indicate that the addition of these reagents to phenol formaldehyde appears to improve the wet strength in plywood containing boron. At present it would appear that results are sufficiently indicative to warrant further tests along these lines.

ITEM 6(d)

EFFECT OF PRESERVATIVE TREATMENT ON BOND STRENGTH*

This work was conducted in co-operation with Preservation Section which was responsible for formulation and preparation of preservative solutions.

The main purpose of the study was comparison of bond strengths in plywood assemblies constructed from untreated veneer and veneer treated with waterborne preservatives in an instantaneous diffusion dip. The work was divided into two experiments.

In the first experiment the effect on bond strength of surface salt concentration as induced by different levels of preservative concentration was investigated with two preservatives.

This work was conducted with four preservatives and five North Queensland species and will be extended to other non-durable species and possibly new preservatives and glue formulations as opportunity permits.

Species investigated were as follows:-

Silver ash (*Flindersia* prob. *bourjotiana*)
Silky oak (*Cardwellia sublimis*)
Queensland maple (*Flindersia brayleyana*)
Kauri (*Agathis palmerstoni*)
Rose alder (*Ackama quadrivalvis*)

The following preservatives were used:-

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*Presented by Mr. Stashevski.

1. Celcure A - proprietary preservative in 10 and 20 per cent. solution.

Celcure A formulation:

$CuSO_4 \cdot 5H_2O$, $K_2Cr_2O_7$, $Na_2H\ AsO_4$, $7H_cO$ + pyro-arsenate 7%.

2. Fluo-copper-arsenate in 10 and 20 per cent. solution. This is really a modified formulation of Tanalith U where water solubility of the preservative was increased by replacement of sodium fluoride (NaF) and dinitrophenol by potassium fluoride (KF).

Fluo-copper-arsenate formulation:

(i)	Potassium fluoride (KF)	38.0 parts
(ii)	Di-sodium hydrogen arsenate $Na_2HAsO_4 \cdot 7H_2O$	27.5 parts
(iii)	Di-sodium chromate $Na_2CrO_4 \cdot 2H_2O$	34.5 parts
		100.0 parts

3. Copper formate was used in 12 per cent. solution which was the highest concentration possible to obtain.

Copper formate formulation:

$Cu(CO_2H)_2$

4. Zinc-chromic acid was used only in 10 per cent. solution because of its low solubility.

Zinc-chromic acid formulation:

ZnO	-	3.3 parts
CrO_3	-	6.7 parts
H_2O	-	90.0 parts
		100.0 parts

The adhesive used throughout the experiment was liquid phenol formaldehyde with 14 per cent. coconut flour extension, hot pressed at 150 lb/sq.in. glue line pressures. In all cases the veneer was dipped in the preservative solution and then block stacked overnight.

The second experiment with 1/16 in. and 1/8 in. Klinki veneer in 3/16 in. and 3/8 in. plywood assemblies studies the effect of two proprietary preservatives - Tanalith U and Tanalith C on bond strength of film and liquid phenolic glues. In addition, the effect of heart and sapwood was also investigated.

Both preservatives were used in 10 per cent. solution and the material was treated in the same way as in the first experiment.

(a) Results

The results of the first experiment do not show any general pattern in respect of the type of preservative or preservative concentration, but appear to be influenced strongly by individual species characteristic.

Of the species investigated, silver ash gave good results with all preservatives except Celcure A and quite often shear strengths obtained from treated material were higher than the controls. It is interesting to note that with the fluo-chrome-arsenate preservative a better bond was obtained with the higher solution concentration and shear strength in boil test was above the figure for control by 50 lb/sq.in.

A similar although not as clear pattern occurred with Queensland maple. Here again, material treated with Celcure A gave low values. The best results were obtained with the zinc-chromic acid formulation where the shear strengths approached those of the controls.

Queensland kauri surprisingly showed reduction in shear strength for all material tested dry, whereas all material treated with low concentration preservatives showed shear strengths equal or improved as compared with the controls.

Silky oak and rose alder both behaved rather badly and in nearly all cases showed reduction in bond strength.

The results of the second experiment indicate that the effect of glue is significant. The liquid phenol glue gives consistently higher results in shear strengths. The wood failures show somewhat similar pattern although some of them show rather low figures.

From the two preservatives investigated, the material treated with Tanalith U shows in nearly all cases a superior bond to that treated with Tanalith C.

(b) Conclusion

In considering these results it should be noted that after some 20 years use of boron compound for Lyctus immunization, the variation obtained with phenolic adhesives is still not fully understood and failures still occur in industry. On the other hand, little or no trouble is being encountered with sodium fluoride at low concentrations. The results, therefore, with any limited series of tests must be treated with due caution. The problem of variability of glued joints on treated veneer or timber is complicated by the many factors contributing to the strength of a joint. The conditions at the interface between adhesive and adherend may be affected by the presence of preservative particles. Specific adhesion may be limited by mechanical blockage and penetration may be prevented. In addition to this, the preservative may have serious effects on the mechanical properties and setting rate of the adhesive. Further, some preservatives may tend to form a gummy deposit with wood extractives and so inhibit proper glue contact.

Preservation with waterborne preservatives requires higher solids retentions than that used for Lyctus immunization and therefore surface accumulations can be higher and interface problems increased. At the same time it is felt that for veneers, concentrations required are such that surface conditions can be controlled sufficiently well to give reliable results with many species, preservative formulations and adhesives. The results indicate, however, that check testing for the preservative, species, glue and conditions of operation are essential.

TABLE SHOWING GLUING RESULTS OBTAINED WITH VENEERS TREATED WITH 12 PER CENT. COPPER FORMATE AND 10 PER CENT. ZINC CHROMIC ACID

Species	Shear Strength / Wood Failure (%)	Preservatives					
		10 Per Cent. Zinc Chromic Acid		12 Per Cent. Copper Formate		Controls	
		72 hr Boil Test	Dry Test	72 hr Boil Test	Dry Test	72 hr Boil Test	Dry Test
Queensland silver ash	lb/sq.in. % W.F.	312 97	484 96	250 98	528 98	294 88	504 100
Silky oak	lb/sq.in. % W.F.	203 20	275 50	190 40	282 71	218 43	326 90
Queensland maple	lb/sq.in. % W.F.	320 98	486 90	275 88	423* 80*	340 95	470 100
Queensland kauri	lb/sq.in. % W.F.	292 92	362 92	290 94	381 81	292 92	405 92
Rose alder	lb/sq.in. % W.F.	250 81	316* 46*	185 74	320 96	252 70	392 98

*Large number of wood specimen failures.

TABLE SHOWING GLUING RESULTS OBTAINED WITH VENEERS TREATED WITH CELCURE A AND FLUO-CHROME-ARSENATE IN 10 PER CENT. AND 20 PER CENT. SOLUTION

Species	Shear Strength / Wood Failure (%)	Celcure A				Controls		Fluo-Chrome-Arsenate			
		10 Per Cent. Solution		20 Per Cent. Solution				10 Per Cent. Solution		20 Per Cent. Solution	
		72 hr Boil Test	Dry Test	72 hr Boil Test	Dry Test	72 hr Boil Test	Dry Test	72 hr Boil Test	Dry Test	72 hr Boil Test	Dry Test
Queensland silver ash	lb/sq.in.	235	420	243	363	308	473	243	439	355	473
	% W.F.	93	80	95	93	96	98	95	90	95	88
Silky oak	lb/sq.in.	162	266	161	248	155	260	149	283	148	223
	% W.F.	93	59	93	57	99	93	100	90	97	79
Queensland maple	lb/sq.in.	218	351	-	-	235	356	224	263	-	-
	% W.F.	75	42	-	-	98	95	94	100	-	-
Queensland kauri	lb/sq.in.	301	372	258	297	315	452	318	408	253	317
	% W.F.	93	71	91	67	93	95	95	99	93	95
Rose alder	lb/sq.in.	170	257	225	254	225	261	185	241	215	292
	% W.F.	55	80	70	100	92	99	76	83	84	99

DRY STRENGTH AND WOOD FAILURE OF KLINKI PLYWOOD TREATED WITH TANALITH U AND TANALITH C AND BONDED WITH LIQUID PHENOL AND TEGO FILM

Preservative		Tego Film		Phenol - Liquid		
		3/16 in. Assembly	3/8 in. Assembly	3/16 in. Assembly	3/8 in. Assembly	
Controls	Heart	369	364	422	354	lb/sq.in.
		64	71	93	63	% W.F.
	Sap	344	371	346	362	lb/sq.in.
		73	67	87	62	% W.F.
Tanalith C	Heart	382	343	316	342	lb/sq.in.
		85	48	65	38	% W.F.
	Sap	315	359	258	288	lb/sq.in.
		84	59	71	38	% W.F.
Tanalith U	Heart	393	392	412	339	lb/sq.in.
		89	59	53	57	% W.F.
	Sap	248	360	354	313	lb/sq.in.
		66	69	79	51	% W.F.

WET STRENGTH AND WOOD FAILURE OF KLINKI PLYWOOD TREATED WITH TANALITH U AND TANALITH C AND BONDED WITH LIQUID PHENOL AND TEGO FILM

Preservative		Tego Film		Phenol - Liquid		
		3/16 in. Assembly	3/8 in. Assembly	3/16 in. Assembly	3/8 in. Assembly	
Controls	Heart	286	300	292	297	lb/sq.in.
		39	62	80	57	% W.F.
	Sap	214	246	251	302	lb/sq.in.
		38	66	77	73	% W.F.
Tanalith C	Heart	237	190	236	238	lb/sq.in.
		22	22	32	12	% W.F.
	Sap	199	146	212	189	lb/sq.in.
		24	12	26	10	% W.F.
Tanalith U	Heart	289	296	287	288	lb/sq.in.
		37	51	56	58	% W.F.
	Sap	224	247	244	256	lb/sq.in.
		68	56	40	48	% W.F.

ITEM 6(e)

METHODS OF PREDICTING OR DETERMINING THE MOISTURE CONTENT OF VENEERS IN DRIERS*

Control of final moisture content in modern driers using fast drying conditions is extremely difficult to achieve because of the very rapid changes in veneer moisture content, even below fibre saturation point. A number of methods have been tried out or are in use in the industry, but none of them can be considered entirely adequate.

To be reliable and to be of practical value to the industry a method of moisture content determination should fulfil certain requirements.

(i) The moisture content should be determined on more than one sheet and within a sheet in more than one spot.

(ii) The actual determination of moisture content should occur inside the drying unit without interruption to the drying cycle.

(iii) In case of progressive type of driers the determination or prediction of final moisture content should be attempted fairly early in the drying cycle in order to give the operator a chance for corrections.

From the methods of moisture content determination used at present in the industry, the testing of individual sheets with a resistance moisture meter is perhaps the most successful one. Although the readings are sufficiently accurate and reliable for most of the practical purposes and several spots can be investigated without much time delay, the drying cycle is interrupted during testing and in progressive mechanical driers correction can be made only after appearance of incorrectly dried material. Also special precautions must be taken when testing hot veneers.

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*Presented by Mr. Stashevski.

Capacity type moisture meters also, giving instantaneous readings, can be very useful especially at low moisture contents, but extreme care is necessary in their use because readings are affected by species density, changes within a species, and field penetration effects. A special property in their favour is lack of temperature sensitivity.

The method of sample boards, as used in solid timber drying, has never established itself in veneer drying because of the time-consuming nature of the test, and also because to be really successful it requires material of reasonable uniformity in density and moisture content to start with.

One obvious method quite often used in industry, mainly to avoid sampling difficulties, is the adoption of standard drying times in conjunction with standard drying conditions. In operations where initial moisture content is reasonably uniform, time schedules can be successful, but where variations occur, serious difficulties can arise. This method is usually adopted by the operators of accelerated veneer drying equipment of either the progressive mechanical, or compartment type.

In some driers, especially relatively low speed compartment or progressive units, inspection of appearance, pliability, and tests with moisture meters can be reasonably successful in end point determination, but the extent of sampling is usually limited and difficulties arise if high temperatures are attempted.

For fast veneer drying conditions, other methods have been examined and after careful study it was established that dry bulb temperature drop across the veneer in the drying compartment could be considered as a measure of the rate of drying and therefore could be related to the moisture content of the veneer. This method is based on a general assumption that the drier is filled with a constant quantity of veneer of the same species and thickness, and that operating conditions are accurately controlled at consistent and uniform temperature and flow conditions. This method can be very sensitive because air has a very low heat capacity. One cubic foot of air at 20°F will fall $8\frac{1}{2}$°F in absorbing only one grain of moisture.

This and the fact that moisture content changes vary rapidly in veneer drying call for rapid response in the measuring equipment. After many observations and exploratory work, it was finally found that the use of thermocouples, wired as differential thermometers, appeared to offer the most practical method for veneer moisture content testing.

In compartment units of the cross-flow type, the method has indicated the average moisture content for a number of species, and hence the end point of drying could be determined with considerable accuracy. In addition, it seems likely that with some experience the operator will be able to establish temperature differences which will give the drying time still required before the end point. This will permit maximum efficiency of drier operation since re-loading times can be predicted.

In mesh-belt driers without radiant heating between belts, prediction was found to be very promising indeed and, by using a workshop potentiometer and a reflecting galvanometer, it was found possible to locate a suitable position in the drier for determining dry bulb temperature differences from side to side across the drying belts. As the observation was made several minutes before drying was complete, it was possible not only to predict behaviour in the drier, but also to make adjustments to feed speed to ensure that final average moisture content was satisfactory. When the method has been fully developed it should be possible for the prediction device to assume at least partial automatic control of the feed rate in driers of this type. In one mesh belt drier tested the temperature difference involved under suitable operating conditions was between 20° and 30°F on 1/16 in. hoop pine veneers to predict end moisture contents in the 8 - 10 per cent. average range. In screened units end point differences are usually between 4° and 12°F for 1/16 in. veneers of different species. In any one species and thickness the difference appears to be consistent to about 2°F.

Results with non-radiant mechanical roller driers have been promising but not entirely satisfactory to date. In this case results are rather more difficult to obtain because the high thermal capacity of both rollers and air ducting (if these latter are present) tend to reduce temperature differences when drying is nearing completion and determination of the drying load is more difficult.

Unfortunately, the method cannot be applied to driers which are entirely radiant heated, that is, where all heating coils are placed between the veneer decks, although it may be useful on cross-flow units which use radiant coils only in the early stages of drying.

The arrangement of the thermocouples in a particular installation is, of course, dependent on the drier design, and to some extent on its method of operation. In mechanical units where several decks are drying veneers simultaneously, it is necessary to install thermocouples so that temperature differences existing in each deck are observed. This can be arranged by installing an array of thermocouples on the inlet and outlet sides in appropriate positions. The thermocouples may be operated in series or parallel to give a single average reading.

In compartment units the location is somewhat similar, although it is desirable to place thermocouples fairly low down when vertical racking is used because when short circuiting of air occurs above short sheets, the top of the drier would fail to give a temperature difference in accordance with moisture content. The readings would indicate that the veneer was drier than was actually the case. Placement of thermocouples 1 to 2 ft above the bottom edges of sheets is usually effective and several couples can be used to assure correct averaging.

When initial moisture contents and drying rates of veneers are uniform the method can be used to establish the drying time for standard conditions and these times used until changes are required. It must be emphasized that the method is applicable only to estimation of average moisture content and cannot locate high moisture content zones of limited area. Under fast drying conditions this problem must be resolved by the drying schedule and the final end moisture content as determined for a particular species and operation. The method must be supplemented by careful observation of the dried sheets so that wet patches can be located with appropriate moisture meters.

ITEM 7. TIMBER PHYSICS

(a) SUMMARY OF RESEARCH ACTIVITIES*

The four main lines of research into the physical properties of wood which have been active since the last Conference are -

(a) The study of wood-liquid relations.

(b) The investigation of rheological properties.

(c) The determination of shrinkage and density.

(d) The collection of correction data for use with electrical moisture meters.

(a) Wood-Liquid Relations

One of the most important lines of work in the wood-liquid relations field is the recently commenced study of the rate of approach to equilibrium during the loss or gain of moisture. This work will be discussed under the next item.

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*Presented by Mr. Kingston.

A detailed study has been made during the last 2 years of the moisture adsorbing properties of a reproducible sample of mountain ash and of its various components, including holocellulose, wood cellulose, the hemicelluloses and lignin prepared in different ways. The hemicelluloses were found to have a greater and the lignins a lower sorptive capacity than the wood or wood cellulose. The heats of wetting from the dry state were found to be roughly in the order of the sorptive capacities of the various components. The swelling of the isolated lignins have also been studied and it was found that at high humidities a large portion of the water adsorbed entered the lignin structure to cause swelling, although at lower relative humidites the fraction was considerably smaller. Different lignins were found to behave very differently, methanol lignin taking up only half the moisture adsorbed by Klason lignin.

(b) Rheological Properties

In the field of rheological properties, the work reported at the last Conference has been continued. Unexplained discrepancies between results which were mentioned then have now been found to be due to the fact that although green and dry wood under constant load show roughly equal proportional creep, wood which is green initially but allowed to dry out during test, has a much faster creep rate and a considerably higher total creep. This effect has been studied fairly fully for mountain ash and work is now being done on blackbutt which appears to behave in a similar way. A few tests on radiata pine gave similar results. In general, the increase in deformation under load has been found to be roughly twice as great for timber drying out as for that kept at constant moisture content. The ratio will probably depend to some extent on the size of the specimens and the difference is thought to be largely due to additional stresses produced by drying. This is obviously quite an important feature, as structural members, especially in larger sizes, are often loaded when green and dry out after the structure is complete and under load. The problem may possibly be less serious for very large members, such as large bridge girders, owing to the very slow drying rate. The fact that it occurs in both blackbutt, mountain ash and radiata pine suggests that it is not appreciably influenced by collapse.

Proportional increases in deformation in compression and tension specimens of green and dry mountain ash proved similar in magnitude to those in beams of the same material. Previously attempts made to compare results for green compression and tension specimens with those for initially green beams showed marked differences.

The strength of wood under dead loads has been investigated fairly fully for all types of loading with green timber and has been found to fall to about 90 per cent. of the short time ultimate load as determined in the testing machine, if held at this load for about 5 min. If held at lower proportions of the short time ultimate load it may still fail but at considerably increased times. For instance, at 80 per cent., in compression and shear, the time to failure is about 2 hr. In bending, however, at this load the average time to failure is approximately 1 day. At 70 per cent., the time rises to a day and a half for compression and shear and about 2 months for bending. At 60 per cent., it has risen to nearly a month in compression and shear and approaches 1 year in bending. These results are very variable from specimen to specimen and the figures are based on the average of a large number of tests.

It can be seen that these reductions are of considerable importance in actual structures should any unexpected weakening occur or gross overloading continue for long periods. The work is being continued to try to assess the life at various loads more closely in order to ensure the maximum economy in design. Other moisture conditions will be investigated and work on initially green material is in progress.

Automatic machines have been developed to enable the rheological characteristics of wood to be studied at very high stresses and work has been carried out up to 95 per cent. of ultimate load in relaxation. A sudden increase in the creep rate has been found to occur at somewhere between 65 and 70 per cent. of the ultimate load. This is above the limit of proportionality. The phenomenon is being further studied and the effect of temperature on it will be investigated in an attempt to find the significance of the yield occurring at this point. Preliminary calculations suggest that the flow units are very small, probably of sub-molecular dimensions and associated with a fairly high energy of activation (the equivalent of about five or six hydrogen bonds), which corresponds with the slow rate at which creep in wood takes place.

Cyclic loading tests show that relaxation is closely reproducible but that under constant stress a considerable amount of mechanical conditioning takes place. This is in the nature of what may be called "time hardening". This mechanical conditioning reduces both the recoverable and irrecoverable parts of creep but neither is entirely eliminated.

(c) <u>Shrinkage and Density</u>

Shrinkage and density measurements have been continued and work commenced on the measurement of shrinkage and density of immature eucalypts. As this work was commenced by a visiting research worker, the material had to be obtained quickly and so most of the species so far studied are of Victorian origin. However, many of these occur also in one or more other States and material will be collected in other States for a similar study in the near future.

An attempt is being made also to fill in gaps which still exist in our information on the mature eucalypts and New Guinea and Island timbers which are being imported into Australia.

The work done here on shrinkage and density during the last 25 years has been collected together and re-analysed and prepared for publication. The results will be issued in the Forest Products Technological Series during 1959 and data of particular importance to the timber industry will be extracted and published in the Forest Products Newsletter.

(d) Moisture Meter Corrections

A detailed study has been made of resistance type moisture meter corrections for brush box. It has been found that moisture meter measurements above 20 per cent. moisture content are very unreliable due to the unusually large dispersion of the results about the mean value. This applies to material from all districts. The mean corrections are very considerable at high moisture contents, being negative corrections of from 6 to 8 per cent. between 20 and 24 per cent. moisture content. Work is also in progress on a number of secondary species of Western Australian origin.

A considerable amount of work has been carried out on the determination of the moisture content of veneers, including those treated with borax. Various electrodes have been used including needle and clamp electrodes with resistance type meters, although the latter is an obsolescent type, and low and high penetration electrodes with capacity meters; a surface hygrometer has also been used. The hygrometer readings appear to be independent of the presence of borax, but there is a small correction due to variation in equilibrium moisture content from species to species at any given relative humidity, as the meter reads relative humidity and not moisture content. The main trouble with the results from capacity moisture meters was variations in reading due to variations in density. The needle electrodes with the resistance meter were found to be easy and quick to use and to be only relatively slightly affected by thickness. This equipment has the advantage, apart from speed, of being in general use for solid timber, and so readily available with appropriate correction data, and its use is being studied in more detail.

Finally, a detailed study of species corrections for radiata pine is being made to find the effect of ring age, height in tree, tree age and locality of growth on the results. The sample being studied at present comes from two localities in South Australia and consists of material from both crown and butt logs.

Discussion

Mr. Bootle asked Mr. Kingston what was the accuracy of moisture meters with brush box at a moisture content below 20 per cent., say 12 - 16 per cent.

Mr. Kingston replied that fairly large negative correction is necessary. The variation in readings is larger than for most species. It is not possible to use moisture meters above 20 per cent. moisture content with brush box.

Mr. Huddleston asked if Mr. Kingston could suggest a suitable method for determining the moisture content of brush box and Mr. Kingston replied that, short of oven drying, he could not. He thought that the density variation of brush box is large, which would rule out the use of capacity type moisture meters.

Mr. Cokley said it is understood that the Techtron manufacturers are bringing out a moisture meter which will read down to 5 per cent. moisture content. Veneer mills in north Queensland are not temperature conditioned and have conditions of high humidity, and he asked whether Mr. Kingston was concerned about the Techtron meter being used under these conditions.

Mr. Kingston replied that the temperature presents no problems but trouble may be experienced because of high humidity unless the meter electrodes are kept clean and dry. The effect on insulation resistance is important.

Mr. Cokley said that some members of the industry in Queensland regard moisture meters as an accurate means of measurement. In veneer mills they have found results which are inconsistent and do not agree with the correction figures of the Division of Forest Products. There are no corrections for a large number of species, especially imported ones. Meters are used blindly and their limitations are not recognized. His department is concerned about this and would like to give industry a suitable means of measurement.

Mr. Kingston mentioned that some imported timbers are difficult, especially where mixed species are marketed. He suggested that correction figures could be forgotten in such cases.

Mr. Huddleston said the variation in corrections for Borneo cedar is similar to brush box. Correction figures for some species around 12 - 15 per cent. moisture content are only about 1 or 2 per cent. They often use moisture meters without applying corrections.

Mr. Cokley asked what is the effect of boron concentration on the results, especially in veneers. It is not uncommon to find differences of three or four concentrations along veneer. Could this matter be looked into?

ITEM 7(b)

RATE OF SORPTION OF WATER VAPOUR BY WOOD*

The rate at which a sample of wood, e.g. a 1 in. board, responds to a given change in external humidity conditions is determined largely by the time required for moisture to diffuse from its surface to the interior. It may therefore be expected that, if the thickness of the wood specimen is reduced, the time required for it to reach equilibrium following a change in humidity conditions would be considerably lessened. However, recent experiments have indicated

*Presented by Dr. Christensen.

that there is apparently a limit to the extent to which reduction in specimen size is effective in increasing the rate of sorption. Thus it has been found for very small specimens, for example, less than 1 mm in thickness, that the rate of approach to equilibrium is independent of the shape or size of the specimen and, further, that the rate is very much slower at high humidities than at low humidities. From results such as these it is clear that diffusion is not the main factor limiting the rate of approach to equilibrium.

These observations are of considerable importance where the conditioning of wood in a finely divided form is required, e.g. in the processing of wood chips, wood shavings, wood flour, ground wood and possibly also wood pulp and paper. Experiments have been carried out to study the rate of approach to sorption equilibrium of small wood specimens and an outline of the preliminary results is now available. These experiments were carried out in vacuum but it is expected that the conclusions will apply also to the equilibrium of finely divided samples in air, provided the approach to equilibrium is not limited by the rate at which water vapour is transferred from the atmosphere to the surface of the wood sample.

Briefly the results of these experiments show that the rate of approach to equilibrium following any increase in relative humidity is determined entirely by the values of the humidity before and after the change according to the relationship $\sqrt{t} \log \frac{p_f}{p_i} =$ constant, where t is the time required for any fraction, e.g. half, of the total change in moisture content to occur and p_i and p_f are the initial and final humidities respectively. This relationship indicates that at high humidities where both p_f and p_i are large and consequently $\log \frac{p_f}{p_i}$ is small, that the time required to reach equilibirum is much greater than for a similar change at low humidities. For instance, it was found that, whereas the time required to reach half the total change in moisture content in a step from dryness to 1.5 per cent. moisture content was 0.0625 hr, the corresponding time for a similar change in moisture content from 13.5 per cent. to 15.0 per cent. was 28 hr, i.e. a change in rate by a factor of 450. However, it was observed also that the time required to attain half the total change in moisture content from the dry state was independent of the final humidity or moisture content chosen. These observations denote a behaviour obviously different from that which would be expected if diffusion was the controlling mechanism and, in fact, calculations using diffusion coefficients determined from experiments on large samples indicate that times very much less than those found experimentally should be needed to reach equilibrium, particularly at the high humidities. A tentative explanation of the phenomenon depending on the rate of relaxation of internal stresses accompanying the swelling of the wood has been suggested.

Experiments so far made have been confined to changes involving increases in humidity and moisture content. Under these circumstances it appears that, when conditioning finely divided wood to a given humidity, equilibrium will be reached more rapidly the lower the initial moisture content. This may be of importance, for instance, in the conditioning of ground wood in hardboard manufacture.

Discussion

Mr. Cokley asked if veneer were overdried and then block stacked would it return to equilibrium moisture content.

Dr. Christensen replied that the results of his experiments suggest that the further the veneer is overdried, the faster it will return to the equilibrium condition. The experiment was carried out in vacuum where an unlimited supply of water vapour was readily available to the sample. It presupposes that the limitations to speed of equilibration of the veneer are not imposed by the rate at which moisture can be transferred to the surface of the veneer.

Mr. Wickett asked whether one is to infer that there is no such thing as a particular equilibrium moisture content value for a sample at a given humidity.

Dr. Christensen said that this was so, and has been found also in materials other than wood. Results of these experiments show that the equilibrium moisture content at a given humidity depends on the size of increment in moisture content by which it was reached and that higher equilibrium moisture contents are obtained following large increases than those obtained following small increases.

Mr. Wickett asked if it could be inferred that different species under the same atmospheric conditions should reach different equilibrium moisture content values.

Dr. Christensen said yes, but there is an additional factor in that case arising from differences in composition of wood of different species.

Mr. Huddleston mentioned that tests were made at the Division of Wood Technology before the war on several species and measurements of moisture content made over several years. Specimens approaching equilibrium showed a gradual continuous decrease in equilibrium moisture content with time. About fifty species were tested and different equilibrium moisture content values resulted in each case. War interrupted this work.

Mr. Kingston said that if Dr. Christensen were to leave the samples in his experiment for an extended time, they may in time reach the same equilibrium value.

Dr. Christensen pointed out that from the rate of change of moisture content at the time of ceasing the tests (1 month), he would have to leave the samples for many months in order that both could have the same equilibrium moisture content.

ITEM 7(c)

ELECTRICAL IMPULSE STRENGTH OF CROSSARMS*

The purpose of impulse testing is to study the effect of voltage surges of short duration, such as those caused by lightning, on electrical installations and their component parts. Experience in the field has shown that transmission lines with wooden crossarms offer a higher resistance to breakdown due to lightning, than do ones made wholly of metal.

Considerable interest has been shown overseas, particularly in Sweden and the United States of America, in the ability of wood to withstand impulse voltages due to lightning when incorporated, particularly as crossarms, in transmission line structures. Most of these tests have been carried out on softwoods and until 1956 practically nothing was known of the impulse strength of hardwoods. In 1956, preliminary tests were carried out at the University of Queensland using an impulse generator which had recently been installed there, to compare the impulse strength of some Queensland hardwoods with figures published overseas for softwoods.

Wood is known to offer poor insulation to 50 cycle voltages of long duration and with such voltages there is considerable risk of it igniting. Thus it cannot be counted upon to meet the demands of voltages of appreciable duration at operating frequencies and these must be entirely met by porcelain insulators. On the other hand, it has relatively high strength to impulse voltages and when dry, softwoods can withstand 4 - 6 kV/cm and when moist or exposed to rain, 3 - 4 kV/cm, when wood alone comprises the insulating material. Hardwoods appear to be at least comparable in this respect with softwoods.

In addition, wood possesses arc quenching properties which are of considerable interest and which have been investigated in detail for Douglas fir.

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*Presented by Mr. Kingston.

The possibility of carrying out further work at the University of Queensland has been discussed by Professor S. A. Prentice of that University, with respresentatives of the Electricity Supply Association of Australia and of this Division, and certain general proposals have been put forward concerning the nature of the work which should be carried out. The work would aim at determining the most suitable timbers for use for this purpose and the best treatment and design from the point of view of protection against breakdown due to surges, as a guide to future practice and to develop suitable empirical formulae for impulse strength of transmission line structures.

The consideration of financial arrangements has been completed but details of the research programme are not yet finally decided upon. However, a Research Fellow has been appointed by the University of Queensland to carry out work on impulse testing and he is at present studying the impulse strength of fibreglass laminates, but will be in a position in the near future to carry out work on wood. This Division has agreed to take part to the extent of co-operating in the planning of the work, discussing its interpretation, sending an officer to Brisbane for one or more short periods to co-operate in its initiation, and co-operating throughout, where problems within the sphere of the Division's programme arise.

One of the biggest problems will be the collection of material of suitable species and this is a problem in which it is hoped that the forest services in the various States will be willing to co-operate, as, without their assistance, the work becomes virtually impossible to carry out. The purpose of outlining this work here is to enable representatives from the various States to know what is intended and the purpose of the proposed work so that when the matter is brought before them at a later stage for more detailed discussion, they will be familiar with the general purpose of the work and arrangements already made.

Factors such as species, moisture content, temporary surface wetting, preservative treatment, surface deterioration and water shedding are under consideration for investigation. It will obviously be impossible to test all species commonly used in crossarm construction but a few of the most important will be selected initially, in discussion with various authorities, for the early stages of the work.

ITEM 8. UTILIZATION

(a) REVIEW OF ADVISORY WORK*

The Division of Forest Products is used as a source of information on forest products. Thousands of enquiries are received per annum and many man hours are occupied in dealing with them. The Utilization Section has to advise on timbers suitable for stated purposes, almost every imaginable use being covered in the course of time. Information is also requested on the properties and uses of specific timbers.

Contact with industry is maintained to give background knowledge of requirements and practices. Observation and systematic recording build up information. Investigations within the Division and by others in Australia and overseas establish data that are drawn upon to answer enquiries. The Division has an Information Officer, and the Utilization Section has an Experimental Officer engaged full time on advisory work, assisted by others in the Section when necessary.

Work in the advisory field does not require the scientific experiment, analysis and conclusion that is characteristic generally of activities of other sections.

Over the years we have endeavoured to prepare statements on species and individual uses. These are available for distribution

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*Presented by Mr. Turnbull.

and have expedited our handling of enquiries. Probably they have reduced the number of enquiries reaching us as they disperse the sources of information and meet needs before they are framed as questions to us.

We act in advisory capacity to Departments, a Service Package Committee, Standards Association, etc., and lecturing makes a further demand on our time.

Constantly recurring topics are: timbers for flooring, weatherboards, joinery and furniture, with advice lately being specially requested on the suitability of Malayan and New Guinea timbers for these purposes. Sporting equipment such as boats, skis and archery items are of continual interest, requests being received for suitable timbers and manufacturing techniques. In the housing field the finishing of flooring, exterior finishing, special timbers for panelling and other features are the subject of repeated enquiries.

Advice on manufacturing processes is frequently requested. This sometimes requires recommendations for the layout of planing mills, joinery plants, furniture factories, special woodworking plants. Recently numerous enquiries have been received relative to briquetting and the manufacturing of particle board.

Some enquiries require experimental work before they can be answered, e.g. finger jointing.

Finger Jointing

Techniques for end jointing have been under consideration as a means for developing utilization of shorts. It is understood fairly generally that butt jointing of square ended pieces is practically impossible under industrial conditions, and that scarf jointing promises to produce the strongest joints.

There has been investigation and development in Europe and North America of variously shaped end joints. Publicity given to some of the machines developed for finger-jointing stimulated interest in Australia and many requests for advice have reached us.

In order to determine the influence of various factors on the efficiency of joints in Australian timber we have made cutters out of steel dado heads in the Division, profiled various timbers and studied the relation of strength of joint to conditions of preparation. The tips of the cutters were made as thin as could be consistent with wearing qualities, the tips being 1/16 in. and the root 1/4 in. The slope of the profile they made approximated that of the slope of grain approved for standard grade structural timber. The length of finger was $1\frac{1}{8}$ in. for slope of 1 in 12. As we used a single cutter head in a milling machine, the profile had to be reversible, every second piece therefore being inverted for assembly. Two and a half fingers were milled in a 1 in. depth.

As end grain gluing was known to be the weakness in end joints loaded in tension and 1/16 in. regarded as a convenient thickness for tips of cutters, some tests were made to determine the influence of the thickness of the fingers left on the tension face (underside) of flooring loaded in bending. Removal of discontinuity of grain on the underface was shown to result in the following.

Thickness of end of finger on underface	1/16 in.	1/32 in.	0
Percentage strength of unjointed	63.8%	68.1%	74.5%

Interest of a firm in South Australia was aroused in finger jointing and three timbers were sent to U.S.A. for finger jointing under commercial production conditions and returned to this Division for test. The profiles used had tips of 3/32 in. and fingers 11/16 in. and 1 in. long. The strength of the joints in bending, compared with the strength of unjointed lengths was as follows:-

Radiata pine	-	54 - 89 per cent.
Mountain ash	-	45 - 66 per cent.
Karri	-	45 - 49 per cent.

Samples of cypress pine also jointed in U.S.A. with fingers 11/16 in. long were sent to us for testing and shown to have 60 per cent. of the strength of unjointed timber in bending.

The specimens we have jointed in this Division have been put together with various glues and at end pressures from 100 to 1,200 lb/sq.in. For timber of medium density there proved to be little increase in strength when end-pressure rose above 200 lb/sq.in. Joints from 37 per cent. to 70 per cent. of the strength of full length pieces were produced. More recent work on jarrah assembled under end pressures of 200 and 600 lb/sq.in. showed that 60 per cent. joint strength could be attained with 200 lb/sq.in., but that some higher strength resulted with 600 lb/sq.in. Possibly there may be merit in exceeding 200 lb/sq.in. with dense timbers.

Under commercial conditions we expect 60 per cent. joint strength to be maintainable. We regard this as more than essential for domestic flooring. The Timber Mechanics Section assembled panels of finger-jointed flooring with matched unjointed pieces and subjected these to the C.E.B.S. proof test (700 lb on $\frac{1}{2}$ sq.in. area for 15 min) and found that joints with 37 per cent. strength withstood the proof load.

Discussion

Mr. Bootle said that in New South Wales clear finishes had been found to have a life of 12 months only and eucalypt weatherboards were far better painted. He felt that the use of clear finishes on radiata pine might encourage decay. He though that a warning should be given the public. Also it was not in the favour of timber to be treated in this way.

Mr. Huddleston commented that Mr. Bootle had been testing clear finishes with disappointing results. Even the most promising materials had broken down quickly. The Madison formula did not stand up to test.

ITEM 8(b)

INDIAN RAILWAY SLEEPER CONTRACT - SUITABILITY OF VARIOUS TIMBERS

Mr. Huddleston said that he had asked for this section to be included because there were, to his way of thinking, several anomalies in the grouping of the acceptable timbers which he felt should be discussed. It was important that the views of the various authorities should be known to each other he felt, since a supervizing engineer of the Indian Railways was at present in Australia discussing the suitability of the various timbers for sleepers.

His own thoughts were that it was anomalous for river red gum to belong to group (1) and forest red gum to group (3), that white mahogany should be included in group (1), and blackbutt, yellow and white stringybark to group (3). Otherwise, he felt that the grouping advised by C.S.I.R.O. should stand.

9. F.A.O. CONFERENCES, OVERSEAS VISITS, ETC.

(a) MADRID CONFERENCE

Mr. Clarke. Two reports were prepared on the Fourth F.A.O. Conference on Wood Technology, Madrid, April - May, 1958, so that further reference here is unnecessary. There was one other matter outside the normal scope of the Committee that was discussed at the Madrid Conference, that is, the formation of an International Association of Wood Technologists. This matter was discussed at the Paris Conference, but only limited progress had been made since. To encourage the formation of the Association, F.A.O. agreed to help out with the initial work leading up to the inaugural meeting of the Association.

An *ad hoc* committee was set up, with Dr. Thunell of the Swedish Forest Products Laboratory as Chairman, to collect all possible information on similar organizations to assist in drafting a constitution and assembling general ideas as to how the Association might be run. This *ad hoc* committee was world-wide in scope and included some fifteen or twenty delegates. Several informal meetings on the matter were held during the Conference, and the general feeling of all the delegates was that the Association should be run entirely by the wood technologists themselves, and that it should be started up in a modest way. It was suggested that a secretary and someone to assist the secretary would be needed. Keeping people informed as to what was happening in different parts of the world, putting wood technologists in touch with one another, and arranging conferences, meetings, etc., would be the major initial function.

I agreed to be a representative on the committee for the Australia - New Zealand region, and it was pointed out that it was hoped to hold a meeting of the committee during 1959. I pointed out the difficulty of representation from more distant countries for a purpose such as this. However, once we know when the conference is likely to be held we may be able to arrange representation from somebody from Australia or New Zealand who is overseas at that time.

It was generally agreed by those present in Madrid that the organization should not set up an examination for membership or maintain too strict a control over the academic qualifications required. This would be impracticable in view of the world-wide membership contemplated. The requirements for membership would be a reasonable technical education and an interest in the wood technological field. It could include anyone who was doing research or acting in a technical capacity in industry or in Government Departments. Thus, it would include our Research and Experimental Officers. However, it would not include, in the major grade of membership, people with training such as kiln operators.

The possibility of keeping people in touch through trade journals was discussed. In some countries it was felt that this means could not be used because of competition between the journals, so that this was a problem which would have to be worked out in the various countries. In Australia, we could get the Australian Timber Journal to publish periodical notes, and in New Zealand the New Zealand Timber Journal could do likewise.

It was felt that wood technologists in countries behind the iron curtain are likely to become members, and that this might help the difficult position of maintaining technical contact with these people. The rate for the major membership classification has not yet been fixed, but all agreed that it should not be too high; probably one, or at most, two guineas per year.

I would be interested to know whether such an Association would be likely to receive support in Australia.

After some discussion on the points raised, it was generally agreed that support would be forthcoming from Australia.

ITEM 9(b)

ASIA-PACIFIC FORESTRY COMMISSION

(i) BANDUNG CONFERENCE

The Fourth Meeting of the Asia-Pacific Forestry Commission was held in Bandung in 1957. There was no forest products delegate from Australia, although a considerable amount of information was prepared for the conference.

(ii) NEW DELHI CONFERENCE

The next conference was to have been held in 1959, but because of changes in the personnel in the F.A.O. Regional Office in Bangkok (Purkayastha has retired and has been replaced by Aung Din) it was decided to postpone the Fifth Meeting of the Commission until 1960. It will now be held in New Delhi in the second half of January and associated with it will be a meeting of the Teak Sub-Commission.

ITEM 9(c)

PRESERVATION CONFERENCE

F.A.O. propose to hold a Preservation Conference in 1959 to consider the setting up of a permanent committee dealing with preservation matters. This committee would probably ultimately come under the control of the Wood Technology Committee. Originally it was proposed to hold the preservation conference in this region, possibly in India, but it is now more probable that it will be held in Europe in 1959. The conference will be quite a small one of six to ten people who will be invited by F.A.O. to consult with them and advise on the setting up of the permanent preservation committee. (This conference has now been fixed for 1st to 4th December, 1959, in Rome).

ITEM 9(d)

PULP AND PAPER REGIONAL CONFERENCE

A conference on pulp and paper in the Asia-Pacific region, similar to that held in the Latin-America region, has been listed for 1960. It was originally proposed to hold it in 1959, but present indications are that it will be held in Japan in the second half of 1960.

ITEM 9(e)

WORLD FORESTRY CONFERENCE

This is to be held in Seattle in August, 1960.

ITEM 10. SAWMILLING

(a) GENERAL

Mr. Turnbull said that sawmilling equipment and techniques are under continual examination. A review of overseas practices and suggestions for Australian industry were delivered at the E.S.T.I.S. Conference (Port Macquarie), and also in Grafton and Brisbane, and published in the Australian Timber Journal.

The full potential saving of cutting to size on the breaking-down bench is not generally appreciated, and technical help is being given where required.

Sawing patterns on the species, E. sieberiana, E. regnans and E. obliqua have been studied in the laboratory with special interest in the effect of different sawing patterns on distortion. Balanced cutting on each side of the log was shown to be necessary.

ITEM 10(b)

SAWING INVESTIGATIONS*

(a) Studies of Breaking-Down Sawing

The last Conference suggested that a study should be made of breaking-down techniques on twin-circular saws to determine how their efficiency could be improved. A series of sawmill investigations was accordingly commenced in which typical twin-circular saw breaking-down machines were studied with respect to the times taken to perform the various operations, the sawing accuracy and the factors which affect the operational times and the sawing accuracy. The results of this

*Presented by Mr. Jones.

work were reported at the E.S.T.I.S. Conference held in April-May, 1958, and have since been published under the title "Improving the Work Balance between Breaking-Down and Benching".

The studies demonstrated that twin-circular breaking-down machines are not as a rule being utilized to their full capacity. Hence, if the accuracy of these machines were improved they could perform some of the heaviest and slowest cuts now made on the No.1 bench and could also deliver dimensioned flitches to the bench. Considerable savings in sawmill costs would then be achieved.

This work is complete.

(b) Power Studies in Sawmills

Following the last Conference the Division of Wood Technology of the Forestry Commission of New South Wales offered their assistance in extending this work into the State of New South Wales. The Division of Wood Technology was accordingly loaned the necessary equipment and is at present engaged in making power consumption studies in a representative selection of sawmills. An officer of the Division of Forest Products participated in the first study which was conducted at Bulahdelah, New South Wales, and the studies are being continued until the planned selection of mills is covered.

In addition, the Western Australian Forests Department conducted a power study in a Western Australian sawmill and equipment loaned by the Division of Forest Products was used. The results of this study are still being computed and analysed. Additional studies in other areas of Western Australia are proposed by the Forests Department and we will again loan them equipment for the work.

The co-operation of State bodies in extending this work to sawmills in other States, whenever opportunity arises, will be appreciated. It is not proposed to publish much about these studies until an Australia-wide picture of power requirements is obtained.

(c) Saw Speeds

A considerable amount of interest in the use of slower saw speeds has been stimulated in the sawmilling industry. The traditional rim speed for circular saws is 10,000 ft/min, but sawmill studies have shown very clearly that slower speeds have the following advantages:-

1. Power consumption is reduced.
2. Saws are more stable and cut straighter.
3. Saws last longer before needing sharpening.

These advantages showed up very strongly in species such as brush box (Tristania conferta) which are difficult to saw, and have virtually revolutionized the sawing of such species.

While it has been established that a rim speed of 7,000 ft/min is better than 10,000 ft/min we are by no means sure that this is the best speed for all conditions. Sawmill studies have been conducted at other saw speeds in a variety of species, and it is hoped to determine optimum speeds for some important sawing conditions. This work will also be continued in our laboratory sawmill.

The fact that saws are more stable and cut straighter when run slower leads one to consider the use of thinner saws to save on recovery. A sawmill study was recently conducted in Tasmania during which the sawing characteristics of saws of various gauges were studied at three saw speeds. The work covered both the twin-circular breaking-down machine and the No.1 bench. The results of this study are still being computed, but some interesting facts have already been revealed. For example, on the No.1 bench at rim speeds of 8,500 ft/min and 7,800 ft/min, 42 in., 12-gauge saws operated very well and are now being used regularly at 7,800 ft/min. The species sawn is mainly alpine ash (Eucalyptus gigantea). A 13-gauge blade sawed fairly well at the slowest speed, but its behaviour was too erratic to allow its constant use. Such gauge reductions on breast bench saws can effect useful gains in recovery.

On the twin-circular breaking-down machine 66 in., 9-gauge saws cut very well at a rim speed of 7,800 ft/min. This could lead to useful savings when breaking-down machines are used to prepare dimensioned flitches for the No.1 bench.

When considering saw speed, saw stability and plate thickness, saw tensioning must also be considered. Saw stability depends so much on tensioning that the above work is incomplete until more is known about the influence of tensioning on the results. Hence the above studies are now directing us towards a fundamental study of saw tensioning. Some preliminary work has already been done to determine how the stresses which result from a given amount of hammering can be measured.

(d) The Pendulum Dynamometer

This sawing research instrument has now been developed to an advanced stage and is being used to study the cutting properties of single teeth. Both the tangential and radial cutting forces can be measured with the pendulum. The tangential cutting force is determined using the fact that the angle of swing after cutting is proportional to the energy extracted in the tangential direction. The radial force is determined by measuring on a cathode ray oscilloscope the change in capacitance between two plates separated by a thin rubber pad. As far as we are aware, this is the only pendulum dynamometer in the world on which radial forces are being measured. A similar capacitance system is being perfected to measure the forces normal to the cutting direction.

(e) Studies of Clearance Angle for Circular Saws

In preliminary investigations of the clearance required for circular saw teeth ripsawing under Australian conditions, the wear of lacquer applied to the teeth was studied. Various clearance angles were applied to different teeth on the one saw in the range from 0° to 21° in increments of 3°. The bevels and hogs were accurately filed, using a special filing jig. Preliminary work with several species, feed speeds and depths of cut indicated that commonly used clearance angles are probably well chosen (even though the clearance required for controlled laboratory tests is generally less).

In an effort to reduce the effect of the variables attending the use of standard hogged teeth in these tests, later work has been done using flat-topped spring-set teeth. It has now become evident that a large number of hitherto unrecognized factors influence the clearances, which in theory and in the laboratory can be as small as 1° without interference on the tooth top. (For example, tooth deflections have caused excessive amounts of lacquer wear on the tops of teeth). The gradual identification of these factors is teaching us much about the operation of circular saws, and these studies are being continued.

In addition to the work done on saws, single teeth have been studied using the pendulum dynamometer. The results from the pendulum dynamometer have shown a much closer correlation with the results of accurately controlled tests at the saw bench than was anticipated, and this raises our confidence in pendulum dynamometer studies. This work is also continuing.

(f) Chain Saw Investigations

Chain saw studies have been continuing, and with the conclusion of the work reported in the article "The performance of scratch type power saw chains" attention was given to testing single teeth on the pendulum dynamometer. The first studies have dealt with the effect of clearance angle on the cutting forces, and they indicate that there is a disproportionate increase in the cutting forces when the clearance angle is reduced below $\frac{1}{2}°$.

Attention has been given to determining the conditions under which ripping can be achieved with chain saws. It was found that if the gouge-type chain were used and the teeth kept sharp, satisfactory ripping cuts could be made in logs.

Cutting tests on locally made chains are being conducted from time to time at the request of manufacturers, and advice given on tooth design for local conditions. A testing procedure for comparing the output of various chain saws in the field has been developed.

Discussion

Mr. Jennings said that some engineering appointments had recently been made to their staff in Queensland and they would be happy to co-operate with the Division of Forest Products on studies in sawmills.

ITEM 11

INVESTIGATIONS INTO THE ECONOMICS OF PLANTATION LOGGING*

About 18 months ago, the Division of Timber Supply Economics, Forestry and Timber Bureau, commenced an investigation into the costs of logging in plantations of *Pinus radiata* in the A.C.T. For the purpose of this investigation, the following operations were studied:-

1. Felling.
2. Trimming.
3. Cross cutting.
4. Snigging.
5. Loading.

From analysis of the results it appeared that loading and snigging were operations in which there was most room for improvement. Various methods of loading and snigging were then investigated with a view to ascertaining the effect of different sets of conditions and the methods most suitable to each.

*Presented by Mr. Blight.

The field study on loading methods has now been completed. The study on snigging is more difficult owing to the greater variations in conditions encountered, but the costs of some different methods have been studied and the trends of changes in these costs, as conditions change, have been ascertained. Reports on both loading and snigging studies will not be available for a few months owing to lack of staff needed to complete them.

It is now proposed to investigate other methods of loading and snigging giving particular attention to avoiding some of the unsatisfactory aspects of the methods already tested, such as increase in soil erosion and siltation which occasionally develop from them. In particular, attention will be given to up hill snigging as against down hill working.

Shortage of staff has permitted very little work being done on the other operations in logging in plantations, but when staff permits it is intended to extend the present studies to felling and hauling of logs in plantations and all the operations associated with logging in the native forest.

Discussion

Mr. Huddleston asked what are the indications of the results.

Mr. Blight replied that the study of loading methods indicated that the crane truck was the most satisfactory and economic. Next came parabuckling of full length logs as in Queensland. Next came the independent crane, then loading from ramps. A bad last in economic loading were hand loading methods. The study revealed that the cost of loading increased with the size of log being handled.

Of the South Australian type crane trucks, the heavier unit was the more economic in terms of volume carried and height raised.

Mr. Huddleston asked for copies of Forestry and Timber Bureau reports.

Mr. Jennings asked for copies of Forestry and Timber Bureau reports and gave a resume of logging investigations on hoop pine.

Investigations showed that a rise of 5/- per 100 super ft in extraction costs could mean a 20 per cent. loss in the nett return from a plantation. In parallel observations to those of the Forestry and Timber Bureau, there appeared to be little room for improvement in cutting but snigging and loading offered the best opportunities for cost improvement.

Felling is done by axe for small trees but trees over 26 in. G.B.H.O.B. must be felled by saw to reduce stumpage - too much waste in axe scarfing. Felling costs were 10d. per 100 super ft cheaper with axe than with hand saw. Nothing has been done on chain saws. Felling costs for average trees 27 in. G.B.H.O.B. are approximately 3/5d. per 100 super ft. The snigging studies showed indications that costs increase with increasing slope.

Mr. Blight requested copies of reports on the above work and asked was there any statistical correlation between cost and slope.

Mr. Jennings replied that it appeared that this might be so, but the study was a limited one.

Mr. Blight said he had found correlation of cost with horse snigging and distance but not with slope and volume, as there were so many side issues to confuse the investigation.

Cross-cutting time per unit area decreases with increase of log size, but this was not so with felling cuts. There was a 12 per cent. increase in cost of cross-cutting logs under 6 in. diameter.

Mr. Colwell queried the use of cable extraction.

Mr. Blight said he was very interested in cable extraction but he knew of none in softwood plantation logging.

Mr. Turnbull asked if cables were used in the Bright pine plantations.

Mr. Benallack said the cable system had been used but there were lots of difficulties, mainly due to the types of equipment being used. They were not successful so far. Cables, wood chutes and metal chutes had been tried.

Mr. Jennings mentioned the possible use of small portable Swiss winches, and said he had grave doubts about the use of expensive mechanical equipment for snigging. The capital investment had to be considered and the equipment must be operated without damage to remaining timber stand. Horses could be used on slopes up to 30°. Snigging distances were usually 5 chains and sometimes up to 8 chains to the roadway. Costs were around 5/- per 100 super ft.

Mr. Benallack agreed with the remarks of horse snigging versus mechanical snigging, but said in Bright and Ovens areas slopes were too steep for horses.

Mr. Reid said he had no reports on the operation of the Wyssen skyline, but it was still being used and seemed to be quite effective. Horses were also used for snigging thinnings.

Mr. Blight asked about damage to trees and the use of chutes.

Mr. Reid replied that damage was not serious but no specific studies had been done - could not comment on chutes.

Mr. Clarke stressed the need for operational research in logging and mentioned the operations of the British Forestry Commission in Scotland.

Mr. Huddleston agreed with Mr. Clarke and said logs were getting too big for horse snigging. Access roads were made for trucks but there were difficulties with cranes and logs churning up the road so that the trucks became bogged.

ITEM 12

REVIEW OF COLLABORATION IN RESEARCH ACTIVITIES

Mr. Huddleston mentioned that in New South Wales a commission investigating overlapping between various Government departments has had the effect of bringing people's attention to this overlapping. Generally speaking, the arrangements with the Division of Forest Products are very good. There is very little overlapping and, in some sections, there is complete agreement as to the work which will be done.

Because of the relationship between the Division of Forest Products and the Plywood Board, and the very high standard of work which is being done by Mr. Gottstein, there are requests for work to be done by officers of the Division of Forest Products. They are coming into New South Wales to do that work without advising the Division of Wood Technology that they are coming, with the result that an officer from the Division of Forest Products often visits a plant immediately following an officer from the Division of Wood Technology.

Mr. Huddleston said he would like to see some arrangement made where the Divisions can work in closer co-operation in this regard. They have no objection to the work being done by C.S.I.R.O., but do not like the position mentioned arising.

Mr. Clarke said that the problem with Plywood Investigations staff is difficult because this is sponsored work and arrangements for visits to plants are made through the Secretary of the Australian Plywood Board. Itineraries are usually flexible and are changed at short notice in response to special requests. The officers concerned are working long hours and it is only possible for them to keep in touch with the Division informally, usually by long distance telephone calls.

Under these circumstances it is not possible to keep other organizations fully informed of officers' movements. Mr. Clarke said that the Division would do everything possible to alleviate the situation, but he was not hopeful of this being at all adequate.

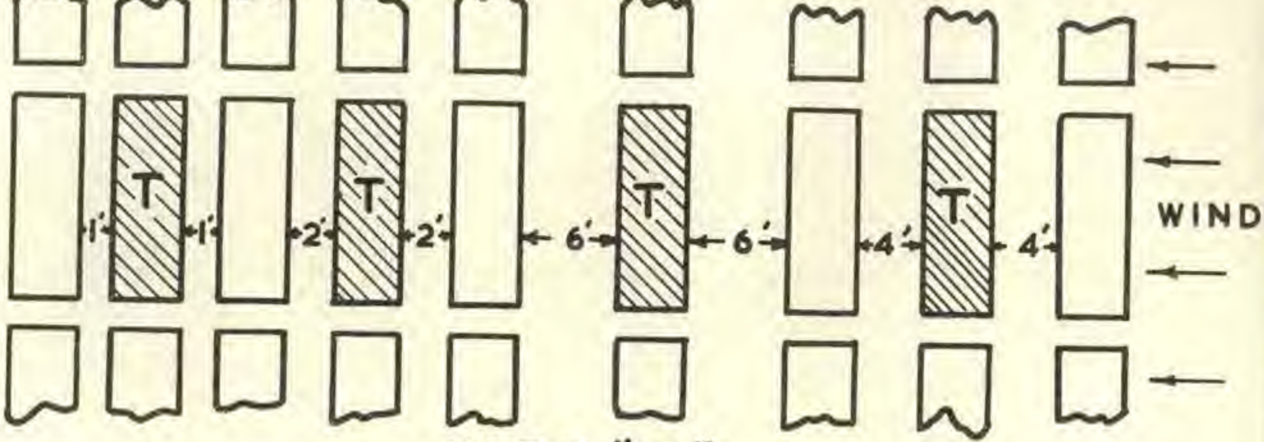
Mr. Jennings said he had discussed this matter with Mr. Gottstein, and he appreciated the problems involved. He offered the co-operation of an officer in North Queensland who could be of material assistance.

Mr. Huddleston said that in the building research field there is the question of the set-up between the Division of Building Research, the Commonwealth Experimental Building Station and the Division of Forest Products. For example, the Commonwealth Experimental Research Station puts out designs for nailed roof trusses, the Division of Forest Products is interested in domestic roofs, and there is a suggestion that the Experimental Building Station proposes to extend that work into free designs of roof trusses. The Division of Forest Products is proposing to publish suitable designs for roof trusses and it appears there is some overlapping. He thought that this work should be co-ordinated.

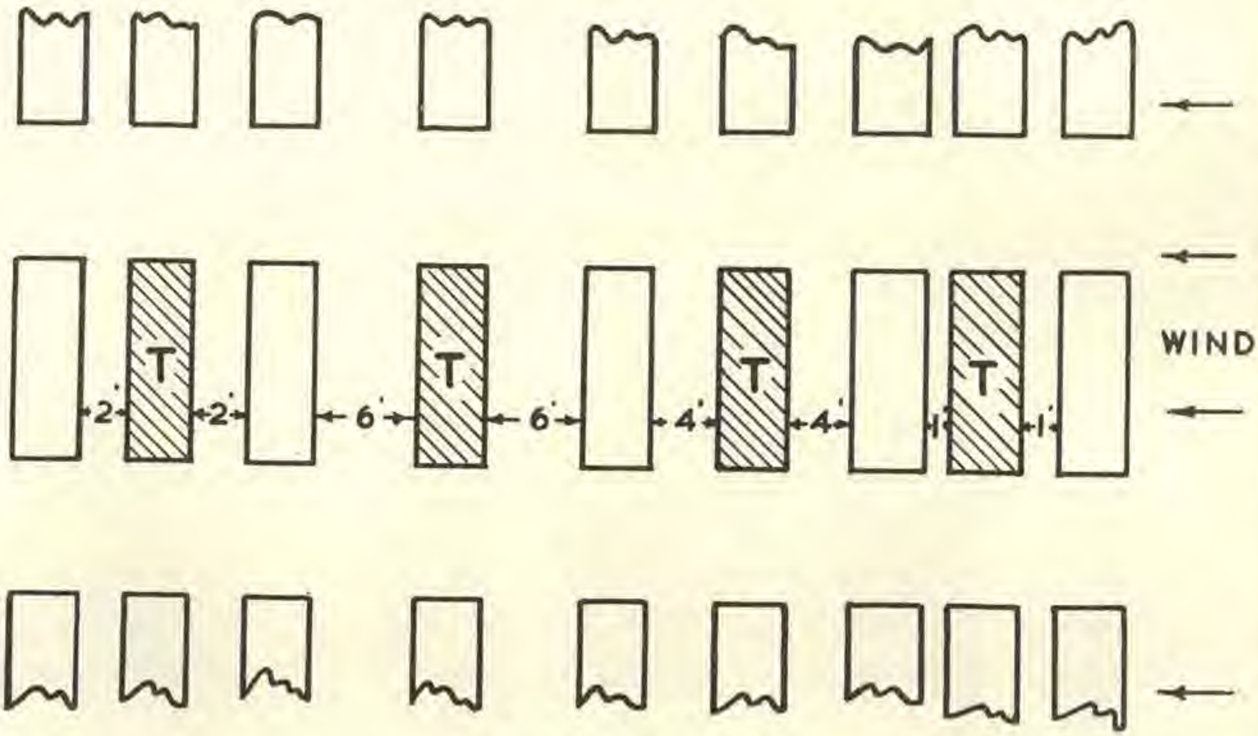
Mr. Clarke explained that the Commonwealth Experimental Building Station's programme of work is discussed by the Building Research Committee to see there is no serious overlap. The programme is also brought before Building Research and Development Advisory Committee, chaired by Professor Francis, where further consideration is given to see where there is any serious overlapping. That Committee in all its deliberations has not considered that there has been any serious overlapping between the Division of Forest Products and the Commonwealth Experimental Building Station. No more can be done - two committees are looking after the question. The policy of the Division of Forest Products is to encourage other organizations to do further work wherever possible.

Mr. Huddleston asked if some publicity could be given so that this arrangement is known.

Mr. Clarke said the Building Research Liaison Service does that. They are represented on both committees and do liaison work between all research bodies and the building industry. There is a large amount of publicity being done on the work of the various organizations concerned in Building Research, and more would not be justified, as already the contribution of information, etc. to the liaison service takes up a considerable amount of research officers' time.

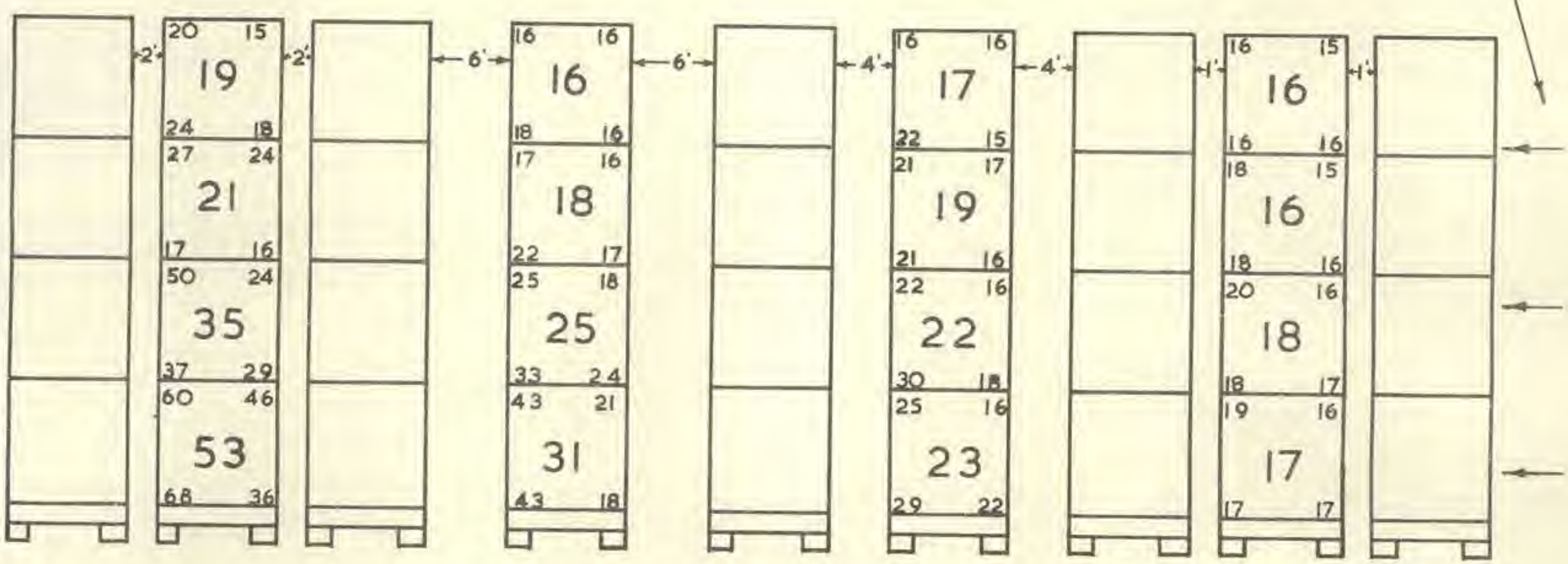


YARD "C"



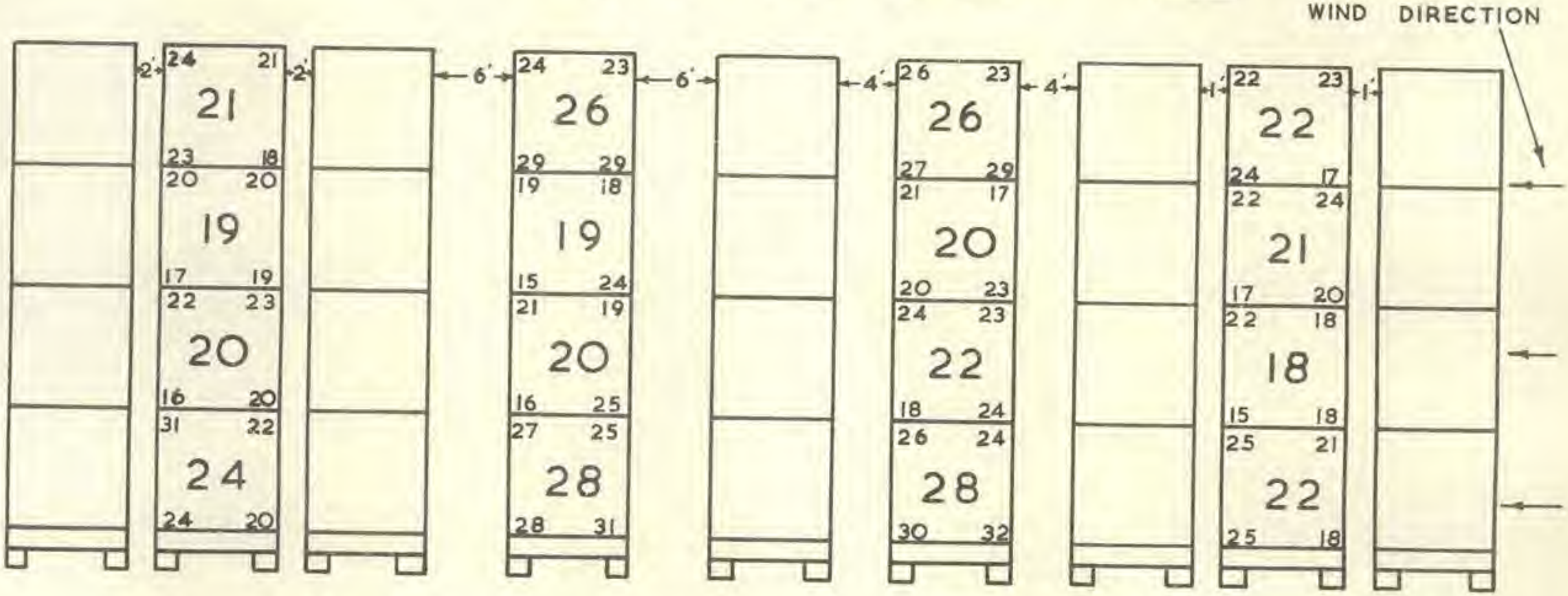
YARD "E"

YARD "A"



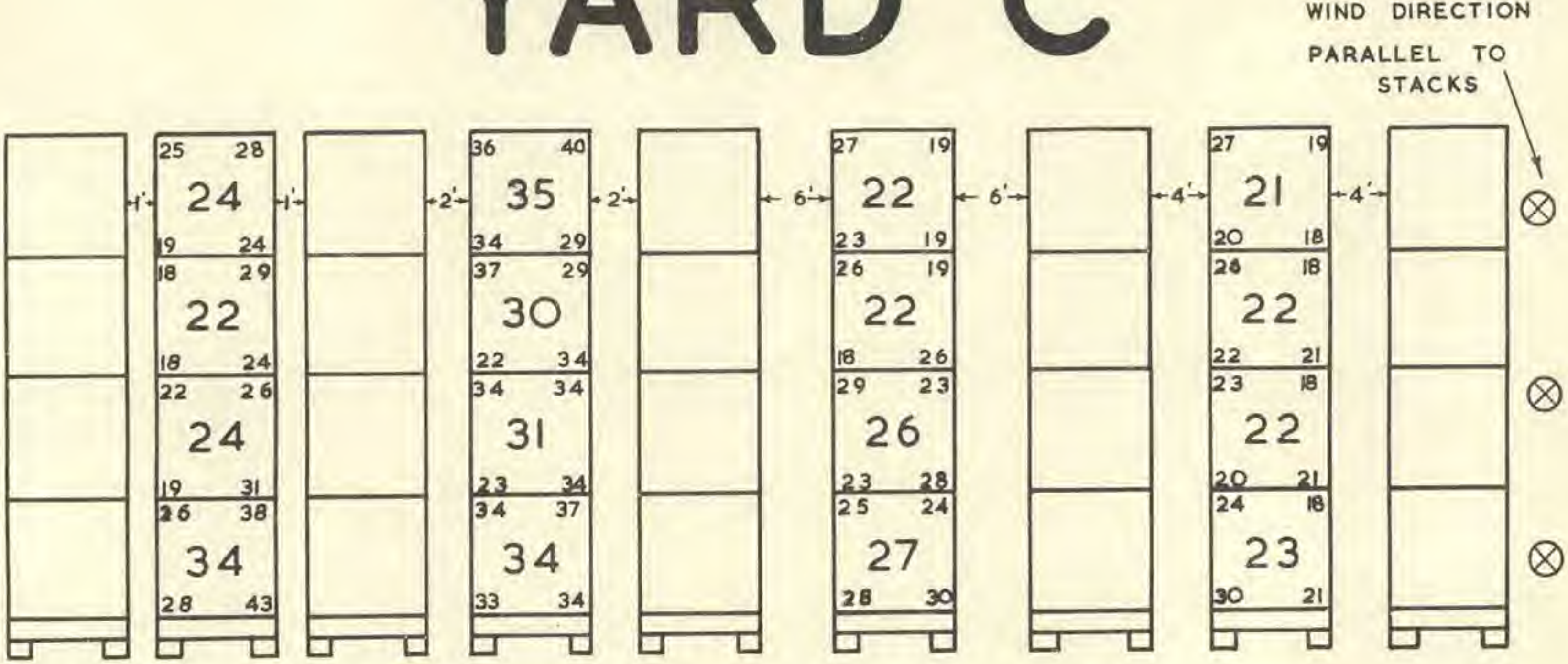
1 IN. MATERIAL AFTER 63 DAYS DRYING.

YARD "E"

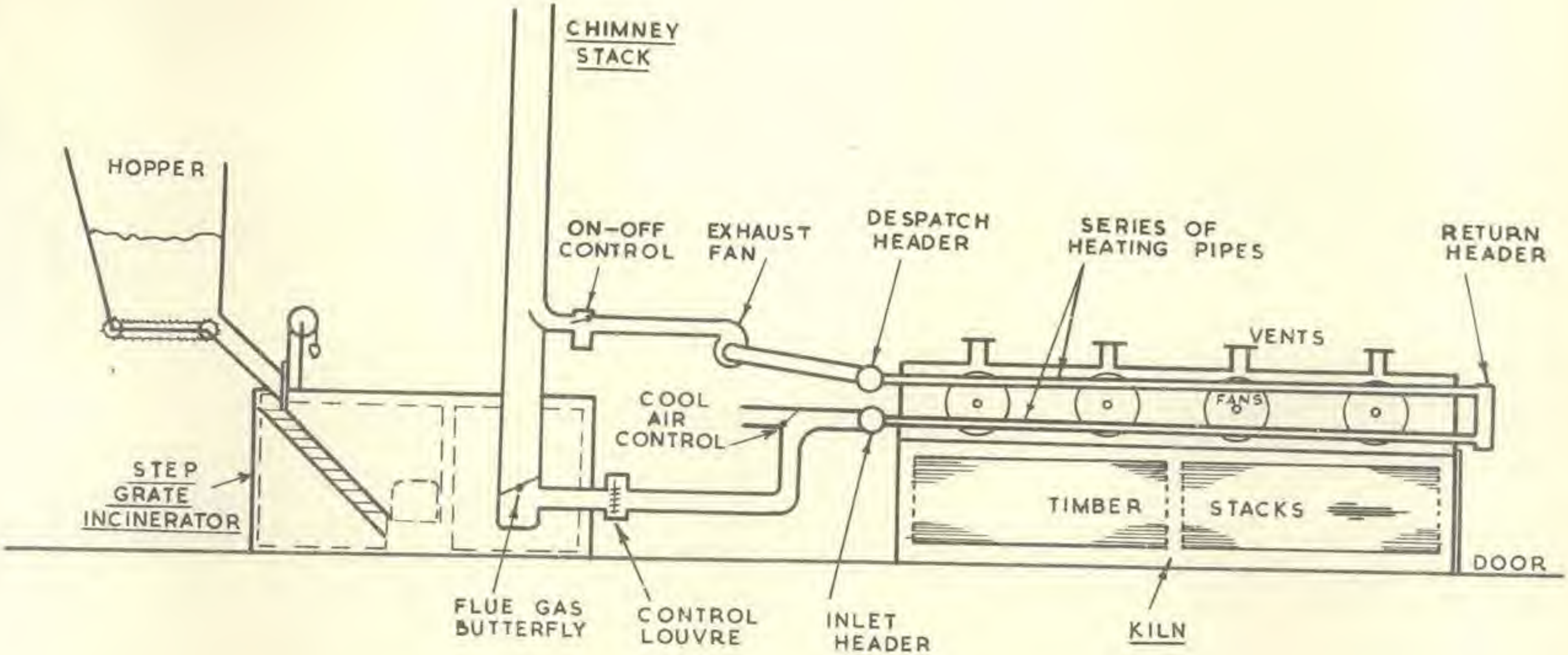


$1\frac{1}{2}$ IN. MATERIAL AFTER 45 DAYS DRYING

YARD "C"



1¼ IN. MATERIAL AFTER 67 DAYS DRYING



SCHEMATIC LAYOUT FOR HEATING KILNS BY FURNACE GAS

DISTORTION IN 4" X 2" RADIATA PINE DURING DRYING FROM GREEN TO 12 %

W — WEIGHTED DURING DRYING APPROX. 70 LB / SQ. FT.

UNW — UNWEIGHTED DURING DRYING

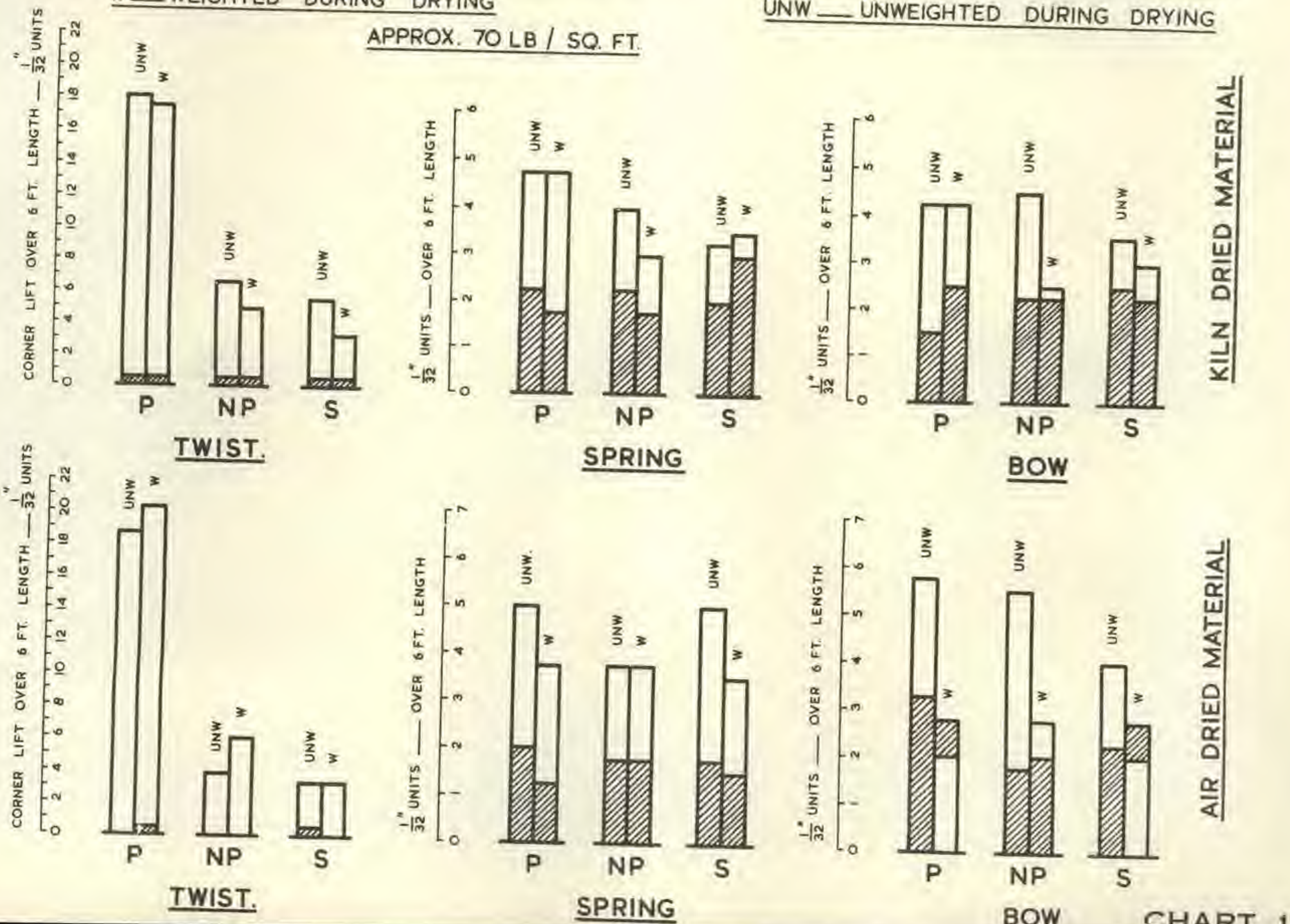
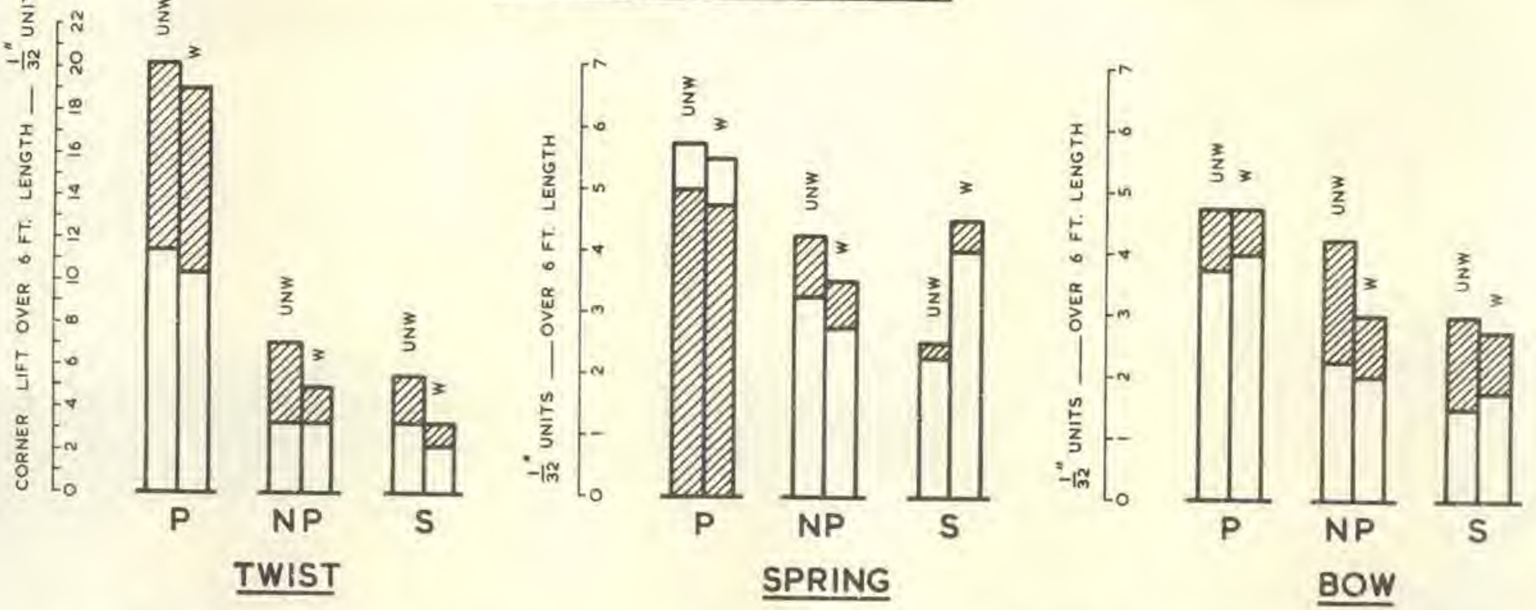


CHART 1

EFFECT OF STEAMING 4" X 2" K.D. PINUS RADIATA SCANTLING UNDER RESTRAINT TO REDUCE DISTORTION



P — PITH INCLUDED MATERIAL

N.P — MATERIAL FROM NEAR PITH BUT NOT INCLUDING PITH

S — MATERIAL FROM NEAR SAPWOOD

W — WEIGHTED DURING DRYING - APPROX 70 LB / SQ FT

UNW — UNWEIGHTED DURING DRYING

▨ — BEFORE STEAMING

☐ — AFTER STEAMING

CHART 2

Shear Strength of Phenolic Glue on Boron Impregnated and Unimmunized Coachwood with Various Setting Times