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TWELFTH

FOREST PRODUCTS RESEARCH CONFERENCE

HELD AT

THE DIVISION OF FOREST PRODUCTS,

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION,

MELBOURNE

JUNE 21-25, 1965

Forestry and Timber Bureau
Library

REPRESENTATION

Division of Forest Products	- J. D. Boyd (Chairman) A. P. Wymond (Secretary) Dr. W. E. Cohen, W. E. Hillis, Dr. H. G. Higgins, R. S. T. Kingston, N. Tamblyn, N. H. Kloot, G. W. Wright, J. W. Gottstein, R. F. Turnbull.
New South Wales	- W. D. Muir, P. Marshall, D. W. Edwards, H. E. Booth, L. H. Bryant.
Queensland	- T. F. Ryley, K. Cokley, W. Smith, N. McConochie
Victoria	- C. W. Elsey, A. J. Threader. (W. Clifford, C. Irvine and A. L. Benallack attended part-time only.)
South Australia	- J. Willington, J. H. Harding, J. Thomas.
Western Australia	- H. C. Wickett.
Forestry and Timber Bureau	- Dr. M. Jacobs, Dr. J. M. Fielding, A. J. Hanson.
Papua-New Guinea	- J. Colwell.
New Zealand	- Dr. J. M. Uprichard, I. Whiteside.
Division of Entomology, CSIRO	- F. J. Gay.
	Observers
Melbourne University	- J. Chinner
U.S. Forest Products Laboratory	- Dr. Richard F. Blomquist

CONTENTS

Page

ITEM 1. WOOD AND FIBRE STRUCTURE

Item 1(a). Review of Research Activities

1. DIVISION OF FOREST PRODUCTS *

The object of the Section's work is to provide accurate data concerning the structure and some of the properties of wood and to gain a better understanding of wood growth. This information will assist the formulation of theories regarding the behaviour of wood in different applications. Also, with the increasing emphasis on wood quality these data are needed to achieve advancement in this direction.

Over the past 2 years, the work carried out included the following aspects.

Identification of Wood. - In addition to routine identifications (about 950), botanically supported wood material from New Guinea and Fiji has been examined. Preparation and revision of cards for microscopic and macroscopic card-sorting keys has been continued.

Fine Structure. - The study of the path of penetration of liquids into and out of wood was continued. Wood has been treated with pulping liquor to the stage when the liquor has reached the middle lamella and caused incipient separation of the fibres. After this stage, liquids preferentially flow through the spaces between fibres, instead of from lumen to lumen via the pits.

An examination of the nature of bonding between fibres in paper sheets has commenced. Sheets made from all types of pulps from E. regnans and P. radiata are being examined in surface view and in section under the electron microscope. It is also hoped to provide photographic evidence of differences in paper quality and to compare

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* Prepared by W. E. Hillis

the papers prepared from different types of pulp. Strong microscopic evidence in favour of the hydrogen bond theory of bonding has already been obtained.

In co-operation with Dr. M. Harada, Japan, a project has been commenced to examine in the electron microscope, the glue line, glue penetration and the role of fillers in glues used for plywood.

The tyloses which block the lumen of the vessels in many hardwoods have been examined. The wall consists of two layers with different orientation of the microfibrils. The outer wall is covered with a granular deposit which may further prevent penetration of the tylosis wall. The tyloses develop by the formation of a distinct layer inside the secondary wall of the ray cell.

An attempt to determine the porosity of the cell wall by means of interference microscopy and other optical methods has been commenced. Previous determinations, based on absorption, have provided evidence suggesting that the dry cell wall has no permanent sub-microscopic capillaries, but this view has recently been questioned on the basis of measurements involving density and cell wall area.

Ultrastructure. - Ultrastructural studies have been undertaken to substantiate and extend information on the fine structure. The development of the primary and secondary walls in Eucalyptus eleophora and Araucaria excelsa has been followed and the involvement of organelles in the cytoplasm at different stages has been indicated. The cellulose microfibrils appear to be formed within the cytoplasm, the plasmalemma breaks down temporarily and the microfibril passes into the cell wall. At the ultrastructural level, the polyphenols (tannins) in Pinus radiata are secreted directly into the tanniferous vesicles in the cytoplasm, whereas in E. eleophora they are formed in the amyloplast following decomposition of starch. The formation of calcium oxalate and silica crystals has also been studied.

A study is being made into the nature of the vital relationship between the tree root and mycorrhizal fungi in order to explain how this very desirable symbiosis can, under adverse conditions, turn into a parasitic condition. When the fungus exists to the benefit of the tree the fungal hyphae penetrate between the cells of the root of P. radiata which retain their normal cell wall structure. The cells usually retain their normal cytoplasmic structure, and do not produce material to inhibit the spread of the fungi.

Reaction Wood. - The extent to which the "gelatinous" layer of reaction wood fibres undergoes lignification, depends on its location. There is evidence for the diffusion into this layer of the breakdown products of cell protoplasts. As the growing season advances, there is a progressive reduction in the number of cambial cells dividing to form reaction fibres.

Anomalous cases of reaction wood anatomy have been investigated. Lagunaria pattersoni, for example, formed reaction wood fibres which differed from normal fibres only in the thinness of their walls and their relatively large cross-sectional area; no "gelatinous" layer was present. There appeared to be changes in the microfibril orientation of the S_2 layer of primary phloem fibres. This and other features must be considered in relation to the mechanisms which cause recovery to a vertical position. Woody monocotyledons also have anomalous reaction anatomy.

Pathological Plant Anatomy. - The anatomy of Apple var. Lord Lambourne infected with "rubbery wood" virus, and of Apple var. Gravenstein infected with "flat-limb" virus has been examined. In the former case, infected wood was similar to reaction wood anatomically. The lignin content of infected wood was low, but the rubberiness was attributed to reduced lignin-carbohydrate bonding. In the case of "flat-limb" virus infected trees, wood and phloem structure were both abnormal. There were associated increases in the contents of starch and extractives in the wood. The anatomy of cankered stem of Exocarpus cupressiformis and Acacia mucronata have also been examined.

Lignin and Lignification. - Various aspects of this project have been examined. The degree of condensation of lignin has been assessed from the NMR spectra. Experimental evidence shows that ellagic acid does not combine with lignin in the wood, but the two may react together during isolational procedures or during pulping. The lignin of reaction wood formed artificially by bending or by chemical treatment, is very similar to naturally occurring reaction wood lignin except in the case of Lagunaria pattersoni. Colour tests (phloroglucinol and chlorine-sodium sulphite) show that differences exist between the lignins of different tissues of the same tree.

Biosynthetic studies of lignification have been continued by infusing intermediates and labelled compounds into growing shoots of E. botryoides.

Kino Veins. - A study on the development of kino veins in Eucalyptus obliqua has shown that they develop in a layer of traumatic parenchyma laid down by the vascular cambium about 10-15 days after wounding the tree trunk. Quite large quantities of polyphenols were accumulated in these traumatic parenchyma cells and later, about 30 days after wounding, groups of the cells broke down, forming a lumen or vein into which the cell contents were released. These cell contents formed the kino of the vein and it is thought that the kino becomes more concentrated as the vein develops, owing to the osmotic withdrawal of water from the vein. By 50 days after wounding, the veins had become lined by a layer of suberised cells closely resembling a typical periderm. This brings the secretory activity of the vein to an end.

The Study of Cell Contents. - Work has continued on the determination of the factors controlling the amount and type of polyphenols in wood. A study of kino formation in ash-type eucalypts has indicated some of the enzymes responsible for its formation and the principles determined in this work have been extended and confirmed by initiating heartwood formation in trees. A study of the formation of extractives in Pinus radiata as a result of insect and mechanical injury has been commenced. Radioactive compounds have been fed to eucalypt leaves to show the inter-relationship of several classes of polyphenols that are important in commercial timbers. Evidence from this and other studies indicates that the ratio of certain classes of extractives can be changed by certain conditions.

In collaboration with Utilization Section, the blunting of cutters when used with green wood has been shown to be largely due to corrosion and in particular to that caused by polyphenols. Blunting can be greatly reduced by applying a negative potential to the cutter. The discoloration of pulps and timbers has been investigated also.

To provide basic data for several projects, the leaves of 316 Eucalyptus species have been examined. The composition of the polyphenols is insufficient to enable the identification of a species but it is a useful taxonomic criterion as it provides an independent check of the conclusions drawn from botanical features. The composition unambiguously supports recent re-classifications of certain species and indicates other possibly erroneous classifications. The examination of samples of E. camaldulensis collected from throughout Australia and E. sideroxylon from most areas of its habitat indicate the possibility of determining the provenance of a tree from the composition of the leaf polyphenols. With the former species, hybrids were detected independently of field data, and the possible parents indicated. The technique may prove useful when attempting to determine the origin of elite trees. The co-operation of the Forestry Departments and others in supplying leaf samples is gratefully acknowledged.

Improvement of Wood Characteristics. - Three studies have been conducted to obtain estimates of heritability for important wood characteristics. Narrow sense heritabilities were obtained for open-pollinated P. radiata and P. elliottii progenies, and currently gross heritabilities are being calculated from the results of an examination of the wood of mature P. radiata clones.

Specimens from several groups of pine trees have been assessed for wood quality. These included P. brutia and P. pinaster trees from Western Australia and P. radiata from South Australia. Four geographic races were represented in the P. pinaster group and results indicated the extent of differences in wood characteristics between races. Additionally, results were compared with those from a previous project to show the effect of soil differences on wood characteristics.

The effect of rate of growth was studied by examining clonal specimens of P. radiata, and currently, P. pinaster specimens are being used in a joint project with the Timber Mechanics Section, to obtain a regression for strength in relation to wood characteristics.

11. QUEENSLAND.

Approximately 3,000 recorded routine identifications were made during the past year, in addition to a large number of unrecorded determinations for multi-salt preservation tests. About 200 species, local and imported, were represented.

The major work during the period under review, involved heritability and wood quality assessment studies in connection with our coniferous tree-breeding programme. This is briefly summarised under a separate Agenda item.

A study of the incidence and cause of pitch-streaks and heart-shakes in P. elliottii has been completed and results should be published shortly. It has been concluded that these are caused primarily by normal stem growth stresses, intensified by enclosure of live branches and lateral roots; that their incidence and extent are relatable to branch size, number and angle and are reduced by pruning; that extension of present pruning practice to a larger proportion of stems and to higher levels at later ages should be advantageous; that pre-selection of seed-orchard candidates for improved branching characteristics should reduce incidence and extent in future stock.

An investigation of stock/scion incompatibility in Araucaria cunninghamii is continuing. Examination of sectioned material so far shows no obvious fault in grafting technique but this needs further study. Initial indications are that grafting of high-vigour scions to relatively lower-vigour stock may be a major factor in delayed failure but, again, no firm conclusion can yet be drawn.

Intra-ring variation in tracheid length in P. elliottii has been studied to determine sampling procedures for parent-tree assessment and heritability work. From this, it has been decided to use whole-ring and/or strip-mean values.

Resin and bark pockets, especially in P. patula, have been under study, but little further work on this may be necessary, in view of recently-located published work on apparently the same defect by Frey-Wyssling, who attributes this to abnormal localised cambial activity following the development of radial checks in the cambial zone due to wind action.

The effect of thinning on the anatomical, physical and mechanical properties of the wood and graded recovery in A. cunninghamii is being investigated.

111. NEW ZEALAND

*Research on heartwood formation in radiata pine has been directed towards the oleoresin enrichment of the heartwood (i.e. the means by which heartwood of old trees becomes more resinous than that of young trees). Holes drilled into the heartwood, (vertically into the heartwood of topped trees, or horizontally into standing trees) become resinous. Chemical analysis by gas chromatography of resin exuded into heartwood, resin-enriched heartwood, resin-enriched late wood, resin exuded into sapwood, resin-enriched sapwood, and normal heartwood and sapwood are being used to detect the type of resin involved, whether fatty acid or resin acid, and

* Prepared by J. Maddern Harris.

the amounts of pinosylvin. It is hoped that these results will indicate the source of the additional heartwood resins.

** A study of the secondary xylem of Dacrydium species is being made with a view to develop methods for their identification. The species under investigation are D.biforme, D.bidwillii, D.colensoi, D. cupressium, D.intermedium, D.kirkii and D.laxifolium. For each species authentic samples have been collected from six trees growing in a wide range of areas. Some of the differences between the species are:-

(i) Nature of growth rings

(ii) Presence or absence of axial parenchyma, spiral thickening and pitting on tangential walls of tracheids

(iii) Number and type of pits in a cross field

(iv) Intensity of pitting on the horizontal walls of ray cells.

An interesting feature which has been recorded for the first time is the occurrence of fine spiral thickening in the tracheids of D.cupressium. These spirals are quite distinct in trees grown in Rotorua district but those grown in other parts of New Zealand show very faint spirals which are often incipient and are almost always confined to the tracheid ends. Eau de Javelle proved to be an excellent clearing agent for resin, protoplasmic residue etc. and thus facilitated the study of cross field pits. From the results obtained so far, it is hoped to improve on the current identification key and/or develop a more positive key, particularly with respect to some of the more difficult species.

* There are 3 programmes in which the Forest Products branch is co-operating on the genetics of P. radiata and effect of environment in wood properties.

(i) An experiment with open pollinated seed from 300 trees (50 mother-trees in each of 6 populations, 4 natural and 2 cultivated) in which it is also hoped to include clones raised from cutting.

** Prepared by R. N. Patel.
* " " J. Maddern Harris.

(ii) In view of the difficulties of interpreting results from open-pollinated families there is also an experiment using a partial dialled cross. (M.H. Bannister - World Consultation on Forest Genetics 1963).

(iii) A study using nine clones as there own roots replicated 5 times on each of 7 sites. Plus, on 3 sites, 5 clonal grafts of 5 ages (1, 10, 20, 30, 60 yrs.) and 5 clonal rooted cuttings of 10 and 30 yrs. each replicated 4 times. Interspersed with control pollinated stock at 8 x 8 ft. spacing.

Discussion

Smith: In relation to the improvement of wood characteristics, I note that work is currently in progress on older clones in P. radiata. What is the age and location of these clones, and, in relation to the current work, how many clones are being studied?

Nicholls: The clones are located at Mt. Burr. They are from 1940 stock which was originally put down by Dr. Fielding and are now in the charge of Mr. Pawsey. We are sampling three trees from each of 19 clones. We hope to follow this up with further work on clones which I think were put down in Canberra by Dr. Jacobs and we hope to start that latter work as soon as it is possible for the Forestry and Timber Bureau to supply personnel to sample them.

Fielding: I take it that no narrow sense heritability work is at present projected.

Nicholls: No, because of lack of suitable material which we feel should be of the control-pollinated type in most cases.

Fielding: Could you give any information on the work you are doing on the effect of soil differences on wood quality?.

Nicholls: I have been working on some P. pinaster material from 2 sites which are sufficiently closely related geographically to share the one climate but which do differ as regards edaphic characteristics. Investigating wood characteristics, we found no differences between site for spiral grain or basic density, significant differences for late wood content, which we ascribe to differences in moisture holding capacity of the site, and we feel we have also uncovered differences at a significant level for fibre length, but we want to confirm this by the examination of more material.

Item 1(b). Assessment of the wood properties of superior trees of P. radiata *

The variation in spiral grain on different sides of trees of P. radiata has been investigated. The amount of variation found is of the order of the amount of variation found from pith to bark in the same tree.

In this study, whole discs from two levels in 10 trees were available and the angle of the grain was measured along 8 radii spaced 45° apart. The great variation found on different sides suggests that sampling along one or two radii is not sufficient to give an accurate picture of the whole cross section. Sampling along 4 radii (90° intervals) appears to be quite satisfactory.

The 11mm increment core has been tested against samples sawn from the tree for the assessment of spiral grain. Where the cores were taken from alongside the sawn samples, considerable differences between the two methods were found. However, when the 11mm core and the sawn sample were in the same vertical line the differences were much less. It is felt that the principal contributing factor to this lack of agreement in samples taken at the same level is the large component of variation on different sides.

A source of error in the 11mm increment core is the bend or "kink" which is often found in the outer portion. In straightening bent cores for the preparation of a reference face, a twist could develop. The bend can be largely eliminated by using a starting block.

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* N. S. W.

Further refinements are being made to the Nicholls and Santer sampling device. The first is the use of a lightweight chain saw motor with the morticing blade fitted in place of the standard chain-saw blade. The second refinement is a rotating jig which will enable the saw to be positioned for the various cuts without the saw having to be removed from the holding jig between cuts.

Differences between sites in respect to both basic density and fibre length have been found. These were both of the order of 15 per cent (approximate). Both seemed to show a negative relationship with rate of growth. Spiral grain was not found to be different between sites.

It is concluded that, where basic density and fibre length are being used in tree assessment, site means should be available for the purposes of comparison.

It is suggested that the conference should give some attention to the matter of developing standards and standard procedures for the assessment of wood characters of elite trees of P. radiata. Co-ordination also of the research into wood properties being undertaken by the various bodies is also desirable. It may be desirable to have a meeting of the people working in these fields so that both standards and standard procedures could be decided on.

Discussion

Smith: Standardisation of experimental procedures should apply to all species, not just P. radiata, and this will be proposed at the forthcoming IUFRO Conference.

Bryant: Mr. Bamber is mainly worried about the spiral grain factor, which in the past was concentrated on one or two points of reference within the tree. We feel now that there should be more attention given to this.

Smith: We usually use an average of two opposite radii. Has the Division of Forest Products any results or observations similar to the Division of Wood Technology?.

Nicholls: We have already drawn attention to the large unsystematic circumferential variation in grain inclination and we have suggested that 4 radii be sampled to provide the most representative determination of grain inclination (this was embodied in material that we presented at the last IUFRO Conference at Madison in 1963). However, two randomly oriented diametrical specimens at right-angles to each other may not always be acceptable sampling procedure. Three sampling procedures have been proposed; (1) A single diametrical strip may be used so that two radii can be sampled to provide a representative picture of grain inclination and this may give a fair indication for practical purposes; alternatively, (2) the sampling direction could be a random choice because no relationship could be established between the maximum grain deviation along the radius and that in the wood adjacent to the bark. However, there is a correlation between the average grain deviation along the radius and the tilt in the fibres in the last formed wood, so that initial investigation around the tree through windows cut in the bark can be of benefit to designate the best sampling direction and enable a good estimate of the mean to be determined from a single strip. (3) The examination of a single diametrical strip may be sufficient to reject a tree. If not, a second specimen can be taken and the tree will be passed, or not, on the grounds of grain inclination. It is then worthwhile doing further work to assess for other factors such as fibre length and basic density. With respect to the form of the specimen for the measurement of grain inclination, we have analysed results based upon, firstly, large specimens, secondly, prepared 11 mm dowels, and 11 mm cores taken in the normal way. All these were taken in the same direction in the tree. By this means we could observe the effect of specimen size reduction, and separately, the effect of the boring operation, on the precision of measurement. It was concluded that 11 mm borings were not suitable for assessing grain inclination on the following grounds:

(i) the 11 mm size did not provide a sufficient gauge length to obtain representative data,

(ii) specimens were not rigid enough to withstand distortion due to handling, or stress release and,

(iii) the action of boring imparted a "wind" to the core.

We would have liked to have incorporated Division of Wood Technology's second refinement in the pilot model, but were unable to do so because of economic limitations. We did mention this particular aim at the time of publication. In talking about extraction of samples, I would like to draw attention to a development at Mt. Burr using a modified plug cutter which is proving quite useful. In fact, we have conducted our latest heritability project using nothing but those cores. With regard to the question of site differences which I mentioned before, we think we may have determined some site difference not necessarily related to rate of growth, but related to edaphic factors, but we would like time to confirm these before we make any announcement.

Smith: We have had similar difficulties in relation to twisting of cores and have found that the starting block obviates much of this difficulty. We feel that in certain cases, particularly in the assessment of wood properties in really small stock, the use of increment cores has much to commend it. We have found it absolutely necessary in wood quality assessment of potential parent trees of P. cariboea where the age ranged from 9 to 17 yr.

Willington: So far there has been no reference to compression wood, but from observations made in our area there seems to be a very definite relationship between compression wood and spiral grain. The information we have tends to suggest that in the presence of compression wood there is an absence of spiral grain and this of course means that this could be leading to some of the variations in spiral grain around the different radii in the tree.

Fielding: I am very surprised that Mr. Bamber found a big variation around the tree. How did he actually measure spiral grain; did he measure the spiral with relation to the axis of the pith or the axis of the sheath of wood around the tree.

Bryant: So far as I know it is being measured in relation to a vertical line on the outside of the tree.

Smith: Mr. Bamber excercises great care to determine the long axis on the relatively small sample and to ensure the serial specimens cut are truly oriented in relation to that axis. He has developed a special jig for the preparation of a planed face at right angles to the long axis of the stem and I feel that the validity of his results is probably unquestionable. I am surprised that he has found relatively little difference vertically over short distances. We have observed a difference of as much as 8° over a 4 in. vertical distance.

Nicholls: On a number of occasions, we have investigated fully around the tree both circumferentially and up and down and even though there has been compression wood formation within the area of search, this has had no influence on spiral grain determination. I would point out that most people who are investigating spiral grain as part of the normal assessment for wood quality naturally enough avoid compression wood. In the trees that we have investigated, in the lower reaches of the trunk at least, we have found grain inclination to be invarient as regards height.

Jacobs: Our trouble with spiral grain is that it is causing twists over quite long distances rather than in small pieces and in recording spiral grain it is very important to record whether it is clockwise relative to the vertical axis, or anti-clockwise. Generally, in the pines like radiata it is almost always clockwise looking down on the tree, but in Hobart there appears to be about 5 or 10 per cent of the second generation which is anti-clockwise.

Irvine: In dealing with Victoria's plus trees, I think that the Division of Forest Products examined samples from about 30 different trees and we eliminated 6 because of spiral grain, and present thoughts are that we should perhaps have only kept 6.

This consideration is based upon the possibility that spiral grain is genetically controlled and it might be better to start off with a much better standard of plus trees.

Item 1(c). Progress in Wood Quality Assessment and Inheritance Studies in Queensland. *

Preliminary narrow-sense heritability estimates have been determined for a number of wood characteristics in morphologically pre-selected P. elliottii, some of the experimental observations being made by the Division of Forest Products. Estimates were calculated for spiral grain, basic density, percent latewood, ring width, tracheid length and micellar angle. Results from two different experimental approaches using the same material showed quite dissimilar estimates for certain basic characteristics, indicating the need for further consideration of methodology if estimates are to be of economic significance.

Estimates from strip mean data can be considerably higher or lower than those from data for individual rings or segments thereof, depending on the characteristics, and strip mean estimates are, in general, considered to be more meaningful economically in wood quality improvement programmes.

The heritability of vigour and several stem and branching traits is also being determined, using the same trees; and phenotypic, genotypic and environmental correlations between morphological and wood characteristics calculated with a view to determining the effect of preselection for certain external features on wood quality indicators.

From results available, it appears that selection for vigour can be expected to bring about reduction in basic density in the progeny in at least the first ten-year increment ($r_G = -0.69$**);

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* Prepared by W. J. Smith.

Low basic density and high mean tracheid length, low micellar angle and low percent latewood are apparently not genetically antagonistic objectives. Basic density and percent latewood were very highly correlated genotypically over at least the first 10 years.

Wood quality assessment of potential seed-orchard trees preselected for superior vigour and morphological characteristics is continuing. Observations on 17 trees in the Beerwah P. elliottii seed-orchard have been completed and comparative ratings are being determined. Final evaluation of the wood quality of all trees in the two existing P. elliottii seed-orchards, one containing 38 and the other 15 clones, will then be possible.

30 pre-selections for the proposed Mary Valley A. cunninghamii seed-orchard have been assessed for wood quality by an objective ranking technique using a combination of trend-lines and strip-means. This is aimed, for the present, at ensuring that wood quality indicators in initial seed-orchard representatives shall be of satisfactory standard, rather than superior. Characteristics considered are spiral grain, basic density, compression wood, tracheid length, micellar angle and, in Pinus spp., percent latewood. The ultimate objective is to continue selection until seed orchards can be established using morphologically superior trees all with all wood characteristics and summations scoring in the upper third of the population range. In A. cunninghamii, only 7% of the trees examined to date fall in this category; 16% in the upper half of that range; and 33% in the upper two-thirds. 21 of 30 trees have summations and spiral grain scores to the minimum standards set.

Wood quality assessment of 23 pre-selections for a proposed P. caribaea seed-orchard in North Queensland is almost completed. Spiral grain, tracheid length and micellar angle values are generally good to 15 years; percent latewood satisfactorily low in most trees examined; and basic density, while quite variable between trees, mostly within the normal range for hoop pine.

Discussion

Nicholls: I presume that the two methods referred to in the first 2 paragraphs have been compared by calculating some sort of weighted mean from individual ring data, and this is to be contrasted with the strip means. One might query firstly the weighting used, and secondly point out that the comparison of the two methods may not be valid in the particular case because of the large standard errors associated with the study.

Smith: We are still investigating the effect of using weighted mean values but preliminary checks indicate that there are no significant differences between weighted mean basic density which was used in an initial check and weighted mean tracheid length, as compared with strip mean values on a 5 yr increment and a 10 yr increment basis. The magnitude of the standard error is a point which will need to be discussed at the IUFRO Conference. We propose to do further sampling in this same population in an attempt to reduce our standard errors by more intensive sampling within progeny groups.

Item 1(d). Anatomical structure in relation to movements of fluids in E. maculata*

Despite long interest in the penetration of wood by fluids on the part of many research workers, practically no information has been obtained on the quantitative spatial relationships between the various tissue elements which constitute timber. Consequently, when discussions arise as to the way in which preservatives or other fluids move through timber, it is difficult to give any clear assessment as to the relative merits of different theories. The following results are designed to show what can be found out using anatomical methods.

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* Prepared by D. S. Skene

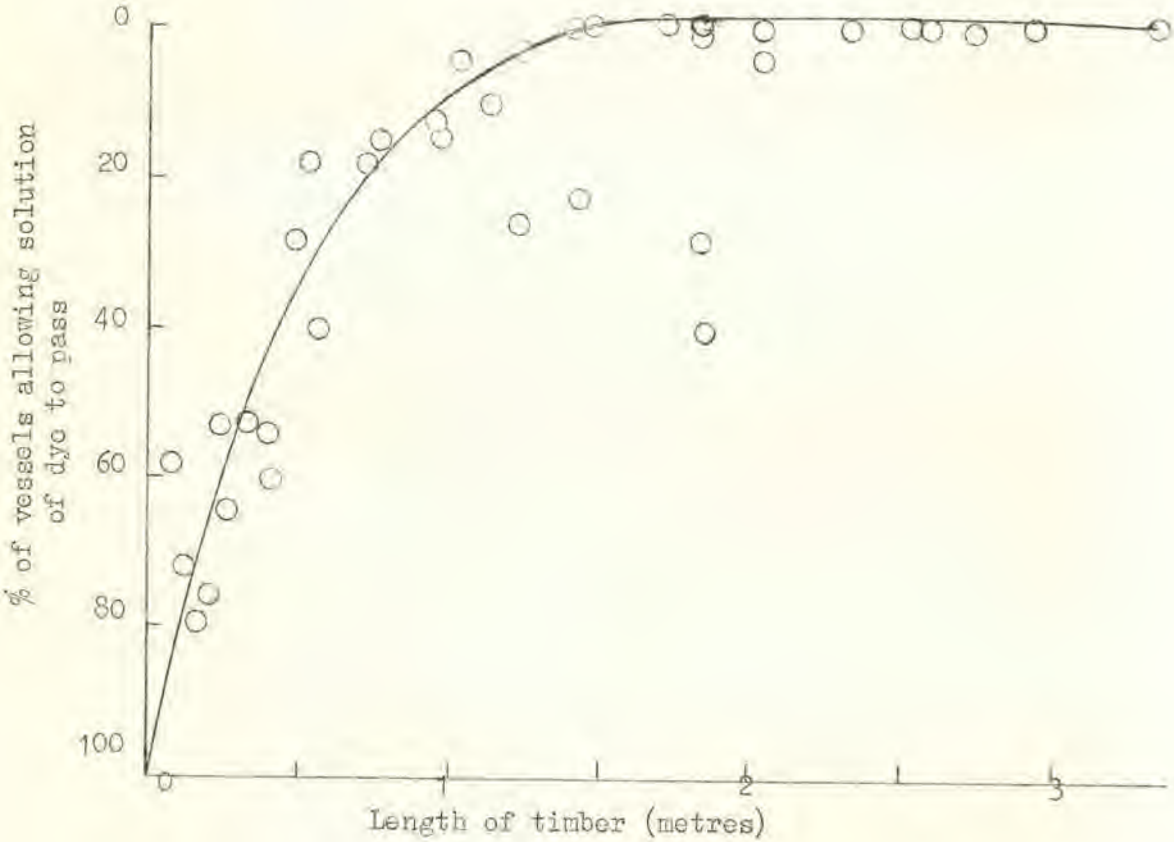
<u>Vessel Length in *E. obliqua*.</u> - Vessels are known to have a finite length, but it is not easy to measure this length directly. One indirect method is to inject a solution of a dye into one end of a long piece of timber and, at the other end of the timber, to count the numbers of vessels, if any, through which the dye has flowed. If this is repeated for different lengths of timber, some idea of vessel length can be obtained. The results of a series of such experiments are shown in the graph, and it can be seen that although a few vessels are longer, most do not penetrate through a piece of timber for more than 1.5 m. The method does not allow any more exact determination than this, but the curvature of the graph suggests that vessel length is somewhat variable.

<u>Contacts between vessels.</u> - Because of the finite length of vessels, extensive penetration of long pieces of timber must involve the passage of fluids from one vessel to another. From a series of transverse sections from *E. maculata* it has been possible to find out its three-dimensional structure over a distance of 4 mm. Out of a total of 149 vessels, 56 came into direct contact, forming 23 groups of vessels with an average of 2.44 vessels per group. Taken as an average for all the 149 vessels, the vessels were in contact for an average of 10 per cent. of their length, and this has been shown to be equal to about 2.1 per cent. of the vessel surface area. Since vessels have a surface area of about 680 mm^2 (they had a diameter of 145 and a length of 1.5 m is assumed) the total area of any one vessel in direct contact with any other is about 17 mm^2. On the basis of present calculations it is doubtful if this area of direct contact is sufficient to explain the observed rates of flow of the transpiration stream through the vessels.

The vessels are in indirect as well as direct contact. By indirect contact it is meant that the vessel walls do not touch each other, but are separated only by tracheids or fibre-tracheids. On this basis there is not only much more frequent contact between vessels, but such vessels form a much more extensive system. At present this can be illustrated only by means of drawings - no calculations have been made to determine to what extent the indirect contacts are a significant route for the movement of fluids from one vessel to another. It is clear, however, that the structure of <u>E. maculata</u> is such that movement through the vessels, and from there to the tracheids and fibre-tracheids, will result in quite extensive penetration of preservatives.

<u>Contacts between Vessels, Rays and other Cells.</u> - A study of serial sections has shown that the medullary rays are in direct contact with the vessels for about 109 per cent. of the length of the vessels (this high figure occurs because the rays can be in contact with both sides of a vessel). Along the rays, there are ray/vessel contacts, on an average, every 0.6 mm. Thus to achieve complete penetration of the rays, it is necessary for fluids to pass from the vessels, along the rays for an average distance of 0.3 mm. It can be shown that practically all the cells in a piece of timber are in direct contact with the rays, thus, once the rays are penetrated, there will be fluid adjacent to virtually all the cells in the timber. Complete penetration will then depend on the amount of connection of the rays with the fibres and vertical parenchyma.

It should be emphasised that these figures apply only to a particular piece of <u>E. maculata</u> and they are not put forward as typical of the species. In particular, the figures can be expected to vary according to the number of vessels/sq.mm. In <u>E. maculata</u> this varies from 4-12/sq.mm; in the specimen examined there were 9.19/sq.mm.



Discussion

Cokley: I am particularly interested in E. maculata in relation to the movement along the outer heartwood. Is it your intention to examine the effect of cell contents on this movement?.

Skene: At the moment my work is mainly concerned with the porosity of the cell wall rather than an anatomical study of E. maculata. It was really intended to give us some idea of what does occur in some species. Obviously what is going to have a very big influence in E. maculata is the presence of tyloses. Rather than go into great detail with E. maculata, I would rather look at other species and find out what happens to them. The porosity of the cell wall has been measured on some occasions but the results have not been very conclusive.

Item 1(e). Anatomical studies of the pathways of liquid penetration into *P. radiata*.

In collaboration with the Division of Forest Products, work has continued on the nature of the wall of the ray parenchyma cells of *P. radiata* sapwood. Examination of these walls with UV light has failed to show the presence of any strongly absorbing material in respect to this wave length. This suggests that lignin is either absent or else very weakly developed and thus supports the observations made on the basis of standard microscopical techniques. Some work has also been undertaken on the nature of the torus. In these tests it has been found that the torus can be dissolved in hot dilute caustic soda. This work is relevant only to sapwood.

No Discussion

Item 1(f). Comprehensive card-sorting key for the identification of the commercial timbers indigenous and exotic in N.S.W.

A card-sorting key which will cater for the wide range of timbers found in general use in New South Wales is planned. The key will not cover the extensive list of timbers included in the Division of Forest Products keys but will concentrate on more common commercial species, including softwoods and Australian and imported hardwoods. Trade sources have furnished the Division with lists of timbers which they would like to see included in this key.

Present plans are to prepare the key, like the Forest Products Laboratory, Princes Risborough, with printed but not clipped cards. The cards will be clipped by the purchaser from information supplied with the key. A charge will be made for the key.

Discussion

Bryant: The prime aim of this key which is in course of preparation for the trade in Sydney, is to reduce the amount of work of the Division. We hope to produce a key with roughly 100 species including most of the species imported into Sydney plus our own indigenous species and those from other States. No decision has yet been made on any charge.

Boyd: We have been worried in relation to the key we are producing in the Division and the cost of meeting requests for these. These keys cost us over £30. and naturally we want to maintain their availability particularly to educational organizations. Whereas in the past we have made them available free of charge, we have decided this is impracticable and we will have to make quite a substantial charge. Part of the reason for this charge is to make people aware of the value of the key, also to offset some of our costs of production.

Bryant: Our intention is not to clip the cards but simply to sell instructions together with the keys so that the buyer can clip them himself. This will save a lot of time and money.

Item 1(g). Bark anatomy of New South Wales Species.

Bark from various species of the families Monimiaceae and Cunoniaceae have been sectioned in accordance with our long range plans in which it is hoped to examine material from the important Australian families. Proper use of bark anatomy in classification and identification is dependent on the establishment of a general picture such as is available in wood anatomy.

No Discussion

Item 1(h). The identification of Pinus spp. on the basis of needle anatomy.

This work is largely completed and covers practically all the known species of Pinus. It is expected that this key will become available for distribution later this year. The key will be sold at a price yet to be determined.

Discussion

Bryant: Joyce Lanyon has been working on this now for the last 3 or 4 yr and it is now virtually complete except for a very comprehensive lot of material which she recently received from Mexico and which will be incorporated into the key. We feel this will be of very considerable interest to foresters in Australia and elsewhere and for this reason it is our intention to publish it.

Smith: We have the problem where the trade and our field staff frequently bring us wood samples of Pinus for identification and this can often be very difficult. I feel that this key is going to solve a lot of our problems.

ITEM 2. WOOD CHEMISTRY, PULP AND PAPER.

Item 2(a). Review of Research Activities

II. DIVISION OF FOREST PRODUCTS. *

The function of the Section of Wood Chemistry, Pulp and Paper is to study the chemical nature of wood, with particular emphasis on the major constituents, the carbohydrates, and the chemical and physical problems involved in their industrial utilization. This programme impinges on biochemistry at one extreme and ranges through aspects of organic and physical chemistry to physics and technology at the other. The main application of the Section's work is in the pulp and paper industry, and the results are discussed at periodical co-operative conferences with the research staffs of Australian and New Zealand paper companies. Further industrial liaison is provided by participation in the annual conferences of the Australian and New Zealand Paper Industry Technical Association, by meetings and lectures on specific topics and by many informal contacts.

The Section is organized at present into four groups, as follows:-

Chemistry of Wood Carbohydrates;
Physical Chemistry and Molecular Structure;
Fibre and Paper Physics;
Pulp and Paper Technology.

Work has continued along basically similar lines to those indicated at the 11th Conference, and considerable progress has been achieved in some projects, such as those aimed at elucidating the principles underlying processes of industrial interest. Investigations falling into this category include the mechanism of beating, the flocculation and flow of fibre suspensions, the permeability and compressibility of fibre pads, the mode of action of beater additives, delignification, the effect of bleaching on fibre properties, and high yield pulping.

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* Prepared by H. G. Higgins.

Advances have also been made in the field of molecular and crystal structure, where the application of physical techniques such as infra-red spectroscopy, X-ray diffractometry and nuclear magnetic resonance spectroscopy has yielded information on hydrogen bonding, ring shape and the arrangement of molecules in the crystals in a number of glucose and xylose derivatives. Studies have been continued on the chemical constituents of the cambial zone in trees, the biogenesis and constitution of cell wall polysaccharides, plant gums, the mechanical behaviour of fibres and paper, fibre morphology in relation to paper properties and the pulping potentialities of various species. For details of the current status of these projects, and the work planned, reference should be made to the Programme of Work of the Division of Forest Products, and accounts of the studies completed are contained in the Quarterly and Annual Reports of the Division and in various published papers. Only a very brief synopsis of some of the results obtained will be given here.

Chemistry of Wood Carbohydrates * - The polysaccharides of E. regnans have been separated into fractions, according to their solubility in various alkaline reagents, and the neutral sugars determined chromatographically in the acid hydrolysates. The non-resistant polysaccarides contain xylose, arabinose, glucose and galactose in the ratio 24 : 2 : 1 : 1. Indications have been obtained that appreciable quantities of glucomannan may be associated with the cellulose fraction, although the galactoglucomannan content is very low. The cambial zone of E. regnans has also been studied and the polysaccharides were found to contain galactose, arabinose, xylose, rhamnose glucose and uronic acid residues. It has been concluded that the non-cellulosic polysaccharides of the primary wall are more closely related to the pectic substances than to the non-cellulosic components of the secondary cell wall, hence secondary thickening involves very different synthetic reactions to those applicable to the primary wall.

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* Prepared by C. M. Stewart, Jean Melvin, J. A. Smelstorius.

The chemical composition of the sapwood, heartwood, bark and knots of Acacia penninervis has been studied in some detail. Wood from a species of Gnetum is also under chemical examination. The Gnetales have exposed seeds and are classified as gymnosperms, but they show some angiosperm characteristics; for example, their xylary tissues contain vessels and give positive Mäule tests.

Further attention has been paid to the chemical and physical properties of plant gums from the following species: A. penninervis, A. senegal, A. cyanophylla, A. microbotrya, A. pycnantha, A. dealbata, A. harpophylla, A. deanei, A. mearnsii, A. sophorae, Flindersia maculosa, Owenia acidula, Brachychiton populneum, and Cassia sophora. Talha, mesquite, tragacanth, ghatti and shiraz gums were also studied.

Physical Chemistry and Molecular Structure *

Crystal Structure of Cellulose, Xylan and Related Materials. - In working towards an understanding of the crystal structure of cellulose and xylan, the principal wood polysaccharides, attention is being paid to smaller molecules of analogous structure. Polarized infra-red spectra of α-D-glucopyranoside, methyl D-glucopyranoside (α and β), methyl β-D-xylopyranoside and methyl 1-thio-β-D-xylopyranoside have been observed, and the infra-red dichroism of cellulose II and cellulose acetate films has also been studied.

An X-ray diffraction study has been carried out, in collaboration with the Division of Chemical Physics, on the crystal structure of methyl 1-thio-β-D-xylopyranoside. The crystal is triclinic with two molecules per unit cell, and all C, O and S atoms have been located. The pyranose ring is in the C1 chair conformation. The hydrogen bonding pattern has been determined and other useful information of general application, pertaining to bond lengths and angles, has been obtained.

Hydrogen Bonding and Conformation in Glucose and Xylose Derivatives. - A system of nomenclature for the conformation of pyranoid compounds was devised, which avoids certain objections in the use of previously suggested systems; it is under consideration by the

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* Prepared by H. G. Higgins, A. J. Michell and B. J. Poppleton.

Carbohydrate Nomenclature Committee of the Chemical Society. Proton magnetic resonance studies were made on all the aldopentoses and the more readily available aldohexoses, from which the pyranose ring conformations were deduced. A series of xylose and glucose derivatives were examined by infra-red spectroscopy, and conclusions were reached about the nature of intramolecular hydrogen bonding and ring conformation in these compounds.

Delignification of Eucalyptus Wood. Lignin-Carbohydrate Relations. - In co-operation with the Pulp and Paper Technology Group, a study of delignification was made by means of infra-red spectroscopy. E. regnans samples in the form of chips, milled wood and thin cross-sections were progressively delignified by the soda, sulphate and neutral sulphite processes. Chlorite holocelluloses were also studied. Spectroscopic examinations were made, at various stages of delignification, on the sections, on milled wood and on thin paper sheets; in each case the samples were enclosed in pressed potassium chloride pellets. The paper-in-KCl technique offers a reliable method of obtaining sharp and reproducible spectra of partially or fully delignified pulps, and may be suitable for developing a rapid method of lignin determination. The spectra of lignins recovered from the cooking liquors and of Klason and Halse lignins in the pulp residues were also studied. The origin of bands in the infra-red spectra of hardwoods and lignin has been summarized, and it has been shown that delignification, deacetylation of the glucuronoxylan and changes in its uronic acid side residues may be followed spectroscopically. The spectra support the view that the major part of the original uronic acid is lost during alkaline pulping.

Infra-red spectroscopy can also make a significant contribution to one of the basic questions of wood chemistry, the nature of the lignin-carbohydrate linkages, and this problem is receiving attention. Information has also been provided on tertiary CH groups and ether linkages in various types of lignin, the presence of lignosulphonic acid in NSSC pulps and the nature of the sulphur linkages in sulphate lignin.

Fibre and Paper Physics *

Flocculation of Fibre Suspensions. - Various methods of measuring the heterogeneity of pulp suspensions and paper sheets have been examined, and it has been concluded that the beta-ray scanning method offers several advantages for paper studies. The heterogeneity of handsheets made from short and long-fibred pulps has been determined with a beta-ray scanner equipped with a promethium-147 source. Flocculation is more pronounced with long-fibred pulps but the reduction in strength with increasing heterogeneity is greater in short-fibred paper. The influence of settling time on heterogeneity has also been determined. The Australian Atomic Energy Commission has given valuable assistance in developing the apparatus for this work.

Flocculation has been considered theoretically in terms of entanglement, bridging and electrokinetic theories of fibre interaction. Apparatus has been set up to measure the zeta-potential at fibre-water interfaces, and the measurements made have been used in evaluating zeta potential and ionic charge density in the double layer in the presence of additives (alum and polyamide).

Permeability and Compressibility of Fibre Pads. - Measurements of specific permeability and compressibility of pads of synthetic and wood pulp fibres have been made in an apparatus in which rate of flow of water through the pad, pressure drop across the pad, external applied load and pad thickness can be controlled and measured. Comparisons have been made between observed permeabilities and those predicted from the properties of the fibre and pad geometry. Relationships between solids concentration, applied stress and pressure drop have been studied for P. radiata sulphate pulps and E. regnans neutral sulphite semi-chemical pulps at various stages of delignification. Work of this nature is relevant to the filtration and pressing stages of paper manufacture.

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* Prepared by H. G. Higgins, V. Balodis, J. de Yong, and K. J. Harrington.

Effect of Bleaching on Fibre and Paper Properties. - Sulphate pulps from P. radiata were subjected to three-stage bleaching treatments with the purpose of assessing the changes in properties at each stage. Bleaching was found to weaken the fibre but to lead to an increase in the strength of paper made from unbeaten pulp, in support of the view that, within limits, fibre strength is secondary to inter-fibre bonding capacity as a factor in paper strength. Chlorinated pulps were found to have anomalously low intrinsic viscosity in cadoxen, which appears to be a function of the shape assumed by the molecules in solution. Bleaching decreases the volume of the wet fibre pad at constant fibre weight and pressure, and lowers the compressibility of the pad. The permeability to water is consequently lower for bleached pulps when measured at a constant pressure drop across the pad. This work has been carried out by Dr. T. Kayama, a Visiting Research Fellow from the Government Forest Experiment Station, Meguro, Tokyo.

Flow of Pulp Suspensions. - In collaboration with the University of Melbourne, work has been continued on the determination of friction losses for the flow of eucalypt and pine kraft pulps. This work is being done mainly by Mr. E. Fish, a post-graduate student in the Department of Civil Engineering. At present he is concentrating on methods of visually examining the various flow regimes by means of high-speed stereoscopic photography, with the aim of testing the validity of a proposed flow model.

Consolidation of Fibre-Water Systems. - Various experiments relating to the process of consolidation of the paper web have been carried out, and two papers have been prepared for the Third International Research Symposium organized by the British Paper and Board Makers' Association, which is to be devoted to this theme, and is to be held at Cambridge in September, 1965. Particular attention has been paid to the significance of lateral conformability of the fibres, which has been shown to have a dominant influence on paper properties. A method of obtaining the lateral load-compression curve of a single fibre has been developed. The effect of non-fibrous materials on consolidation has been studied in terms of surface tension, fibre collapse and hydrogen bonding. Further analysis of the flow curves for suspensions of different types of fibre has yielded information on the process of network formation, which is manifested as a transition from virtually Newtonian to Bingham flow behaviour.

Pulp and Paper Technology. *

Pulping Investigations. - Items 2(b), (c) and (d) on the agenda will deal with pulping studies on various species of interest to delegates, and with the assessment of pulping potentiality. These subjects will therefore not be dealt with here.

Beating. - The PFI mill has been used to study the effect of beating load, stock concentration and the clearance between the beating surfaces on both eucalypt and pine sulphate pulps. The construction and operating conditions permit all of the above factors to be varied over a wide range. The mill can be operated at stock concentrations as high as 50 per cent but beating efficiency decreases rapidly above 30 per cent. The clearance between the beating surfaces was found to vary negatively as a linear function of both applied load and the logarithm of the number of revolutions. An analysis of the beating action showed that it was necessary to consider the beating of a thin pulp pad rather than the more usual concept of beating single fibres. The beating effect was at a maximum under conditions where the compressive forces could be most efficiently applied.

Beater Additives. - In an initial study of the mode of action of beater additives, the effect of cationic starch on paper properties was examined over a range of starch cooking conditions and at different degrees of beating. The work was extended to include the effect of other modified starches and starch fractions on interfibre bonding. The results led to the conclusion that the bonding efficiency depends on the state of dispersion of the colloid, the internal cohesion of the dried colloid film and the adhesion at the colloid-fibre interface.

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* Prepared by A. J. Watson, A. W. McKenzie and F. H. Phillips.

High-Yield Pulping. - In collaboration with the Physical Chemistry Group, studies have been made of the mechanism of neutral sulphite semichemical pulping. It has been found that the relationships between temperature and some pulp properties, including ease of defibration, show discontinuities in the vicinity of 160°C, and the way in which lignin plasticization contributes to these effects has been studied. The kinetics of delignification is also being investigated. A procedure has been developed whereby a comparison may be made of the energy consumed in obtaining fibre separation of chips subjected to different cooking conditions. Morphological examination of NSSC pulps in the Section of Wood and Fibre Structure showed that fibre separation occurred mainly in the middle lamella zone, with a subsidiary amount of S1-S2 separation. Within the chip the delignification process is highly heterogeneous.

General Remarks

The Section was represented overseas in 1964 by Mr. A. J. Watson, who attended the Symposium International sur la Chimie et la Lignine, de la Cellulose et des Hemicelluloses at Grenoble, the Symposium on Novel Methods of Pulping and Delignification at the American Chemical Society meeting in Chicago, and the Fifth International Mechanical Pulping Conference in Vancouver. A paper on "An Infra-red Spectroscopic Study of Delignification of E. regnans" by A. J. Michell, A. J. Watson and H. G. Higgins was presented at the Chicago symposium. Six papers from the Section were presented at the Appita Conference in Sydney in 1964, and four at the Hobart Conference in 1965. Papers were also delivered at the Fourth and Fifth Australian Spectroscopy Conferences, in Canberra in 1963, and in Perth in 1965, respectively. The 19th Pulp and Paper Co-operative Research Conference was held in the Division in 1963 and 27 items were presented by members of the Section. An instrument for measuring the load-elongation characteristics of individual wood fibres was demonstrated and described at an Exhibition of Original Rheological Instrumentation and Symposium on

Rheological Measurements held in Sydney in 1965. A paper was delivered at the Tewksbury Symposium on Fracture, held in Melbourne in 1963. Several lectures were given to local sections of Appita, and lectures and demonstrations were held for students of the University of Melbourne, the Australian National University and the Creswick Forestry School. Other lectures were given to the Infra-Red Spectroscopy Group and to the research staff of a paper company. Several internal seminars were held.

A few changes of professional staff have taken place. Mrs. Joan Melvin, formerly of Fodder Conservation Section of C. S. I. R. O. has joined the Section. Mrs. R. B. Ali resigned her position to return to Pakistan. Mr. J. A. Smelstorius took up a position in the Section in 1963. Mr. K. J. Harrington returned after spending a year in the Research Laboratory of the Oxford Paper Co., U.S.A. Mr. A. T. Proszynski who had been occupying a temporary position during Mr. Harrington's absence, ceased duty in the Section.

Visitors from overseas who have worked in the Section include Dr. T. Kayama from Tokyo, Mr. J. S. M. Venter of the South African C. S. I. R., Mr. F. Chu, a Colombo Plan Fellow from Sarawak, and Mr. G. Sherbini from Egypt. Members of the F.A.O. Eucalypt Study Tour also spent some time in the Section discussing problems of pulp and paper manufacture from eucalypts.

II. NEW ZEALAND. *

During the last two years studies on the chemical composition of pine and beech (Nothofagus) species, from the Nelson area, have been carried out as part of a pulpwood assessment project.

In the work on pine (item (b)) samples from trees of P. radiata and P. nigra, obtained during a study of wood density, were examined for their variation in extractives, lignin, cellulose, and pentasans content. The trees came from two main age classes, 30-year-old trees or 15-year-old thinnings. Corresponding samples have been retained for future pulping studies.

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* Prepared by J. M. Uprichard.

Silver beech (N. menziesii) was the subject of pulping studies at A. P. M. laboratories, Fairfield, Melbourne, and a number of the trees collected for the pulping study were examined for their variation in wood anatomical features and chemical composition. Red beech (N. fusca) has been the subject of both wood quality assessment and pulping studies at F. R. I. Work on the two beech species is discussed under item 2 (c).

Some work on the arabogalactan content of New Zealand grown Larix decidua stemmed from the possible use of this material for lamination studies (galactan in Western larch has been reported to give rise to gluing difficulties with this species). The arabogalactan content (at breast-height) of the trees studied was relatively low, range 3 to 10 per cent, compared with Western larch. In general there was a decrease in arabogalactan content with height in the tree until the region of the green crown was reached, when there was a slight but significant increase in arabogalactan content.

Discussion

Uprichard: What success has been achieved with the detection of lignin in neutral sulphite pulps using infra-red techniques and can you follow the course of pulping?

Higgins: We can follow the delignification quite adequately and we are working towards a method of determination of lignin by infra-red spectroscopy. A paper on a spectroscopic study of delignification will shortly appear in Tappi.

Bryant: Since we are now becoming very interested in problems of removal of waste material from a paper industry based on Pinus spp. we are going to ask soon whether the Division can look at this in conjunction with our group who are working on the problem of Pinus nutrition.

Boyd: This is a big and important question, particularly as Australia is planning for considerable increases in softwood planting. It is going to be important to have as fully an integrated industry as possible to use the products of these plantations. To do this, it would be highly desirable to be able to develop pulping plants in areas where the water supply is very limited and where there could be problems from effluent. This problem will probably need extensive study in the near future.

Watson: The question of disposal of pulping waste depends on the pulping process being used and this will depend to a certain extent on the species in which we are interested. This matter is under consideration in all pulp-producing countries and has become a more serious problem in the last twenty years because more stringent regulations regarding stream and sea pollution have been enforced. It is also receiving attention in various areas similar to the inland areas in Australia where water is not plentiful and the means of disposal are not readily available. Each case has to be dealt with on its merits. There are almost as many methods of treatment as there are plants producing these contaminated effluents.

Bryant: The problem in Tumut is not of limited water supply, but of contamination of the existing water supply. We feel we can solve the problems at Tumut, but it is important to decide the type of pulp to be produced. Then we can probably work out a system whereby you can use the material produced for some other purpose.

Jacobs: The three main types of pollution are atmospheric, objectionable liquids and metallic salts like common salt, which is one of the big problems in the Murray Catchment. One of our objections is to the thought of, say, a railway truck of salt being put into the Murray Catchment every day.

Watson: The salt pollution depends on the type of process being used. In the sulphate process, or any other with a total recovery system, there are only relatively small quantities of salts being added to the general system. With some other processes, for example, the neutral sulphite semi-chemical process or sulphite process as usually operated, virtually all of the salts are discharged into a river or stream, either before or after some sort of treatment, and a general build up of salts would be expected. However, even in these cases, there are recovery processes which can be operated, but the critical point is whether they can be operated economically.

Bryant: As the sodium is the real problem, what is the economic feasibility of calcium or magnesium based cooking processes? It seems that this is the key to the successful use of these materials on land apart from the question of putting them into streams, which seems to be out of the question in the Tumut Valley.

Watson: Pines and softwoods are frequently cooked by the sulphite process and the usual cooking chemical is calcium bisulphite, which can be replaced by magnesium bisulphite which is well adapted to a recovery process. However, the calcium salts, which are not nearly so readily recoverable, are normally disposed of in the effluent. The limited experience which we have had of using the sulphite and bisulphite processes on P. radiata has shown them to be reasonably satisfactory with no obvious problems. Pitch and resinous material can cause problems, but providing the amount of such material is reasonably low, there should not be any great difficulty in using the sulphite process for handling them. A modified bisulphite process is being used at Millicent (Apcel) for pulping pines.

Item 2(b). Pulping of plantation grown pines - P. radiata and P. pinaster

I. DIVISION OF FOREST PRODUCTS. *

Chemical and mechanical pulps have been made from P. radiata thinnings from Mt. Burr, South Australia. The trees were selected to represent widely different growth conditions. The papermaking properties of sulphate pulps were similar to those of pulps prepared from mature trees of the same species, except for lower tearing strengths due to the shorter fibre length of the young trees. Mechanical pulps prepared in a laboratory Bauer defibrator had papermaking qualities similar to pulps from mature wood.

Similar investigations were made on P. pinaster thinnings from Pemberton, W. A. The papermaking properties of both sulphate and mechanical pulps were a little inferior to those of pulps prepared under comparable conditions from P. radiata; tearing strength, however, was higher, owing to the greater proportion of thick walled late wood fibres.

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* Prepared by A. J. Watson and F. H. Phillips.

II. NEW ZEALAND. *

The extractive content, lignin, cellulose, and pentosan contents of the trees of P. radiata from the Nelson area, were in general similar to those found for trees of the same age grown in Kaingaroa Forest. The results are summarised in the following table:-

Chemical Composition of P. radiata (Nelson)

Property	Rings from Pith				
	1-5	6-10	11-15	16-20	21-25
Extractives (%)	3.3	2.0	1.5	1.6	1.5
Alpha-cellulose (%)	47.1	49.4	53.0	52.5	53.0
Lignin (%)	28.1	27.4	27.6	26.7	27.1

The results obtained on Nelson grown P. nigra indicate that while this species in that area has an extractive content of about 2 per cent it has a somewhat greater alpha-cellulose content than P. radiata of the same age.

Item 2 (c). Pulping of hardwoods - E. calophylla, E. marginata, E. diversicolor, Populus angulata, Nothofagus (NZ) and tropical species.

I. DIVISION OF FOREST PRODUCTS. **

Pulping studies have been made on old trees and pole size regrowth of E. calophylla, E. marginata and E. diversicolor and on sawmill slabwood of E. marginata and E. diversicolor. Both the sulphate and NSSC (neutral sulphite semichemical) pulping processes were examined in some detail. It was found that pulps made from the regrowth wood had better papermaking qualities than pulps made from the old trees. However, even the best pulps obtained from these species were not as satisfactory for papermaking as the commercial

* Prepared by J. M. Uprichard
** " " A. J. Watson and F. H. Phillips

grade eucalypt pulps produced at present. Slabwood gave a rather low grade pulp, but this was improved when wood near the centre of the tree was eliminated. Cold soda semichemical and mechanical pulps were also made from the above species; in all cases pulps with poor papermaking properties were obtained.

Sulphate, NSSC and mechanical pulps were prepared from three year old Populus angulata grown at Grafton, N.S.W. Pulps of good quality were obtained by all three processes, the papermaking characteristics being similar to those of pulps made from E. regnans.

Pulping and papermaking studies have continued on New Guinea hardwoods. Alstonia scholaris, Flindersia amboinensis, Planchonella spp., Calophyllum spp., Terminalia brassii and T. calaman anai have been examined and Sterculia conwentzii and Mangifera minor are at present under investigation. All species could be pulped readily by the sulphate and NSSC processes. The pulps prepared from Planchonella spp. had rather poor papermaking properties but all the other species gave pulps which approximated to commercial grade eucalypt pulps.

. NEW ZEALAND.*

Samples of silver beech (Nothofagus menziesii) were used in the pulping study. The basic density ranged from 28 to 31 lb/cu.ft., whilst fibre length was in the range 0.7 to 0.9 mm. Fibre diameter was 16 to 18 microns and the ratio of lumen diameter to fibre diameter averaged 0.61. The fibre content was over 60 per cent of the wood volume.

The small diameter trees contained little heartwood (0 to 3 per cent) and had low methanol extractive contents (3 per cent of O.D. wood). The large diameter trees which had a higher heartwood content (11 per cent) had a methanol extractive content of 5 per cent in sapwood and 8 per cent in heartwood. Lignin content ranged from 19 to 20 per cent of extractive-free wood, alpha-cellulose content was

* Prepared by J. M. Uprichard.

50-54 per cent and pentosan content 17 to 19 per cent. The smaller diameter samples had an alkali-soluble content of 15 per cent (in 0.1N NaOH), large diameter samples were 19 per cent soluble in alkali.

The silver beech samples when cooked with 13% alkali at 24% sulphidity by the kraft process gave screened yields of 47.5 to 50.2 per cent, the lowest yield being obtained from the large diameter (older-aged) material. The physical properties of the kraft pulps were somewhat similar to those of commercial eucalypt pulps. Thus at 350 freeness (Lampen mill evaluation) pulps had a tear factor of 100 to 110, breaking lengths of 9 to 11 km., and burst factors of 65 to 75.

A small number of neutral sulphite semichemical pulps were prepared from a composite sample of silver beech in the yield range of 69 to 76 per cent, using 10 to 15 per cent of Na_2SO_3. The pulps were weaker than the kraft pulps, typical values were tear factors of 70, breaking lengths of from 6-8 km., and burst factors of 40. These pulps had, however, good resistance to crush after corrugation, and gave figures as high as 90 lb.

Most of the pulping work on red beech (N. fusca) has been carried out on samples from small (W1) diameter (9 inch) and large (W2) diameter (28 inch) trees. Basic density, after correction for extractives, ranged from 29 to 30 lb/cu.ft.

Morphologically red beech was similar to silver beech, fibre length was 0.9 to 1.1 mm and fibre diameter 16 to 17 microns. The ratio of lumen diameter to fibre diameter ranged from 0.66 in the case of small diameter trees to 0.61 for large diameter trees. The percentage of fibres by volume was 60 per cent.

In the large diameter trees methanol extractives in heartwood ranged from 10 to 16 per cent, compared with 4 to 6 per cent for small diameter material. The sapwood contained 18-20 per cent of alkali-soluble material and the heartwood 25 per cent.

Lignin (18-20%), alpha-cellulose (50-54%) and pentosans (18-20%) content were generally similar to those of silver beech.

When pulped by the kraft procedure the small diameter red beech samples gave screened yields of from 46 to 47 per cent and the large diameter material gave yields of 42 to 43 per cent. Kraft pulps from small diameter trees at 350 freeness had tear factors of 100-106, breaking lengths of 8.5 to 9.0 km., and burst factors of 55 to 60. The large diameter trees gave pulps somewhat lower in strength.

Currently red beech is being pulped by the sodium bisulphite process, with the aim of producing high brightness pulps. Some difficulties due to "chip-burning" have been experienced. It has been found, using cooking schedules of 4 hours to temperature, followed by a 2-hour period at cooking temperature, that little or no burning of chip centres occurs. The cooked chips require at least one pass in a mechanical refiner. Yields were 50-55 per cent. It has proved difficult to obtain pulps with Kappa numbers less than 30-40 under the type of schedule indicated above.

III. PULPING OF NEW GUINEA TIMBER SPECIES.

The forests of the Territory of Papua and New Guinea contain extremely large volumes of tropical hardwoods, which, typical of most tropical rainforests, occur in stands containing a multiplicity of species exhibiting a wide range of densities and fibre characteristics.

Production of pulp and paper is a part of the general process of industrialisation which it is hoped can be achieved in this Territory. If large scale investment can be attracted, large tracts of forest land can be acquired and made available for these operations. Volumes in the order of one thousand or more million superficial feet occur on areas already assessed.

For optimum utilisation of the timber available in such areas, an integration of manufacturing processes is desirable, producing sawn timber, veneers, pulp and possibly building board.

Any industry establishment of this size would no doubt aim at silvicultural treatment of the cut-over areas to achieve as soon as possible a uniform supply of a homogeneous raw material, taking full advantage of the high growth rates achieved under managed-forest conditions in the Territory.

To facilitate the establishment of a pulp and paper industry in the Territory in co-operation with the Division of Forest Products, we have had examined 13 species, are awaiting the results on a further 6 and work is continuing.

The completed work has yielded a fair coverage of the information required on two associations.

1. The vast mangrove associations of the Delta Region.
2. The mid-montane rainforests of the Bulolo Valley.

Further work in the future will be directed towards the lowland rainforest species, since these are the species prevalent in the large scale acquisitions previously mentioned.

Resource assessment techniques presently employed are basically directed towards estimation of merchantable sawlog volume. Thus the species by volume distribution for the purposes of pulpable volume assessment can be used as a guide only, and more intensive sampling would be needed in particular areas considered as potential pulp operations. This, however, presents no real problem and could be carried out at short notice in a relatively short space of time.

Silvicultural techniques have been determined for the establishment and management of plantations of many species including the Araucarias and various Eucalyptus species (which probably would be the regenerated species).

Thus the main void existing at the moment is data on the pulping properties of the bulk of these lowland species, and continued research at an accelerated rate is sought.

Item 2(d). Rapid assessment of pulping potentiality.

I. DIVISION OF FOREST PRODUCTS. *

The direct determination of the pulping and papermaking potentiality of any species can be a time consuming operation, and special equipment is required for many of the tests. It is possible, however, to make a preliminary assessment of the papermaking properties of a species from a knowledge of the dimensions of the fibre, the basic density of the wood, the percentage of fibres in the wood and some chemical data on the composition of the wood. Much of this information may be already available in the literature or in laboratory records, but if not, it may be obtained with equipment which is available in most laboratories. The main requirements of pulpwood may be summarized as follows:-

(1) Basic density preferably below 40 lb/cu.ft.
(2) High fibre length (if tearing strength is important).
(3) Low extractives content.
(4) Should not contain a high percentage of parenchyma tissue, ray cells, vessels, etc.
(5) Light colour.
(6) Tree not over mature.
(7) Freedom from decay.
(8) Only small amounts of reaction wood.

Of the above, (1) and (2) are the most important.

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* Prepared by A. J. Watson and F. H. Phillips.

Basic density is a guide to cell wall thickness, thin walled fibres giving papers with good bursting and tensile strengths. However, if a species contains large amounts of parenchyma tissues, vessels and/ or other non-fibrous elements it may be low in basic density and still have fibres with relatively thick walls. Thus if basic density is being used as a guide to pulp wood quality data are also required on the amounts of the non-fibrous elements present in the wood.

II. NEW ZEALAND. **

A survey of the wood properties of exotic conifers grown in Nelson has recently been undertaken. Results for physical properties are complete. The statistical basis of the survey was (a) to select the major species from N.Z.F.S. data - P. radiata, P. nigra, Pseudotsuga taxifolia, P. ponderosa in that order. (b) To decide on the ages for sampling - thinning, plus clear-felling ages where applicable to pulpwood. (c) To determine sampling intensity: from the known variability within and between stems it was decided that four borings from b.h. from 16 randomly selected trees would give average basic density for the stand to ± 1 lb/cu.ft. at the 95% confidence level. (d) In the event 25 trees were sampled on each site, and trees were selected for felling to give a well stratified sample of 5 trees per site. (e) These were used to compile the regression for b.h. values of density related to average for the entire stem. The stratified sampling greatly improved

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** Prepared by J. Maddern Harris.

the regressions obtained, and also provided the best sample for other tests on chemistry anatomy and mechanical properties.

Discussion on Items 2(b), (c) & (d)

Boyd: It is necessary to make an initial classification of of species which are suitable for pulping, to reduce the amount of pulping work. We ask for co-operation in accepting this type of advice as a preliminary to undertaking any research of the pulping properties.

Uprichard: D.F.P. publications have indicated to me the importance of fibre volume in hardwoods, and I would put it second after basic density in indicating the pulpability of wood.

Watson: I did not enlarge on the question of vessels, parenchyma and ray cells as information on these is available for a number of species and it is thus possible to make an assessment.

Jacobs: Is there any sign of a use for extracted lignin? Does kino cause any trouble, and have you assessed E. sieberiana?

Watson: There are many uses for lignin, but unfortunately they are nearly all of low tonnage. It is used in ceramics, cement, battery manufacture, etc. However, the difficulty of any one mill in Australia making really effective use of lignin products is restricted because of the relatively small amounts required. Several mills in the U.S.A. are making use of all of their lignin for a specific end product, but these are supplying the full market.

Kino initially causes trouble during the pulping process by increasing the chemical consumption. It also introduces difficulties during the recovery process. It should also be noted that kinos are not soluble in the sulphite cooking liquor.

The pulping of E. sieberiana was investigated at this Division in 1936-37. Three trees were pulped and although the method of assessment was cruder than present methods the general picture showed this species to be quite satisfactory; it is being pulped by A.P.M. at their Maryvale mill.

Uprichard: Was there a high content of latewood in the slow grown P. radiata? You have previously shown that latewood has an adverse effect on pulp quality from P. radiata, but there is quite a big difference in the case of P. pinaster from Western Australia and P. elliottii and P. taeda. Can you account for the differences as being due to a lower amount of latewood in radiata.

Watson: Yes, even the slow grown sample of P. radiata had only relatively narrow bands of latewood and in the fast growing samples the bands were almost absent. With P. taeda and P. pinaster there were much heavier bands of latewood.

Higgins: Concerning the utilization of lignin, a considerable amount is now being used in the paper industry itself, with the development of high yield pulping, and this process may be extended even further. It appears that one drawback about lignin in paper is its bulking action and concentration around the outside of the fibre. This reduces the conformability of the fibre, making it unsuitable for high-strength paper. If the lignin could be broken down by some process, e.g. radio-active radiation, i.e. partly breaking it down without complete solubilisation, we may overcome its bulking action, and thus leave even higher amounts of lignin in the fibre. This is a line of work which should be kept in mind.

Bryant: Some years ago we were interested in using lignin as an additive to adhesives but the material which we were able to get in Australia was too expensive. I think it was produced experimentally by A.P.M. at about 4/- a pound. To be attractive to the glue-maker it would have to be at a price of a few pence a pound, necessitating high production for a market which probably could not take the amount required to make the price low enough. Dr. Higgins' suggestion of using it within the industry seems to be the obvious answer.

Hillis: The question of lignin utilization was discussed with Swedish chemists last year. Their industry is no longer subsidising research into finding a use for lignin.

Jacobs: At what age is radiata pine capable of producing pulp of reasonable tear strength?

Watson: This is associated with the point where you get maximum fibre lengths and this occurs after about 12-15 years. If you are pulping only pines, 15 to 20 year old trees will be very satisfactory material, but if you are looking to the pine to improve the tearing strength of eucalypt pulp then you need the older trees, e.g. 25 years plus, in which pulp is diluted to only a small extent by the fibre from the inner portion of the tree. This is one reason why slabwood has very real advantages, i.e. it has a maximum of long fibre.

Threader: What disqualifies E. goniocalyx as a pulping timber? Has it any future as a chemical or groundwood pulp?

Watson: E. goniocalyx is borderline as far as density is concerned for use as a chemical pulp. It is beyond the borderline as far as density is concerned for use as a mechanical pulp. Generally the hardwoods in the 20-25 lb/cu.ft. basic density bracket are the most suitable for mechanical pulp. Small quantities of E. goniocalyx in the mixed foothill species are pulped by A.P.M.

Threader: This species is not listed in the Company's specification but perhaps it cannot be separated out when the wood is barked. It is said to be not acceptable but it exists in large quantities.

Watson: I have seen it listed among species which are pulped. It may be worth looking at this species to see whether there is anything abnormal about it.

Smith: With reference to tearing strength being higher due to a higher percent. of latewood and higher fibre length in P. pinaster than in P. radiata, could higher tearing strength be expected in P. elliottii than in P. radiata? Is the higher tearing strength due more to an increase in fibre length than to a greater conformability of the fibre due to a relative flatness in cross section? What is known of the pulping potential of P. caribaea which is a relatively low latewood species that has high fibre length with relatively thin walls? Could some work be done on the pulping potential of North Queensland brushwoods because we have had enquiries on their possible use? What are the current views regarding the effect of cell wall organization on the strength of paper?

Watson: We have carried out a limited amount of pulping on _P. taeda_, including an investigation of latewood and earlywood in samples which had well-defined bands of late and earlywood. These pulps, and particularly those from the late wood, had a high tearing strength. Current work at D.F.P. and overseas has shown that tearing strength is related to fibre length, but once a fibre length of 3 to 4 mm has been achieved you cannot achieve any marked improvement in tearing strength by increasing fibre length. However, fibre strength becomes important in this particular case. When a piece of paper is torn, some of the fibres are torn out of the paper and other fibres are broken, hence both fibre strength and fibre length play a role.

P. caribaea is pulped in southern U.S.A. Some of the pulping characteristics of _P. caribaea_ are very similar to _P. taeda_ and _P. elliottii_.

North Queensland brushwoods have not been investigated. One of the problems in this area, as with areas in New Guinea, is the multiplicity of species and any pulping work should be done on species available in reasonable quantities. The first assessment should be made on basic density, colour and quantity available.

Regarding cell wall organization, the only aspect investigated is one which has a minor effect on strength properties, viz. micellar spiral angle. Wood with a very high micellar spiral angle gives paper with an extremely high stretch. This ceases to become very marked when the micellar spiral angle approaches the average for the species. This effect is not of major interest because, by taking the wood from near the centre of the tree, we also get much shorter fibres and we lose more than we gain from the higher micellar spiral angle.

Higgins: Regarding conformability and tear strength, it should be emphasised that the criteria which determine tearing strength are quite different from those determining other strength properties. Most strength properties depend on inter-fibre bonding but tear in general becomes worse as bonding becomes better. The factors which determine tearing strength are fibre length and cell wall thickness, but increased conformability, leading to improved bonding, may be deleterious to tear. Early in beating tear passes through a maximum and then begins to decrease, and in some situations other strength properties may be improved while the tear is reduced.

ITEM 3: PHYSICS.

Item 3(a). Research Review (DIVISION OF FOREST PRODUCTS) *

Work during the last two years has continued generally along the same lines as at the time of the last conference, the main fields of work being sorption studies, rheological investigations, and work on the electrical properties of wood. In detail, however, the emphasis has changed somewhat, work on swelling pressure being planned, work on the physics of fracture commenced, and a study of microwave methods of measuring moisture content undertaken.

Sorption Studies

Kinetics of Swelling of Wood Cell Walls. - Previous work has shown that the rate at which single cell walls of wood take up water vapour following a sudden increase in humidity is not determined by the speed of diffusion of water through the cell wall but by a much slower process thought to involve swelling stresses. In particular, it was found that equilibrium was re-established much more slowly if

* Prepared by the Staff of the Physics Section.

the vapour pressure change was small than if it was large. Sorption was also slower for a given size of vapour pressure or moisture content change if this occurred at high vapour pressures, compared with one at low vapour pressures.

This work has been extended to study the rates of swelling of wood cell walls when they are rapidly immersed in water. These measurements have shown that initially dry wood swelled to very nearly its final volume within a few seconds. When wood of higher initial moisture content was wetted there was very little effect on the rate of swelling provided the initial moisture content lay below about 15%. When wetting commenced from higher initial moisture contents than this, the time taken to reach the final swollen state became very much greater the higher the initial moisture content, requiring several days in extreme cases. When methyl alcohol was used as the swelling liquid and the dry wood was first conditioned to selected methanol contents, the time to reach swelling equilibrium was found to increase steadily with increasing initial methanol content, over the complete range of initial methanol content from zero. A tentative theory of the mechanism of sorption and swelling has been developed which appears capable of explaining most of the observed phenomena.

Retention of Water during Vacuum Drying of Wood. - In the course of making precise measurements of the sorption of water vapour by wood, difficulty was experienced in being able to re-dry a given wood specimen to exactly the same final weight. These dryings were made at room temperatures by evacuating the wood to a final pressure of 10^{-4} mm Hg in the presence of P_2O_5. The possibility of contamination of the specimen by various substances within the sorption system was eliminated and it was concluded that the variations were due to the retention of water. It was found that the amount of water retained (up to 1%) varied according to the previous sorption history of the specimen. The driest state reached was obtained with a high degree of reproducibility (± 0.01%) only if the sample was dried from the wetted state. If a specimen thus dried was exposed to water vapour for a period of at least a few hours and then re-dried under identical drying conditions, a quantity of water was retained which depended on the length of time of exposure and the pressure of water vapour during exposure. On re-wetting and re-drying the same specimen, the reproducible minimum weight was again attained. Further studies are in progress to explain these phenomena, and relate these results to other methods of drying.

Rheological Studies. - A new project has been initiated, namely the study of the mechanism of failure in wood. Crack propagation is at present being observed and fracture energies measured. An attempt will be made to locate the parts of the structure where fracture originates under various conditions.

Dependence of elastic moduli and internal damping on frequency of vibration has been investigated for the lower audio-frequency range at various temperatures and moisture contents. The species tested, hoop pine, mountain ash and grey ironbark, were chosen as representative of woods of various densities. The form of the dependence on frequency of Young's modulus and damping differs from that expected from a linear viscoelastic body. In particular, the time-temperature relation applicable to many synthetic polymers cannot be applied to wood, and hopes of curtailing the necessary rheological testing programme cannot be realized. Dynamic testing is now being concentrated on very low frequencies (down to about 1 cycle/min.), a range in which static and dynamic results can be compared and where information is not at present available.

The increase in deformation of loaded wood during moisture changes has been investigated further and leads have been sought to the interpretation of the effect. A comparison of normal wood with compression wood, drying from the green state while held at constant deflection, showed a decrease of stress in normal wood to about half its initial value, and in the presence of compression wood or defects to almost zero. Experiments have been designed to check whether a load applied in one direction influences the swelling and shrinkage components in that direction at the expense of those in other directions. Results, so far, do not corroborate this suggestion but tests are not yet sufficiently conclusive to allow it to be dismissed.

Tests on small beams under load in vacuum are being carried out to study further the behaviour of green and resoaked wood of hoop pine and alpine ash during drying. Previous tests showed that the deformation in resoaked hoop pine only increased during drying below the fibre saturation point, whereas those in green alpine ash increased from the commencement of drying from the green state. The effect of moisture cycling on deformation of small beams in vacuum and larger beams in air-conditioned cabinets at stresses between 20 and 50% of their ultimate strength is also being studied. For the small beams at a stress of 20% of the ultimate it appears that the magnitude of the deformation occurring with each moisture cycle continues to decrease slightly with each successive cycle. So far, 30 cycles have been completed.

The effect of temperature cycling on the deformation of beams is being investigated and it appears that although the deformation is enhanced during the first increase in temperature, subsequent increases have no effect. The increase in fractional deflection during a temperature rise from 20°C. to 50°C. is similar in magnitude to that occurring in a beam drying under load, but as the effect of moisture change continues with subsequent cycling, it assumes greater importance.

Electrical Studies

Salts in Power Pole Timbers. - Some concern has been expressed at the apparent increase in electrical conductivity of power poles which have been treated with soluble salts. The main area involved seems to be in Queensland where the rainfall and humidity are higher than average. At the request of the University of Queensland, we have commenced a small test on spotted gum, to study (a) the effect of salt on the electrical conductivity of the sapwood at a given moisture content, (b) the effect of salt on the moisture content at a given relative humidity, and (c) the variation of electrical conductivity of the specimens when exposed to outside weather conditions. At the moment work is in progress on (a).

Microwave Moisture Meter. - Preliminary work has commenced to assess the practical application of the attenuation of a beam of microwaves as a measure of moisture content in wood and wood-based products. A beam of radiation of 3 cm wavelength is passed through the specimen under test from a transmitting horn and picked up by a similar horn connected to a receiver. The added attenuation due to the presence of the specimen in the beam is a measure of the total quantity of water present in the beam. The advantages of the system are:-

(1) A firm contact with the specimen is not required, i.e. it can be used on moving material.

(2) The instrument is not unduly influenced by the exact location of water within the beam, i.e. by moisture gradients.

(3) It is more insensitive to conducting salts than the normal type of R.F. moisture meter.

The main disadvantages are:-

(1) Initial cost. £500-1000.

(2) Readings are proportional to the density of the timber. The instrument measures the water in a given volume of the specimen instead of on a weight basis.

Collection of Data

In addition to the research programme, a systematic collection of data is being made along the following lines:-

(a) Shrinkage and density of woods from New Guinea, Fiji and the Solomon Islands.

(b) Moisture meter correction data for woods from the same sources.

(c) Creep data for use in engineering design.

Discussion

Bryant: I am interested in the microwave moisture meters. Apparently they suffer from much the same disabilities as the capacitance type meter but the cost of the instrument seems to be much lower than the American types. Could this instrument be adapted to field measurements of moisture content in sections of growing trees?

Clarke: Overseas this meter has been used for measuring the moisture content of brick walls of some substantial thickness, also concrete, so I think that at least theoretically it would be possible to use it on sections up to 12 in. thick.

Jacobs: Does work on fracture include compression?

Grossman: At the moment we are concentrating on shear but we certainly have in mind investigating compression and tension as well.

Uprichard: Maddern Harris reports that following the theoretical work done by Barber and Meylan (Holzforschung 1964) relating shrinkage in wood to microfibril angle, practical work by Harris and Meylan will be published in Holzforschung later this year. This shows that the relationships between microfibril angle and longitudinal and tangential shrinkage are not linear. Longitudinal shrinkage is at a minimum for microfibril angles of approximately 30° but rises very sharply at angles greater than this.

Additional work is planned to study the effects of cell wall thickness using species such as Douglas fir, Cupressus spp. etc.

Jacobs: Does the work on electrical conductivity give any lead at all on what happens when lightning strikes?

Kingston: I do not think so. The electrical impulses on the pole struck by lightning are rather different from the sort of static conditions that apply in this work. The Queensland University is doing a lot of work in this field.

Ryley: I have a comment concerning salt treated power poles in Queensland. Two people were killed on treated poles which were blamed for the fatality.

In the past 3 years or so in Queensland only treated poles have been used and according to the electrical authorities, the incidence of accidents has been no greater than it was with untreated poles. They are practically convinced that the moisture content of the pole is the critical factor, not necessarily the treated sapwood. They have tested a number of poles in Brisbane and the pole that was showing the highest conductivity was an untreated pole that had been up for about 15 years. The Southern Electric Authority have an instrument which they are using on all poles before they are climbed to ensure that there is no danger. Treated poles have been erected in Queensland in some instances within a week of treatment. Now no pole leaves the treatment plant until it has been drying for about 6 weeks or has been checked with this instrument to ensure that the conductivity is not high enough to cause any injury.

Boyd: There was a fatality recently in Victoria during the erection of a pole which touched a high voltage line, but in this case it appears that the pole was quite wet at the time of erection; however, because it was a treated pole the treatment was blamed.

Kingston: From work overseas it appears that there is as much as an order of magnitude of difference between the conductivities of poles treated with different salts.

Clarke: We have found that the sapwood of spotted gum treated with Celcure A has a conductivity about three times greater at almost all moisture contents as compared with a water treatment using the same species. Overseas it has been found that red pine treated with the corresponding salt has roughly 6 - 8 times the conductivity of the same species that has just had a water treatment.

Edwards: Have you carried out any tests on Boliden salts bearing in mind the comparisons that have been drawn between the oxide formulations on the one hand and preservatives such as Tanalith C on the other? Secondly, what was the size of the specimens on which the work was carried out?

Clarke: We have only used Celcure A. There is a paper published in the Journal of the American Woodpreservers Association by Katz and Miller which deals with the conductivity of red pine impregnated with Boliden salts. The specimens we used were 1 in. square and 12 in. long and contact was made with them at the ends by means of conducting silver paint.

Ryley: Treated sapwood is not the only cause of this trouble, as the linesmen when they are climbing have their irons into the heartwood. Some of the electrical authorities think that the answer is to take more care with the insulation at the top of the pole.

Clarke: The very limited tests that we have made on the heartwood of spotted gum have shown that the conductivity of the heartwood is negligible.

Cokley: The Southern Electric Authority found that invariably leakage through poles is associated with the heartwood. This problem has caused us some concern and one of the Regional Electricity Boards have requested a treatment plant to treat with Boliden salts. We have advised them and the Commission that none of our plants are treating with Boliden and we would be reluctant to accept the small amount of work done overseas as applying to our species. The Southern Electric Authority is now satisfied that, with their method of pre-testing, the matter is under control.

Smith: Amongst the disadvantages of microwave moisture meters, it is stated that the reading is proportional to the density of the timber. Is not this possibly a disqualifying disadvantage, in that the density of material coming from a planer can vary from one part of a board to another, especially in hardwoods where sapwood is present and in Pinus species due to variation in percentage of late wood.

Clarke: The industry now uses both the dielectric constant type of moisture meter and also the power loss type of moisture meter. Both of these give a reading in proportion to the water in a given volume, hence would suffer exactly the same disadvantages as the microwave type of moisture meter.

Item 3(b). Moisture Meter Correction Figures. *

Imported Timber. - Many enquiries are received regarding correction figures for moisture meters for imported timbers, in particular those from Malaya. Our advice is that if readings below 15% can be obtained, then the timber is most probably dry. Testing timber brought in for m.c. determinations shows this is usually so.

Has any investigation of correction figures been carried out or proposed?

Local Timber. - The correction figures are determined for air dried timber, where the moisture gradient is normally low. Testing kiln dried timber has given variable results, principally depending on thickness, and the nature of the moisture gradient.

If this is steep, the meter may give a low reading. If the blades reach the wet core, a high reading can be obtained.

Using nails for thicker timber gives the high core reading only. This usually has very little correlation to the average moisture content of the piece.

Comments on the above would be appreciated.

Discussion

Wright: The only solution to this problem is to cut a section and to do a moisture distribution test. It must be recognized that we accept certain limitations in the moisture meter. Timber inspectors can often overcome the problem by driving nails progressively into the timber, in which case the gradient can be picked up by a sudden change in moisture content reading.

Marshall: Unfortunately, the nail method does not give the average moisture content. This problem arises particularly in mills which are dressing timber; the case may give an acceptable moisture content reading but after dressing the blades of the meter penetrate deeper into the core resulting in a higher reading and the timber being rejected.

* Prepared by P. Marshall.

Uprichard: In New Zealand there is a continuing demand for correction figures for minor species (for the Techtron meter). Other makes of meter are on the market including the K.I.M. and Protimeter. Some correction figures are being provided for these and it is noteworthy that one maker claims that correction figures are not needed.

Marshall: Judging by the literature we receive on imported moisture meters, Australia seems to be the only country in the world that worries about correction figures.

Clarke: Princes Risborough published some figures some time ago covering a range of European species, so apparently they at least are aware of the problem.

Whiteside: Have there been any correction figures prepared for Fijian species?

Edwards (D.F.P.): We are working on both Fijian and New Guinea species at the present time and have issued figures for 32 Fijian species. Another 18 Fijian species are being tested. Provisional figures have been issued for 15 New Guinea species and we are testing another 21 species at the moment.

Marshall: The Malayan species, particularly the merantis, are creating quite a problem in New South Wales. We have checked some of them in the oven, particularly in the region of 12 to 15 per cent., and generally the correction does not appear to be particularly high.

Blomquist: Referring to the problem of moisture meter correction figures, in Madison, we are aware of the difficulties but have always considered a moisture meter to provide a relative indication only to enable sorting into moisture content classes. We have encouraged the users to do their own spot checks by oven-drying methods and hence to develop a relationship with the meter figures. Whilst we are not unaware of the problem we have not made any major effort to develop correction tables for our timbers.

ITEM 4. WOOD PRESERVATION

Item 4(a). Review of Research Activities

I. DIVISION OF FOREST PRODUCTS *

Important aspects of our work since the 1963 Conference are discussed briefly in this review. Items listed for later discussion are mentioned only sufficiently to retain continuity and perspective.

Small Specimen Field Tests. - The very comprehensive test of preservatives, involving over 6000 stakes, has been installed at 8 sites in Papua - New Guinea, Queensland, New South Wales and Victoria. In all, 42 different preservatives were used for the treatment of sawn pine sapwood, round eucalypt and sawn eucalypt heartwood specimens. Sites chosen were respectively near Port Moresby and Rabaul; at Innisfail and Millaroo (about 40 miles west of Ayr); at Pennant Hills (Sydney) and Manning River (near Taree); and at the O'Shannassy reservoir near Warburton and at Walpeup in the Victorian Mallee.

The Division has received much help from other Departments in the provision of sites and the installation of specimens and will be grateful for the continued co-operation of the Forest Services to facilitate regular inspections.

Marine Borer Tests. - These tests of preservatives have now been in progress for about 5 years in the Brisbane River, at Sydney and at Kwinana and Port Hedland in Western Australia.

At the last Conference it was reported that fixed copper salts at about 1.7 lb/cu.ft. were proving as effective as creosote or creosote-tar in both pine and eucalypt specimens. This good result has continued to hold for the sawn radiata pine specimens, but with the round eucalypt the copper salts have proved less reliable than the creosote, particularly at Port Hedland. At this site the results appear to condemn CCA salts for treatment of eucalypt timber.

* Prepared by N. Tamblyn.

Rail Sleeper Tests. - The test of treated sleepers at two sites on the Commonwealth Railway (197 and 817 miles west of Port Augusta) when inspected after 11 years service, provided an impressive argument for high pressure creosote treatment of karri at loadings as low as 4 - 5 lb/cu.ft. It is disappointing that more than a year after our report was issued there has still been no action by the timber or preservation industries to capitalize on this favourable result, despite a trend towards use of concrete sleepers by the Commonwealth Railways.

A small test of 3 species of mangrove sleepers from Papua - New Guinea, after 11 years under heavy traffic in the Melbourne metropolitan track, has also given a most favourable result for the creosote pressure treatment. As these mangroves appear to treat at 200 lb/sq.in., the possible commercial significance of this result should not be overlooked.

Tests of Timbers and Preservatives in Cooling Towers. - During the last 5 years small slats of about 20 timbers have been exposed to soft rot in 29 cooling towers located in all States. One preservative treatment (Tanalith C at 1.25 lb/cu.ft. in radiata pine sapwood) was included for comparison. As expected, this treatment has proved superior to the best untreated timber (Californian redwood), but the main lesson of the test has been that accepted natural durability ratings give little indication of resistance to soft rot. Thus Douglas fir has proved superior to wandoo, and radiata pine heartwood superior to jarrah, while karri has proved slightly better than tallowwood.

A new test of many different preservative treatments has now been commenced in 8 selected towers.

Termite Investigations. - Previous field tests of specimens protected from leaching have shown that boron compounds are much less termiticidal than arsenic compounds. These tests have also suggested that their field performance is not as good as indicated by laboratory tests.

A new and better controlled field test is now in progress using pine specimens pressure treated with borax and protected from leaching. Results so far are more favourable than expected and indicate that about 0.25 lb/cu.ft. boric acid equivalent may be sufficient to deter Coptotermes sp., when untreated specimens are also readily available.

A survey of the incidence of termite attack in the Melbourne area is being made and about 600 cases of infestation have now been plotted on a map which is proving very useful in assessing hazards in particular areas.

A new site for termite tests, with high hazard from Coptotermes acinaciformis, has been obtained on the Victorian Mallee Research Station (Department of Agriculture) at Walpeup near Ouyen. Over 1200 specimens have already been placed in test.

Retention and Distribution of Creosote in Eucalypt Poles. - A study has been made of the retention and distribution of creosote in pressure treated eucalypt poles but unfortunately a confused and unsatisfactory picture has emerged.

Weighing of individual poles has revealed a very wide scatter in loadings (often 4 - 20 lb/cu.ft.) and shown that with mountain grey gum over 25 per cent. of the poles were failing to reach 8 lb/cu.ft. compared to about 5 per cent. in two other species. Analysis of plugs has shown that while variation within a pole in a straight line from butt to top is seldom important, variation around the periphery at a given level may occur to an alarming and inexplicable extent. Variation from about 6 - 14 lb/cu.ft. has been found in plugs taken around a pole - all the same height from the butt. Because of this "sectoring" no single measurement appears to give a reliable assessment of treatment. This conclusion has been borne out by examination and analysis of old creosoted poles from the Belgrave test site. No correlation could be found between present condition and the origianl or present creosote loadings and it was observed that radial distribution of creosote in the sapwood was a further variable and complicating factor.

Penetration of Preservatives. - A fundamental study is being made of the movement of liquids in wood when injected under pressure. This work is being done by Dr. Rudman who is temporarily absent on a fellowship at the University of Leeds.

With eucalypts it is now well established that preservatives enter the wood by movement along the vessels followed by slow and usually restricted distribution into the surrounding elements via the pits. In heavy eucalypts such as spotted gum, this lateral movement may be so limited with non-polar liquids such as creosote, that almost all the preservative may remain indefinitely in the vessels. At present there seems little hope of developing new treatment schedules for eucalypts which would greatly improve existing good practice.

Treatment of Timbers from Papua-New Guinea. - Approximately 70 species from Papua-New Guinea have been tested for treatability in pressure and diffusion treatments using material from 5 trees per species, cut from the cambium inwards to give an 8 in. wide quarter-sawn flitch.

In pressure treatment at 200 lb/sq.in., with a CCA preservative, 16 per cent. of species treated readily to the full 8 in. depth and a further 16 per cent. were reasonably permeable. The remaining 68 per cent. were considered too impermeable or too erratic for pressure treatment of sawn timber with non-diffusing preservatives. By comparison, the picture with 1 month diffusion treatment was most favourable as all species penetrated at least reasonably well.

Pressure Treatment of Eucalypt Sapwood. - Tests on eucalypt sapwood, including sapwood of spotted gum have been made with a CCA preservative, to determine the merit of a long high vacuum and of treating at higher than usual moisture contents as is now recommended in Queensland.

Results show that the long high vacuum does increase net retention a little (because of less kickback) but it does not appear to improve penetration when judged macroscopically.

Treatment at near green condition does seriously reduce uptake of aqueous preservatives but at lower moisture contents (e.g. 30 - 50 per cent.) a satisfactory treatment can be obtained. This latter result has been known to the Division for some years but we have been, and still are, cautious in making recommendations because of difficulties in measuring and controlling moisture contents above 30 per cent., and because of the possibility of sludging of CCA preservatives.

Retentions for Metal-Chrome-Arsenic Preservatives. - The schedule of retentions recommended for metal-chrome-arsenic preservative by this Division and presented at the 1961 Conference has now been in unofficial use in Australia for some years. During this time it has been thoroughly examined by the Preservation Committee of this Conference and has been enlarged to include recommendations on penetration. It has been circulated abroad and in its latest form has been submitted on request to the Australian Standards Association for inclusion in a standard now being drafted on "Preservation of Building Timber". Unfortunately the drafting panel for this standard is trying to mutilate these recommendations and the results of a serious research project since 1959 are in some jeopardy.

Effect of Pressure Treatment on Sirex Emergence. - The Division has co-operated with Plant Quarantine to determine whether pressure treatment of sawn radiata pine with a CCA preservative will prevent emergence of wasps. The results have shown that such treatment is ineffective, though almost certainly only the pupal stage is resistant.

Laboratory Tests on Australian Creosotes. - Work reported at the last Conference indicated that a creosote of low phenolic content, produced by Union Carbide, compared most unfavourably with other Australian creosotes, when tested in radiata pine sapwood by the ASTM method. This result has since been confirmed with several eucalypts, with longer weathering and incubation periods, and with 3 brown rot fungi other than Lentinus lepideus. Termite tests by the Division of Entomology have produced the same pattern though with somewhat less difference between preservatives.

This work has resulted in amendments to Australian Standard K.55 to increase the phenolic content of creosotes for wood preservation.

Durability of Timbers from Papua - New Guinea and Fiji. - Laboratory decay tests by the soil-block method have been completed for 27 timbers from Papua - New Guinea and 27 from Fiji. These tests were made on the inner and outer heartwood of several trees of each species, and for comparison 5 or 6 well known "yardstick" timbers were included in each test.

Tests on Lyctus susceptibility are in progress on about 90 timbers from Papua - New Guinea and 33 from Fiji. In most cases 5 trees from each species are being tested. Tentative susceptibility gradings have been made for about 70 species from Papua - New Guinea, about 20 from Fiji.

Addition of Arsenic to Creosote Oils. - It has been found that small quantities of arsenic trioxide can be dissolved in Australian commercial creosotes, that this arsenic is carried into the wood in pressure treatments, and that most of it is resistant to leaching.

It is considered that as little as 0.3 per cent. As_2O_3 in commercial creosotes would increase the termite resistance of treated poles and posts at very low cost. The question must now be asked whether this addition should be recommended without further test as practical proof of its effectiveness would be slow and difficult to obtain.

Effect of Wood Characteristics and Preservative Distribution on Decay Resistance. - A preliminary study has been made of the effect of timber species and wood density on performance of CCA preservatives. Results show that considerable differences in threshold occur with different timbers but no clear cut relationship has been found with botanical classification, density or decay susceptibility of the untreated wood.

There is much need here for further work as any effect of density on preservative thresholds is of great importance in Australia.

In other work the progress of decay is being studied in situations where treated and untreated wood are in close contact. Results using a CCA preservative and specimens made from $\frac{1}{8}$ in. laminations, have indicated that an untreated lamination sandwiched between treated wood will decay, with or without retardation, depending on the fungus and the adjacent retention. It also appears that proximity of untreated wood can accelerate decay in adjacent treated wood.

The Durability Pattern in Eucalypts. - It has been established for jarrah, that the durability of the heartwood decreases as it ages in the green tree, probably because of chemical changes in the toxic extractives. Thus the relatively non-durable core increases with the age of the tree and wood which was once durable becomes progressively less so. There is some evidence that this is a common pattern in eucalypts and that therefore more attention should be paid to elimination of inner heartwood from sawn timber purporting to be highly durable.

Plywood Preservatives. - At other Conferences we have criticised the sale of plywood made from non-durable timbers but described as "marine", "waterproof" or "external" though given no preservative treatment other than Lyctus immunization. Unfortunately proprietary CCA preservatives when used for treatment of green veneer have been blamed for subsequent gluing difficulties or avoided because of high arsenic content and the probable hazard from sanding dust.

In an attempt to meet this problem several preservative formulations have been developed for test. These are metal-chrome-arsenic preservatives containing copper, zinc and nickel oxides, used alone and in combination, and containing arsenic at minimum concentration. These preservatives are now being compared with typical proprietary salts in regard to leach resistance and residual toxicity after leaching and some will be selected later for gluing tests.

<u>European House Borer</u>. - Most estates in Victoria containing imported prefabricated houses have now been thoroughly examined by Housing Commission inspectors for signs of <u>Hylotrupes</u> infestation. All cases of infestation in those houses have been studied by Officers of the Preservation Section and we have now reached the opinion, that with one possible exception, all infestation seen originated before the timber was imported. We are constantly looking for any indication that breeding has occurred in Victoria, as we believe that sooner or later establishment of <u>Hylotrupes</u> somewhere in Australia is inevitable. If this philosophy were accepted by all and the utmost vigilance exercised, chances of eradication would be much improved.

In a hoop pine plantation area in Queensland a discovery was made during routine collection of fruit bodies for the Division's collection, of a fungus which appears to be identical with <u>Fomes anosis</u> which is a destructive pathogen in Europe and in parts of America. It causes root rot in certain conifers. It is not yet known whether the Queensland fungus, which appears to be harmless to Araucaria could or would be pathogenic to Pinus species. A similar situation exists in New Zealand where a fungus believed to be <u>Fomes anosis</u> is being watched very carefully.

<u>II. NEW SOUTH WALES</u> *

Many of the items mentioned here will be discussed in more detail elsewhere. In this review the work is described as far as possible under broad species groups in accordance with the Commission's new integrated research programme.

<u>Exotic Softwoods</u>.

(a) A long term study has commenced of the fungal degrade of exotic softwoods. In this work special attention is being paid to plantation grown radiata pine. Suitable techniques have been developed for the sampling of pine logs, and bark, and progress has been made in methods

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* Prepared by D. W. Edwards.

for the sampling of soil and air spora.
Main lines of work are the ecological succession of stain and decay in stored radiata logs; the effect of severe fires on such successions; and the development of fungal degrade in seasoning stacks, and timber in service.

(b) A detailed study of the ecology of the furniture beetle, Anobium punctatum is under way. Again special attention is being given to the future utilisation of radiata pine. The excellent cooperation received from the Pest Control industry, C.S.I.R.O. and Government Departments, has made it possible to commence detailed mapping of the distribution of Anobium in N.S.W, and the establishment of laboratory cultures of the insect. During the coming year it is proposed to investigate the effects of high roof cavity temperatures on mating, egg laying, and larval development. A new insectary has been completed which gives precise temperature and humidity control and it is intended to use this to evaluate new Anobiids.

(c) The third survey of imported prefabricated houses and other locations in which Hylotrupes attack was possible has now been completed. A further inspection is planned for 1966.

(d) A 1000/200 psi experimental pressure plant designed by Mr. Dale (D.F.P.) is under construction. It is proposed to use this plant to investigate within-charge variations of retention in locally grown radiata, and for experimental semi-green treatments.

(e) Field tests. At the Commission's request, D.F.P. prepared and treated a large number of radiata pine stakes for field testing of CCA and boron salts. These have been installed at three sites, two (by DWT) in N.S.W. and one in Victoria (by D.F.P.) and are expected to yield a great deal of useful data on current commercial formulations.

Brush Box. - Stake tests comparing brush box with several other N.S.W. timbers have been laid down at three N.S.W. test sites. In addition we have set up an above ground "V-joint" durability test (Utilisation Section) and a ground contact test.

Messmate stringybark. - the problems of pencil streak and brown stain have been investigated in over-mature *Eucalyptus obliqua*. The N.S.W. pencil streak condition is due to fungi associated with insect attack and does not appear to cause decay. Three types of wood decay were consistently isolated from the brown stained areas including *Polyporus portentosus*, Berk. The effect of these fungi on the utilisation of the material for mining timber will be discussed elsewhere.

A new species of pin-hole borer has been found in the course of this work.

Flooded Gum. - Plantation grown in N.S.W. *Eucalyptus grandis* is subject to considerable degrade from insects and decay. It has been shown that the decay is associated with mechanical damage, principally wood moth attack and faulty branch shed, and it is most common around the branch traces. A number of wood decays have been isolated but these have not yet produced identifiable sporophores. Progress of these decays is rapid in the non-durable truewood.

Pressure impregnation of a number of flooded gum transmission poles give disappointing results due to absence of sapwood at the branch trunk junctions. The economic future of the species is in doubt.

Hardwoods. - A small scale investigation of the hot and cold bath creosote process has been made at N.S.W. first commercial plant of this type. Results are very encouraging.

The Hudson rapid test for creosote retentions was compared to the standard A.W.P.A. test. The former test appears unsuitable for Australian hardwoods.

Work has been done on the effect of vessel diameters, and starch thresholds on Lyctus attack; on bromine type fire retardants for fibre board; the field testing of preservative treated bee boxes; the fixation of copper pentachlorphenate in veneers; the development of conductiometric methods for the continuous recording of preservative leaching; the usefulness of X-ray techniques for Lyctus and Anobium studies, and on bostrychid attack in logs.

Field Tests. - The Commission has field testing stations in several parts of the state where both its own and the large scale C.S.I.R.O. tests are installed. Space at these sites will be made available also, wherever possible, to other members of Conference. Details of several of the long term tests are reported elsewhere.

General. - The generous assistance given to the Section by C.S.I.R.O. by way of staff training, plant design, materials, and advice is acknowledged with much pleasure.

III. QUEENSLAND *

Over the period under review, the main aspects in this field have been the following:

Sawn Timber. - The use of CCA salts has expanded to such an extent that currently there are 20 plants either in operation or under current construction. These range in size from 30 ft x 3 ft diameter to 88 ft x 6 ft with an average size of the order of 50 ft x 4 ft 6 in. Production ranges from approximately 1,000 super ft/charge to 10,000 super ft/charge with an overall average of 3 - 4,000 super ft. Products include sawn building timber, poles, piles, posts, cross-arms, cooling towers. These plants have introduced a number of major problems and as a result the primary work in this field ranged from detailed study into the solubility of CCA salts with hard waters and the effect of softeners to methods of plant control.

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* Prepared by K. Oakley.

As the result of problems with local species, incidence of insect attack in predrying etc., work was concentrated on the development of high vacuum techniques, the development of the Vacuum Pressure Diffusion Process and treatment characteristics of local species, particularly the rain forest species.

In spite of these developments, this Department does not consider the expansion in general purpose treatment justified particularly where plants are operating primarily at immunisation levels. Consequently a considerable amount of time is spent in endeavouring to dissuade unnecessary installation, or, where such plants have been installed, recommendations have been made to use boron as the immunisation chemical.

In all cases it has been necessary and desirable that studies be carried out on the commercial level and corresponding chemical analyses made to determine species characteristics, plant variation and effectiveness of treatment.

Two major publications upon this work have been completed in the draft form, and a third is to be prepared in the near future.

Chemical Analysis. - Chemical analyses in this field have occupied the major time of the laboratory and approximately 400 analyses of components per month of both treated timber and solutions are made. In addition, spot tests, primarily of Boron treatments, of the order of approximately 2,000/yr are carried out. A total of 5,000 chemical analyses were carried out last year.

Detailed studies into methods of analysis of fluoride in veneers, CCA preservatives and spot tests have been carried out. The opportunity was available to test out atomic absorption and after discussion with the Division and Division of Chemical Physics; it was found that with CCA preservatives this instrument is at present suitable only for copper and chromium. Check determinations by X-ray spectrographs and by the 3-metre grating spectrograph are being carried out on our behalf by English firms.

New Formulations. - This is referred to under a separate section but recently one firm introduced a new anhydrous formulation which has given difficulty in mixing. We have suggested that the firm revert to the previous formulation until investigations of the new salts are completed.

Field Tests. - Stake tests installed at three centres are inspected annually. These tests include 11 major species and 4 treatments. In addition separate undercover tests against Lyctus have been carried out. In total, approximately 5,000 specimens are involved.

Railway Sleepers. - Test sites for rail sleepers at Normanby and Milton in Brisbane and Deeral in North Queensland have been inspected. Whilst Milton and Deeral have been installed for a few years only, present indications favour the oil-borne treatment. Results at Normanby (approximately 13 years) show the major effect of species and oil-borne treatment.

Dieldrin treatment of veneer. - Application of the Dieldrin treatment of veneer for Lyctus by momentary dip has continued to expand and currently 5 plants are using this treatment.

CCA treatment of veneer. - Our studies of veneer and plywood treatment by CCA salts have made us reluctant to see veneer treatment above the 0.35 lb/cu ft level because of gluing difficulties. In the case of plywood, whilst treatment is satisfactory except for certain species, re-drying presents a major economic and practical problem.

Sodium fluoride treatment of veneer. - Whilst this will be referred to elsewhere, major attack by both Lyctus bruneus and Lyctus decidens developed in fluoride treated veneers at one plant in North Queensland.

Detailed surveys of treatment by fluoride in North Queensland showed that for practical purposes it was not possible to obtain solution strengths over approximately 3.5 per cent. and although mills were doing all that could be expected, approximately 40 per cent. of the veneers analysed were below the legal minimum of 0.1 per cent.

Anti Sapstain (veneer). - Considerable application of sodium PCP has been made and in commercial operation it was necessary to insist on plant control of both pH and concentration. A suitable field method for both aspects has been developed using Laviland comparator techniques.

IV. NEW ZEALAND

Methods of Treatment *

(a) O.P.M. A technical paper covering the first series of experimental O.P.M. trials was published in 1965 and the final series has been evaluated and is awaiting publication. So far all trials have been satisfactory technically and economically. T.P.A. approval has been granted for O.P.M. treatment of 2" and 3" building timbers (radiata and Corsican pine) and successful trials have been made with radiata and Corsican pine fence battens and fence posts, and radiata marine piles (45 ft x 16 in. butt diam.)

(b) Lowry treatment with copper-chrome-arsenate solution. Trials showed very little disturbance of the solution balance but a slight rise in the pH with successive charges. It has now been given a general approval by TPA and is likely to be used increasingly for both building timber and natural rounds.

(c) Suction sap displacement. A simple cheap and economic unit has been developed for treating fence posts with copper-chrome-arsenate solutions. All softwoods appear to treat satisfactorily although some take a fair time, 6-10 hours. Hardwoods are variable; some do not appear to treat at all while some are extremely good. Poplar posts treat in $\frac{3}{4}$ hr giving a good distribution and fixation of the salt.

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* Prepared by A.J.McQuire.

Toxicity Testing *

(a) Creosote and creosote/oil in radiata sapwood.

Soil block tests showed that the toxicity of creosote/fuel oil mixtures was dependent on the amount of creosote in the mixture; the fuel oil contributed nothing. Threshold values for the standard creosote used in treating radiata pine railway sleepers were about 4 lb/cu.ft. after weathering.

(b) Toxicity of creosote/oil mixture in radiata heartwood.

A preliminary investigation using heartwood showed that the retentions obtained were inadequate (0-4 lb/cu.ft. of creosote/oil mixture) to prevent decay. Retentions of creosote and oil (plus extractives) gave less protection than equal retentions of creosote and oil in the sapwood.

Degrade in P. radiata posts ** - Experimental stacks are being placed out at monthly intervals in two Central North Island seasoning yards, and sampled after 1 and 3 months to determine (1) the frequency and seasonal prevalence of sapstain and decay in P. radiata posts during seasoning, and (2) the relative importance of the fungi responsible for these types of degrade. This project was started in November 1964, and is still current.

Results to date show that sapstain and decay occur only after 3 months, though often severely, in posts erected in midsummer. From late summer onwards both types of degrade were present in at least 50% of the posts after 1 month. By the third month all posts were stained, many heavily, and at least 75% of them had incipient decay present.

Spore trapping in seasoning yards ** - Using the agar-plate method, and trapping at weekly intervals, the effect of climate on, and the seasonal periodicity of, spore dispersal of both sapstain and decay fungi is being investigated. Daily meteorological readings are taken in conjunction with this work.

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* Prepared by A.J.McQuire.
** " " J.A.Butcher.

<u>Deterioration of wood chips in outside storage</u> ** - This project has recently been undertaken in conjunction with Tasman Pulp and Paper Co. Ltd. An experimental stack measuring approximately 60' long x 30' wide x 10' high was erected in April 1965. Samples are being taken at monthly intervals from predetermined areas throughout the stack for mycological examination. The temperature of the stack and moisture content of the chips are being determined by Tasman Pulp & Paper Co. Ltd., who are also responsible for the pulping studies.

It is too early at this stage to provide an interim report of this work.

<u>Staining in red beech sapwood</u> ** - This investigation was undertaken in conjunction with a seasoning trial of red beech which demonstrated that both forced air drying and treatment with a sodium azide/borax dip prevented sapstain. Antisapstain, and boron solutions were shown to reduce the staining slightly, and steaming of the boards to increase it, when compared to the controls.

Fungal hyphae were not present in either the forced air dried, or azide treated material. In the boron, antisapstain and control material, hyphae were predominantly present in the rays. An unusual feature was that all the hyphae were hyaline, and their presence appeared to be related to the discoloration (orange-red) of the contents of the ray cells.

<u>House Fungi</u> ** - A survey of fungi causing decay in housing timber throughout New Zealand has been undertaken. Material is being supplied by the New Zealand Wood Preservers' Association and the State Advances Corporation.

<u>Identification of Basidiomycetes</u> ** - A continuous project is the identification of wood rotting basidiomycetes in reference to their cultural characteristics.

** Prepared by J.A.Butcher.

P. radiata heartwood ** – A project has just been implemented concerned with the treatability and durability of P. radiata heartwood. The main facets of this investigation will be to:

(a) Study the range of durability of populations of P. radiata on a geographical basis.

(b) See if there is any correlation between durability and treatability.

(c) Improve methods of treatment of P. radiata heartwood.

(d) Establish the causes of natural durability.

Wood Preservation Chemistry * – Extensive use is made of X-ray spectrography for the analysis of copper-chrome-arsenate preservatives both for routine analysis and for research projects. A study is being made on the distribution of the components of these preservatives in certain native species, particularly kahikatea (Podocarpus dacridioides), matai (Podocarpus spicatus) and rimu (Dacrydium cupressinum), in which preferential absorption of the copper component is particularly marked.

Discussion

Marshall: Regarding distribution of creosote in poles, has the moisture content been accurately determined?

Tamblyn: Yes, so also has density, and we have found considerable variation in these and in green moisture content. This problem is partly inherent in the wood itself.

Wright: We have found that poor stacking results in wet spots at various places along the length of a pole and this must inevitably affect subsequent treatment. Rain can also cause the upper surface of horizontal poles to be 10 or 15 per cent. higher in moisture content than the lower surface. It is therefore a matter of education to see that pole preparation is carried out using proper stacking and covering procedures.

** Prepared by J.A.Butcher

* " " N.Cummins

Smith: What were the three species of mangrove tested for sleepers? We are rather interested in this for possible use in sugar areas.

Tanalith-treated hoop pine is being used in cooling towers in Queensland and we expect it to perform as well as treated radiata pine.

We are aware of the existence of root rot fungi in plantations in Queensland and we are interested to see that the Division is watching this. We are not certain that Fomes attacks hoop pine, but we do know that there is a root rot pathogen attacking hoop pine in North Queensland and we think there may be a root rot of some type in South-east Queensland plantations.

Tamblyn: We can supply details of the species of mangrove tested for sleepers.

DaCosta: We tested only one set of preservative-treated cooling tower slats as the project was mainly on the durability of untreated timber. For the treated slats we used radiata as this was readily available, but, I have no doubt that we would have had the same result with hoop pine. However, we cannot assume that all species of timber will perform similarly with the same preservative. This test was intended to prove that CCA treated timber would perform better than the best of the naturally durable timbers, which it did.

We are familiar with the Queensland work on root rots in hoop pine and I think we have identified one of them tentatively as Fomes noxius. Our discovery of what appeared to be Fomes annosus in North Queensland is of particular importance. This is a matter that forest pathologists throughout Australia have been worried about with regard to our pine plantations, as Fomes causes very severe losses in Europe and quite severe losses in the U.S.A. We therefore have no reason to assume that it will not cause severe losses here, particularly on regrowth material. However, there is still considerable doubt as to whether it is really Fomes annosus. Morphologically, it is identical, but I believe they have the same problem in New Zealand where what appears to be Fomes annosus is not behaving typically and the whole problem is now under intensive examination in North Carolina by Dr. C.S.Hodges Jn. who is making a study of Fomes annosus from all over the world. We have sent the Queensland material to him and are awaiting his report.

Walters: Fomes noxius and Fomes lamaensis, are very similar fungi, Fomes noxius coats the base of the trunk with a smothering layer and both of them appear to be parasites. However, we are not familiar with them in the field. As far as Fomes annosus is concerned there is another fungus Fomitopsis insularis (F.annosus is known here as Fomitopsis annosus) which has very similar conidiophores in culture and this has been most confusing. It may be that we are dealing with different strains of the one fungus. Fomes causes varying degrees of damage overseas but the strain we have may be milder and the problem may not be serious here.

Smith: We would like to know how seriously New South Wales regards Anobium attack in Pinus radiata and whether attack has been observed in other species of Pinus.

Edwards: We have sent samples of New South Wales grown radiata to New Zealand and they were readily infested there. As yet there has been an insufficient interval since the utilisation of radiata pine in New South Wales for us to have any firm opinions. However, we receive between 1000 and 1500 enquiries annually regarding insects attacking timber and about 25 per cent. of these refer to Anobium attack, mostly in imported softwoods. We have seen only three or four cases of Anobium attack in local radiata in New South Wales. We have a strong suspicion that the optimum condition for Anobium attack is an e.m.c. of about 18 - 20 per cent. We anticipate that the majority of attack will be in sub-floor areas where poor floor ventilation will produce a high e.m.c. Overseas indications are that the temperatures to be anticipated in roof spaces in the Sydney area would be high enough to prevent Anobium activity, but our own work on the subject points to the fact that the insects can survive under these conditions.

Beesley: In Victoria it is very rare for us to find Anobium attack in Pinus radiata. We encounter a certain amount of attack in the Melbourne metropolitan area and the impression of the pest control industry is that it is on the increase.

Howick: Where we find Anobium attack in flooring, it is often concentrated on those portions having poor sub-floor ventilation, although this does not appear to be essential.

DaCosta: Regarding pencilling in messmate stringybark, we have observed pencilling in a number of eucalypt species and I think the macroscopic symptoms are the same, but I doubt if the fungus is always the same as there are several fungi which can cause this symptom. There is some doubt as to whether these fungi will ever cause decay in the timber in service, and I wonder whether inspection of the mines where timber is being rejected because of pencilling would perhaps show that it has been in service for many years and has not decayed more than the surrounding clear timber?

Edwards: Pencilling is associated almost exclusively with insect attack in the stand which we have studied, but we have found no wood decays in close association with it and thus cannot say that the pencilling has reduced the timber strength.

Bryant: Most of the so-called incipient decay in P. radiata, that has occurred in Sydney is due almost exclusively to the entry of water to the end-grain. We think that examples of hitherto inexplicable decay in the middle of boards on western walls of radiata clad houses in Sydney is probably due to the effects of incipient decay produced in the seasoning yards in New Zealand where much of this timber originated. The New Zealand preservation authorities have also realised this and legislation now exists prohibiting this material remaining in the open for more than six months simply because this type of decay can occur under these conditions. I believe that much of the radiata sold in the early days suffered from this decay which, of course, cannot be seen macroscopically.

DaCosta: I would like to stress the importance of incipient decay in radiata pine. It is not only a question of paint failure, but we feel that it is the cause of uneven distribution in preservative treatment. It also affects finishing and probably gluing.

Willington: Is there a simple method available to operators using the Lowry multi-salt treatment mentioned by New Zealand by which the solution balance can be checked.

Uprichard: In general, the check of solution balance in New Zealand is by hydrometer. By backing up hydrometer readings with regular analyses the plant operators soon get to know the reliability of this method.

Johanson: I think the hydrometer readings could be misleading and the only effective method would be by chemical analysis.

Uprichard: Extensive checks have shown only about 7 to 10 per cent. error using hydrometer readings. However, adequate chemical control backed by intelligent use of the hydrometer makes this a very useful instrument to plant operators. We do all our CCA analyses now by the X-ray method and we can perform three-element analyses within three or four minutes.

Johanson: Sludging is often accompanied by reduction in hexavalent chromium and once this reaction commences it is self-catalytic; alkalinity is produced with the formation of more sludging. This process may have an effect on the successful use of oscillating-pressure impregnation. With this method we may have some difficulty with those species which have a large content of soluble constituents.

Item 4(b). Preservation in the Territory of Papua and New Guinea *

Introduction

The biological hazards to which timber in use becomes subjected in the Territory of Papua and New Guinea are, as with any tropical country, extremely severe. Fungi, termites and borers find the warm humid conditions ideal for extensive activity and all have a considerable selection of species in which to operate.

Few species in the Territory possess natural resistance to the activity of the prevailing hazards and the few "durable" species available do not have a life expectancy comparable with the durable species in use in more temperate zones.

The associated problems thus faced by the local timber industry are of considerable economic importance:-

Life expectancy of timber in use is low and maintenance costs high.

Preference for the more durable species has led to a creaming of forest areas, with high unit area logging costs, incomplete forest utilisation and a decrease in the availability of preferred species.

The availability of alternate building materials is on the increase and, on a life expectancy basis, prices are competitive.

The need for timber preservation to play an integral part in preparing timber for use is thus obvious. Although the need has been recognised for many years, the introduction of preservation techniques on a wide scale has met with numerous difficulties. The financial year 1964-65 has, however, seen the successful introduction to the industry of a preservation

* Prepared by S. J. Colwell.

process for the protection of building timbers increasing the availability of treated timber from a negligible quantity prior to July, 1964, to a figure at present representing 75% of the Territory's building timber requirements.

History.

The following summarises preservation activities in the Territory prior to 1964:-

(1) As early as 1954, interest was shown in the preservative treatment of the highly susceptible Araucaria species aimed at its use for building construction in the coastal areas of high hazard. Towards the end of 1955 these species were being successfully treated by Commonwealth New Guinea Timbers, Bulolo, using the C.S.I.R.O. dip diffusion process with its formulation of boric acid, borax, disodium hydrogen arsenate (later arsenic pentoxide), sodium dichromate and sodium fluoride.

Approximately 150 houses were built in Port Moresby late in 1955 using treated pine from this sawmill. Maintenance reports on these houses have indicated the necessity for minor replacement work only.

(2) In 1956, Pacific Island Timbers established a pressure treatment plant in Port Moresby and commenced treatment of sawn timber using Tanalith "C".

(3) In 1960 dip diffusion plants were established at two small Papuan mills.

(4) In 1959 a detailed survey was carried out in the Territory by the Department of Forests in conjunction with the Division of Forest Products, C.S.I.R.O., the purpose of the survey being to ascertain the severity of the biological timber hazards throughout the Territory, to decide whether treatment of timber was warranted and to recommend suitable treatment methods. This survey and other observations over a number of years recognised

the biological hazards in the following order of importance:-

(a) Fungal decay
(b) Dry wood termites
(c) Subterranean termites
(d) Sapwood eating insects.

This revealed the necessity for the treatment of sapwood and of non-durable heartwood. In view of the prevailing problems it was recommended that all building timber should be treated in both the sapwood and heartwood and that one treatment be introduced aimed at bringing all species to the same high level of durability.

(5) In 1961, to act as a pilot operation, a diffusion plant was installed at the Administration sawmill at Lae. This operated over almost a complete year and proved most satisfactory. A mechanically controlled dip and a mechanical feed spray race were both tried out satisfactorily.

Introduction of Preservative Treatment to the Industry

Having established, beyond argument, the need for the preservation of building timbers, it was necessary to consider how preservation was to be introduced to the industry, i.e. was it to be made compulsory or was it to be left to the discretion of construction authorities or home builders.

Circumstances forced the decision that initially preservative treatment would be obtained on government buildings by contract specification. The private builder can, therefore, presently construct buildings using untreated timber.

The Process Introduced

The decision that the dip diffusion process would be the preferred treatment was made after careful consideration of the requirements, prevailing conditions in the Territory and the consequent advantages and disadvantages of available treatments. Some of the arguments influencing this decision follow:-

(1) Pressure treatments allow the use of salts which become fixed on contact while salts available to the diffusion

process are mostly leachable. However, the major requirement is for building timbers largely protected and paint maintained and not in ground contact.

(2) The major requirement was for treatment of heartwood as well as sapwood. Few Territory species accept penetration of the heartwood through pressure impregnation. Treatment by diffusion permits penetration of all heartwoods.

(3) Pressure processes require dry timber whilst diffusion processes insist on the use of green timber. The lack of drying facilities and the climatic conditions thus lent weight to the diffusion process.

(4) Cost of installation of process plants in this Territory with its large number of small sawmill operations was a major consideration. Efficient diffusion plants can be established at relatively small cost without the necessity to import materials and equipment. Many sawmills are dependant on costly air freight.

(5) There has been a considerable increase in the information available on species properties and uses over recent years, however, the problem of identification of the great diversity of species and the recognition of their requirements for preservative treatment still remains a major one. Diffusion overcomes this problem in the main by bringing all species to the same high level of durability.

The Dip Diffusion Process

Dip diffusion, a method of preservative treatment originally used in Australia for the protection of veneers, has recently been modified for the treatment of sawn timber of any thickness and now permits application of preservative chemicals by means other than dipping.

C.S.I.R.O. have developed a preservative salt consisting of a combination or mixture of inorganic water soluble compounds which are capable of being prepared in the form of a very concentrated solution from which the components will diffuse into the timber. C.S.I.R.O. have a patent on this method of treatment using this mixture of compounds.

Initially the salts used consisted of boric acid, fluoride salts, arsenical salts and chromium salts which had to be mixed with water at the treatment plant. Later developments indicated that the necessary preservative would be prepared as a single combined "dry mix", however, the cost of the "dry mix" is reduced by using two separate dry powders, one the boric acid and the other the "fortifier" containing all the other necessary chemicals to complete the formulation. At present only four licences have been granted for the manufacture of the C.S.I.R.O. patent preservative. The companies holding these licences are Hicksons Timber Impregnation (Aust) Pty. Ltd., United Chemicals Pty. Ltd., Celcure (Aust) Pty. Ltd., and Stauffer Chemical Co. (Aust) Pty. Ltd. These suppliers are required to give technical advice on the C.S.I.R.O. patent and are equipped to do so. Packages are pre-weighed and plastic sealed within 44 gallon drums, thus mixing is simplified, loss due to spillage is prevented and handling is minimised.

Although a C.S.I.R.O. patent, control of the dip diffusion process in the Territory has been undertaken by the Department of Forests who have the sole right of allowing or disallowing licences to operate the process.

The basic requirements of the dip diffusion process are:-

(1) The mixing of the chemical to the required concentration - approximately 39.7% - 40.0% (W/W) expressed on a borax pentahydrate equivalent.

(2) The application of the chemical solution to green-off-saw timber to wet the timber surface entirely.

(3) The placing of the wetted timber under minimum drying conditions for a period sufficient to permit diffusion from the highly concentrated solution with the natural water in the timber, to a set minimum depth.

The chemical can be applied by either dipping or spraying and both methods are being used in the Territory. As the requirement is for timber to be only wet with the chemical, efficient draining facilities permit maximum recovery of excess chemical.

The minimum penetration required is ½ inch. Under efficient diffusion conditions this penetration can be achieved in 21 days with most species. Efficient diffusion conditions are considered to exist when:-

(1) Chambers are used and constructed to the following specifications:-

(a) Of a size sufficient to accommodate two days' cut, no more and no less, so that mimimum air space remains between the top of the stack and the ceiling.

(b) To a design which encourages high humidity conditions within the chamber and prevents the entry and circulation of air. This means a cement or sealed wooden floor, double walls of rough sawn timber lined with polythene or of close fitting T & G or weather board. Gàlvanised iron roof with board ceiling and close fitting doors.

(2) Polythene or vinyl plastic is used to completely enclose stacked timber. This latter method has not been encouraged due to a tendency on the part of the operator to make stacks too large, resulting in premature drying of the chemical over sections of the stack. Torn covering must be carefully repaired and the cost of polythene or plastic encourages its over-use when damaged beyond repair.

Dip diffusion chambers of varying designs have been accepted for use. The designs used have generally been influenced by sawmill size and available space and the operator's ideas of economic handling. Mechanical handling is being perfected in a number of cases with the use of live rollers, conveyor belts and green chains. The Department of Forests has not laid down specific designs but approves or disapproves submitted plans before the issue of a licence is recommended to C.S.I.R.O.

The Department does specify the following:-

(a) That timber be dipped as soon as possible after sawing, the maximum allowable delay being two days.

(b) That the delay between dipping and stacking be kept to the minimum time necessary to drain off chemical not required.

(c) That timber be block stacked and square ended within chambers.

(d) That loading into any one chamber be restricted to a maximum of 2 days followed by complete close down of the chamber for the specified minimum diffusion period.

Control

Over and above routine inspections further checks are made by the Department to ensure treatment efficiency.

During the early stages of treatment at individual plants, samples are taken from all chambers. Timber is released from these chambers only after tests indicate satisfactory penetration. From these tests minimum diffusion periods for the particular plant are established. Later control is maintained by spot checking of samples taken from chambers, timber yards or building sites.

Each treatment operator is required to register a brand design with the Department of Forests and each piece of treated timber leaving the plant must carry an imprint of the design on the end grain. Brand designs are circulated to contractors and works authorities. In the event of decline in efficiency at any plant, the brand design concerned is de-registered and withdrawn from circulation. Failure to improve the operation of the plant results in licence disqualification.

Plant operators are required to keep true and particular records of all timber treated by the process and all chemicals used. These details are submitted for checking on monthly returns and all details are checked periodically during routine inspection.

Safety

The poisonous nature of the chemical is stressed on all operators and the Department insists that the following precautions be taken against accidents.

(a) Dry chemicals must be kept in a separate locked room with the floor off the ground.

(b) Plastic chemical containers must be destroyed after use and chemical drums must not be put to any dangerous use.

(c) Dipping vats, spray races, mixing containers etc., must be covered when not in use.

(d) Operators must wear approved gloves and aprons.

(e) Satisfactory washing facilities must be provided.

Statistics

(1) Number of recorded sawmill companies operating - 66

Number of dip diffusion licences issued or pending - 47

Number of licence holders not yet treating - 7

Number of sawmills producing for domestic purposes only (mostly missions) - 17

Number of these with treatment licence - 2

Number of commercial mills without licences - 4

(These are not producing for local sawn building supply).

(2) Approximate sawn volume produced for Territory use January 1965 to March 1965 - 7,000,000

Of this approximate volume of building timbers - 5,000,000

Volume of timber treated January to March 1965 - 4,000,000

(3) One of the main benefits noted since the introduction of treatment has been the increase in the number of species being utilised. Prior to treatment the main species were:-

Pometia	Calophyllum	Intsia
Dracontomelum	Canarium	Pterocarpus

Anisoptera	Nothofagus	Neonauclea
Eucalyptus deglupta	Geijera	Toona
Araucaria hunsteinii	Homalium	Vitex
" cunninghamii	Eugenia	Elmerrillia
Podocarpus	Dysoxylum	Agathis
Hopea	Terminalia	Acacia
Flindersia	Amoora	Diospyros
Anthocephalus	Garuga	Grevillea
Dacrydium		

This list has now increased to include the following species:-

Planchonia	Artocarpus	Lumnitzera
Garcinia	Aleurites	Pasania
Koompassia	Antiaris	Melaleuca
Eucalyptopsis	Buchanania	Endospermum
Manilkara	Castanopsis	Firmiana
Gordonia	Campnosperma	Litsea
Bischofia	Celtis	Mangifera
Planchonella	Cerbera	Myristica
Xanthostemon	Chisocheton	Nauclea
Albizia	Cinnamomum	Octomeles
Alstonia	Cryptocarya	Palaquium
Tetrameles	Duabanga	Papuadendron
Xanthophyllum	Elaeocarpus	Pericopsis
Bridelia	Tristiropsis	Pterygota
Excoecaria	Bruguiera	Pterocymbium
Lithocarpus	Dillenia	Sloanea
Oreocallis	Ganophyllum	Spondias
Pleiogynium	Endiandra	Vatica
Burckella	Parinari	Gmelina
		Rhizophora

Comments

The dip diffusion process has been introduced to the industry without upset, however, it was natural to expect some difficulties and these have occurred.

Of major concern is the persistant attack of the Ambrosia group of borers both within chambers during the diffusion stage of the treatment and in stacks prior to drying. This attack is generally not sufficiently severe to cause concern in structural timber, however, from an appearance point of view the occurrence is disturbing.

Good "housekeeping" at treatment plants is recommended to reduce the populations of the insect and it was hoped that well constructed diffusion chambers would provide an effective mechanical barrier. This has not proved sufficient and it is felt that steps will have to be taken, without delay, to overcome the problem by more positive means.

Severe surface mould formation caused concern with early treatment batches. This has now been reduced to a minimum by the addition of pentachlorphenate to the treatment mix.

The foaming associated with some species caused trouble with a number of spray units. Antifoam compounds will reduce foaming but these are expensive. Modifications to the spray unit design are now processing effectively.

Low temperatures at high altitudes prevented rapid solution of the preservative chemical and heating was found necessary.

Discussion

Beesley: According to our Head Office records there are now 41 licensees for diffusion treatment in the Territory as opposed to 47 in Mr. Colwell's statement. There appears to be a minor discrepancy here. The consumption of the diffusion preservative in the Territory for the last 12 months period is exactly 200½ tons.

Edwards: What measure of analytical control is exercised over the industry in the Territory and has the economics of .5 per cent. B.H.C. sprays for the control of Ambrosia attack been investigated?

Colwell: Control has been exercised mainly by relating the volume of wood treated to the volume of salts used. This is done monthly by return from treatment operator. Periodic checks without warning are made on treatment plants, extensive sampling to determine penetration are taken from plants, from millers' yards and from building contractors' sites. A large number of analyses are also carried out. We are not certain of the economics of .5 per cent B.H.C, but on the other hand we are fairly certain that B.H.C. is not satisfactorily controlling Ambrosia in sawn timber.

Beesley: We occasionally get enquiries from overseas for information on the use and practice of the dip diffusion process. In certain instances, we have referred these in part to New Guinea in the belief that they have the only complete handbook on this subject. Are these still available, or would Mr. Colwell prefer that we did not refer such enquiries to him?

Colwell: The handbook has been re-edited recently and copies are available on request.

Item 4(c). Report of Preservation Committee on Retentions and Penetrations for Waterborne Preservatives. *

Introduction. - At the 1961 Conference, the Division of Forest Products presented a paper in which minimum retentions were recommended for 7 different waterborne preservatives in all their likely uses in Australia. This paper was based on a 2 year study during which time a questionnaire survey had been made to obtain the most informed opinion available on retentions necessary for different uses, and all available data including other specifications, field

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* Prepared by N. Tamblyn.

test records etc., had been considered. It gave a detailed statement of the reasons why different retentions were recommended and of the methods used for their calculation.

To consider this paper adequately the Conference appointed a Committee representing the Division of Forest Products, the New South Wales Division of Wood Technology and the Queensland Forestry Department, to study and amend the proposals until they were mutually acceptable to the three organizations. This has been done over a period of 4 years in which many suggestions from the industry and from abroad have been received and considered and the general scheme has been subjected to practical trial as an unofficial standard in Australia.

Following a meeting in Brisbane in September 1964, when the recommendations were reviewed and enlarged to include minimum penetration requirements, the Committee considered that all objectives had been sufficiently met for a report to be submitted to the 1965 Forest Products Research Conference.

Recommended Retentions. - The retentions recommended for 7 proprietary preservatives, now used, or likely to be used in Australia, are set out in Table 1, and are expressed as the weight of the commercial product, subject to the following requirements:-

(a) Minimum Charge Retention

(i) Retentions specified in Table 1 are minimum retentions for any single charge of timber or plywood given vacuum-pressure treatment to approximate refusal. In normal practice they would be calculated by the plant operator and entered in his records.

(ii) The retentions as above are to be based on the estimated volume of treated wood in each charge. This calculation of treatable wood volume should be made for each charge by the plant operator and shown in his records.

TABLE 1

RECOMMENDED MINIMUM CHARGE RETENTIONS FOR METAL-CHROME AND METAL-CHROME-ARSENIC PRESERVATIVES

REVISED SEPTEMBER, 1964

Class	Protection Required	Type of Use	Examples	Timber Spp. or Density (lb/cu.ft.)*	Minimum Charge Retention (lb/cu.ft.)†						
					Tanalith C	Tanalith CA (Old)	Tanalith CA (New)	Celcure A	Boliden K.33	Boliden S.25	Celcure Old
0	Lyctus or Anobium only	Timber, veneer or plywood containing susceptible sapwood, fully protected from wetting, and requiring borer protection only.	Sapwood on timber or plywood used indoors as framing, flooring, lining, trim, doors, furniture, etc.	‡	‡	‡	‡	‡	‡	‡	N.A. N.R.
1	Decay and insects	A. Timber or plywood used indoors above ground, where, for exceptional reasons, greater protection than Class 0 is needed. B. Painted sawn timber used outdoors above ground.	A. Framing, flooring, lining, trim, interior plywood, etc. B. Weatherboards, window joinery, etc., under moderate conditions.	up to 40 41 - 55 over 55	.35 +25% +50%	.26 +25% +50%	.23 +25% +50%	.33 +25% +50%	.22 +25% +50%	.28 +25% +50%	.60 +25% +50%
2	Decay and insects	A. Unpainted round or sawn timber used outdoors above ground. B. Painted or unpainted plywood used as above. C. Painted sawn timber, used as above but under severe conditions.	A. Fence battens, rails, droppers, gates, house decking, verandah floors, etc. B. Plywood in caravans, boats, etc. (no marine borer hazard). C. Weatherboards and window joinery, etc., under severe conditions.	up to 40 41 - 55 over 55	.50 +25% +50%	.50 +25% +50%	.43 +25% +50%	.50 +25% +50%	.40 +25% +50%	.50 +25% +50%	.75 +25% +50%
3	Decay and insects	A. Round or sawn timber, exterior or marine plywood under severe conditions above ground. B. Fence posts, rail sleepers. C. Permanent mine timbers.	A. Greenhouses, wet factories, steps and palings reaching to ground, bridge decking, cooling tower timbers over 1½ in. thick, plywood in silos, etc. B. Round posts, sugar tram sleepers. C. Pit props, bars, sawn mine timbers.	up to 40 over 40	.75 +1/3	.75 +1/3	.64 +1/3	.75 +1/3	.60 +1/3	.75 +1/3	1.0 +1/3
4	Decay and insects	Round or sawn timber in ground contact where the highest permanence is required.	Transmission poles, friction piling, house stumps, fence posts under severe conditions.	up to 40 over 40	1.0 +1/3	1.0 +1/3	.86 +1/3	1.0 +1/3	.80 +1/3	1.0 +1/3	1.33 +1/3
5	Soft rot	Cooling tower fill (coniferous timbers only) up to 1½ in. thick.	Slab and supports up to 1½ in. thick. (For heavier timbers see Class 3.)	redwood, hoop, radiata) pine§)	1.25 1.50	1.50 1.75	1.25 1.50	1.25 1.50	1.25 1.50	N.R. N.R.	1.25 1.50
6	Marine borers, decay and insects	A. Round or sawn timber, exterior or marine plywood, exposed to marine borers. B. Bridge piling - fresh or salt water.	A. Marine piling, braces below tide level, boat planking and plywood sheathing. B. Bridge piling - fresh or salt water.	all timbers	2.0	2.0	2.0	2.0	2.0	2.0	2.0

*Air dry density (species mean as 12 per cent. moisture content after reconditioning) as given in D.F.P. Technological Paper No. 13, or other approved authority.

†As commercial product, calculated as minimum charge retention and subject where required to compliance with specified retention and penetration requirements as determined by analysis and by visual or spot tests.

‡The retention shall be such that no part of the susceptible sapwood shall contain less than 0.05 per cent. As_2O_5 equivalent, determined on the oven dry weight of the treated wood.

§Other conifers, up to 40 lb/cu.ft. air dry density are acceptable, if requirements of penetration and quality are met.

N.A. = not approved. N.R. = not recommended.

(b) Minimum Retention by Analysis of Wood Samples. - The requirements under (a) previous page, are intended to set a general standard of practical value to the plant operator and to safeguard the purchaser from any gross undertreatment. Where this is not considered sufficient, as for example in control under State legislation, chemical analysis of representative specimens of treated wood may be required. The following requirements shall then apply:-

(i) A charge or parcel of treated timber shall be accepted if in a sample representing not less than 1 specimen per 1000 super feet, and not less than 6 specimens in all, the retention in each specimen is at least 2/3 of the specified minimum charge retention based on the air dry volume of the wood (12 per cent. $\pm$ 3 per cent.), and all specimens meet penetration requirements as subsequently defined.

(ii) If one or more specimens fail to meet either of the above requirements for retention or penetration, a further sample as above shall be taken. All specimens in this further sample shall then meet the requirement(s) not satisfied by the first test.

(iii) Each specimen of treated wood used for analysis shall be taken from a separate piece of timber and shall be cut at least 18 inches distant from the end.

(iv) Wood subjected to analysis shall be treated wood, thoroughly representative of the treated area as seen on the complete cross section, after the original surfaces have been lightly sanded or planed.

(c) Minimum Retention by Analysis of Plywood or Veneer Samples. - Where compliance with the minimum charge retention as specified in Table 1 and in Section (a) previous page, is not considered sufficient, chemical analysis of treated plywood or veneer may be required. The following requirements shall then apply:-

(i) A charge of treated plywood or veneer shall be accepted if in a sample representing not less than 1 specimen per 100 sheets of plywood or veneer, and not less than 2 specimens of plywood or 6 specimens of veneer in all, the retention in each specimen is as follows, based on the air dry volume of the wood (12 per cent. $\pm$ 3 per cent.) and all specimens meet penetration requirements as subsequently defined.

<u>For Plywood</u> - At least $\frac{3}{4}$ (75 per cent.) of the specified minimum charge retention using a specimen representing all veneers in the sheet.

<u>For Veneer</u> - At least 2/3 of the specified minimum charge retention.

(ii) In plywood where uniformity of treatment is in doubt, analysis of separate laminations may be required. In this case no single lamination when sampled representatively shall contain less than $\frac{1}{2}$ (50 per cent.) of the specified minimum charge retention.

(iii) If one or more specimens fail to meet either of the above requirements for retention or penetration, a further sample as above shall be taken. All specimens in this further sample shall then meet the requirement(s) not satisfied by the first test.

(iv) Each specimen of treated plywood or veneer used for analysis shall be taken from a separate sheet of plywood or veneer and shall be cut at least 12 inches distance from edges or alternatively cut from the centre of the sheet.

(v) The wood subjected to analysis shall be the whole cross section of the specimen (except where individual laminations are required to be sampled in a sheet of plywood) after the original surfaces have been lightly sanded or scraped. With veneer, sanding or scraping of the surfaces shall not reduce the weight by more than 10 per cent.

TABLE 2

PENETRATION REQUIREMENTS

Class	Type of Use	Examples	Penetration Pattern*
0	Sawn timber, veneer or plywood containing susceptible sapwood, fully protected from wetting and requiring borer protection only.	Sawn timber, veneer or plywood	A See A.S. 0.60 - 1956
1	A. Timber or plywood used indoors above ground where, for exceptional reasons, greater protection than Class 0 is required.	Framing, sub-floor timbers, flooring, lining, trim interior plywood	A(1, 2, 3) B(4) A(1, 2) B(3, 4) E
	B. Painted sawn timber used outdoors above ground.	Weatherboards, window joinery (after machining)	A(1, 2, 3) B(4) " "
2	A. Unpainted round or sawn timber used outdoors above ground.	Fence battens, rails, gates, droppers, house decking, verandah floors	A(1, 2, 3) B(4) A(1, 2) B(3, 4)
	B. Plywood in caravans, boats, etc. (No marine borer hazard).	Plywood	E
	C. Painted sawn timber used outdoors above ground, under severe conditions.	Weatherboards, window joinery	A(1, 2) B(3, 4)
3	A. Round or sawn timber, exterior or marine plywood under severe conditions above ground.	Greenhouses, wet factories, steps and palings reaching to ground, bridge decking, cooling tower timbers (+ 1½ in.), plywood in silos	A(1) B(2) C(3, 4) E
	B. Fence posts, rail sleepers	Round fence posts, rail sleepers (sugar tram)	F A(1, 2) B(softwoods, 3)
	C. Permanent mine timbers	Round props ½ round bars sawn timber	F H A, B, C according to hazard and spp.
4	Round or sawn timber in ground contact where the highest permanence is required.	Transmission poles, friction piling house stumps fence posts under severe conditions	G G Round G(1, 2) Sawn A(1) D(2, 3, 4) F
5	Cooling tower fill (coniferous timbers only) up to 1½ in. thick	Slats, supports to 1½ in. thick	B
6	A. Round or sawn timbers, exterior or marine plywood exposed to marine borers.	Round piling, pile bracing, boat planking, plywood sheathing	H D E
	B. Bridge piling in fresh or salt water.	Bridge piling	H

*Numbers in brackets refer to durability classification (Classes 1 to 4) as used by Division of Forest Products.

Recommended Penetrations. - The proposed minimum penetration requirements are summarized in Table 2 and represent the best solution which the Committee is able to offer at present to a very difficult problem.

In arriving at penetration requirements it was recognized that penetration in softwoods (conifers) is fundamentally different from penetration in hardwoods and that the pattern obtainable in one is often not obtainable in the other.

For this reason the uniform envelope treatment usually obtainable on the heartwood faces of softwoods as a result of lateral penetration, was not made a limiting requirement in treatment of harwoods, where penetration occurs typically along the vessels. The compromise adopted, of requiring a percentage of the cross section to be treated in a hardwood, may produce rather less effective treatments but no other solution was available for quick fixing (non-diffusible) CCA preservatives, except virtual rejection of most sawn hardwoods because of erratic penetration in heartwood.

The need to adjust minimum penetration in heartwood according to its natural durability was recognized. It was decided therefore to adopt the durability rating system used by the Division of Forest Products and to adjust heartwood penetration requirements according to this rating and the usage of the timber. The following specific requirements are proposed -

The penetration of preservative, determined visually or by colorimetric test shall be in accord with the requirements in Table 2 and as defined below -

(a) Sawn Timber

Pattern A - Complete penetration of all sapwood but no requirement for heartwood. For Class 0 read "sapwood containing starch" for "sapwood" and refer to AS No. 0.60 - 1956 for sampling and other requirements.

Pattern B - Complete penetration of all sapwood and at least $\frac{1}{4}$ inch penetration on all exposed heartwood faces. Alternatively for hardwoods only, penetration of not less than 1/3 of the cross section will be accepted provided all sapwood is treated.

Pattern C - Complete penetration of all sapwood and at least $\frac{1}{2}$ inch penetration on all exposed heartwood faces. Alternatively for hardwoods only penetration of not less than $\frac{1}{2}$ of the cross section will be accepted provided all sapwood is treated.

Pattern D - Not less than 80 per cent. of the cross section to be penetrated.

(b) Plywood and Veneer

Pattern E - Evidence of penetration of preservative in all plywood laminations and in all veneers.

(c) Round Timber

Pattern F - Complete sapwood penetration or $\frac{3}{8}$ inch, whichever is the greater, except that in species of durability Class 1, complete sapwood penetration without other qualifications shall be accepted.

Pattern G - Complete sapwood penetration or $\frac{1}{2}$ inch, whichever is the greater, except that in timbers of durability Class 1, complete sapwood penetration without other qualifications shall be accepted.

Pattern H - Complete sapwood penetration or $\frac{3}{4}$ inch, whichever is the greater, except that for timbers of durability Class 4, depth of penetration shall not be less than 2 inches.

Important Considerations

(a) Effect of Density on Preservative Retentions. - Although a density correction is given in Table 1, it should be regarded only as a tentative proposal subject to confirmation, amendment or rejection as further evidence is obtained. The Committee recognizes that present opinion may well differ on this matter.

(b) Class O - Although treatment with boron and fluorine compounds to obtain Lyctus immunization is covered by AS No. O.60 (1956), there is now increasing use of pressure treatments with CCA preservatives for this purpose, which is not covered by the above specification. It was therefore considered desirable and fully consistent with the present review, to include use of CCA preservatives for borer immunization together with their uses for other purposes.

The threshold core loading, equivalent to 0.03 per cent. As_2O_5 based on O.D. wood which is at present approved in Queensland and New South Wales, was discussed and also the laboratory work from which this threshold was derived. Consideration was also given to New Zealand work with Anobium which is the basis for the present requirement in New Zealand of 0.06 per cent. As_2O_5 in the core.

It was decided to increase the present minimum core loading from 0.03 to 0.05 per cent. As_2O_5 for the following reasons -

(i) The 0.03 per cent. figure did not give a proven safety margin as the lowest loadings used in laboratory tests were only slightly below this figure.

(ii) The New Zealand figure was considered safely reducible to 0.05 per cent. for Anobium control and this figure was preferred as the Australian work with Lyctus had indicated a threshold not above about 0.025 per cent., thus allowing a clear safety factor of 2. While it was considered that under suitable conditions, many rain forest hardwoods were probably susceptible to Anobium, the above minimum core loading of 0.05 per cent. As_2O_5 was considered adequate based on New Zealand work.

(iii) It was observed that 0.05 per cent. As_2O_5 was approximately the termite threshold and that Lyctus treatments at this minimum core concentration should confer a useful degree of termite resistance. However, no specific claim to this effect was considered desirable at present.

(iv) The Committee recommended that the Standard 0.60 (1956) - "Wood Treated with Lycticides" should be revised and should incorporate approval for use of arsenical preservatives.

(c) <u>Class 1</u> - The toxic score method of comparing retentions for metal-chrome-arsenic preservatives was accepted for Class 1 where leaching is only a minor hazard. For this type of service, the toxic score method, originated by the Division of Forest Products in 1961, has not been seriously questioned either within Australia or overseas.

It was noted that the toxic score ratings at present used (Cu = 2; As = 1; Zn = 2/3) are not necessarily final comparative values and that they should be reviewed periodically. It was also considered desirable to stress the fact that comparisons based on the above scores had been made by the Committee only within a closely similar group of preservatives and that they should not be applied by others outside this group without competent technical advice.

The Committee drew attention to the fact that calculation of retentions by the toxic score method is strictly mathematical, and that because of this, and in fairness to all preservatives, no attempt should be made to "round off" or group retentions in Class 1, even where there was close similarity as between Tanalith C and Celcure A.

(d) <u>Ground Contact Factor for Boliden K.33</u> - The evidence for and against the use of a 0.8 ground contact factor for the Boliden K.33 salt (compared to 1.0 for Tanalith C and Celcure A) was very carefully considered. It was decided that the balance of evidence was quite strongly in favour of the 0.8 factor and that use of the 1.0 factor for Boliden K.33 did not appear to be a "sensible cautious decision" as had been suggested. The Committee was unanimous in this decision and further expressed the opinion that on the evidence available, use of a 1.0 factor should be regarded as a negative approach which would not encourage advances in preservative formulations and could even result in a reduction in toxic content of preservatives not given due credit for their higher toxic content.

TABLE 3

FORMULAE OF PRESERVATIVES

Preservative	Formula of Commercial Salt (Per Cent.)	Elements Based on Commercial Salt (Per Cent.)
Boliden K.33	CuO - 14.8 CrO_3 - 26.6 As_2O_5 - 34.0 Water - 24.6	Cu - 11.82 Cr - 13.83 As - 22.17
Boliden S.25	ZnO - 11.6 CuO - 3.9 CrO_3 - 23.0 As_2O_5 - 36.0 Water - 25.5	Zn - 9.32 Cu - 3.12 Cr - 11.96 As - 23.47
Celcure A	$CuSO_4.5H_2O$ - 32.0 $K_2Cr_2O_7$ - 40.0 $As_2O_5.2H_2O$ - 21.0 $Na_4As_2O_7$ - 7.0	Cu - 8.14 Cr - 14.14 As - 11.84) 14.80 ~~21.03~~ As - 2.96)
Celcure (Old)	$CuSO_4.5H_2O$ - 45.0 $Na_2Cr_2O_7.2H_2O$ - 50.0 $Cr(C_2H_3O_2)_3.H_2O$ - 5.0	Cu - 11.45 Cr - 17.45) 18.50 Cr - 1.05)
Tanalith C*	$CuSO_4.5H_2O$ - 35.0 $K_2Cr_2O_7$ - 45.0 $As_2O_5.2H_2O$ - 20.0	Cu - 8.91 Cr - 15.91 As - 11.27
Tanalith CA	$CuSO_4$ - 22.4 $Na_2Cr_2O_7$ - 39.0 $As_2O_5.2H_2O$ - 33.4 $Na_4As_2O_7$ - 5.2	Cu - 8.92 Cr - 15.48 As - 18.82) 21.03 As - 2.20)
New Tanalith CA	$CuSO_4$ - 29.7 $Na_2Cr_2O_7$ - 31.7 $As_2O_5.2H_2O$ - 26.3 $Na_4As_2O_7$ - 12.3	Cu - 11.82 Cr - 12.58 As - 14.82) 20.03 As - 5.21)

* Tanalith C is also prepared in an anhydrous form known as CT 106, in which 82 parts by weight are equivalent to 100 parts by weight of the Tanalith C formulation as listed above.

(e) <u>Ground Contact Factor for New Tanalith CA</u> - The 0.85 ground contact factor for new Tanalith CA as proposed by the Division of Forest Products, was fully discussed. This factor had been derived from detailed study of leaching tests submitted by Dr. Belford of Hicksons, in which both Tanalith C and Boliden K.33 were included for direct comparison with the new preservative. Each member of the Committee was fully conversant with details of these leaching tests and with the procedure used in deriving the 0.85 factor.

The Committee decided to approve the provisional listing of New Tanalith CA in the table of retentions using the toxic score system for determining retentions in Class 1 and the 0.85 factor for ground contact and similar use. It was however, considered essential that before final recommendation for inclusion in an Australian Standard, evidence of satisfactory results of decay tests on leached blocks should be produced by Hicksons.

Although the Committee desired to facilitate the acceptance of this preservative, it was also agreed that at the discretion of State Authorities, its <u>initial use</u> might be at the same retention as Tanalith CA (old), until it was clear that no unexpected plant problems would develop. However, as soon as sufficient evidence was available, including satisfactory use in the initial stages, it would be accepted on the above terms, or alternatively on the fairest terms possible.

(f) <u>Cooling Towers.</u> - In the original (1961) recommendation, retentions for CCA preservatives for control of soft rot in cooling tower fill were based on the copper content of the salts, without consideration of their arsenic contents or their relative fixation.

The Committee reviewed this matter and decided as follows:-

(i) Only coniferous timbers should be accepted at present for cooling tower slats and small supports up to 1½ in. in thickness.

(ii) Pending further evidence, ratings based on Cu content only should be discontinued and all preservatives except Tanalith CA (old) and Boliden S.25 recommended for use at the same retention (as commercial product). The exceptions were that Boliden S.25 should be excluded because of its very low copper content and also because of the manufacturers advice against its use in cooling towers, and that Tanalith CA (old) should be recommended at slightly higher retentions until proof is available that its copper is as well fixed as in the other preservatives, or that its performance in cooling towers is equally good.

(iii) Redwood (Sequoia) should be treated but should be accepted at a slightly lower retention than other available conifers, because of its lower density and high natural durability in cooling towers.

(g) Marine Timbers (exposed to marine borer hazard). - In the original (1961) recommendations, the retentions specified for all CCA preservatives were 1.5 - 2.0 lb/cu.ft. for piling and 1.5 lb/cu.ft. for plywood. The Boliden S.25 salt was excluded because it was not recommended for this use by the manufacturers, and no Australian test data were available.

The Committee reviewed this marine class in the light of experience since 1961 and with data from Australian marine tests now available. The decisions were:-

(i) All preservatives should be used at the highest practicable retention which was set at 2.0 lb/cu.ft. for both piling and plywood.

(ii) Since the Boliden S.25 preservative has performed similarly to the CCA salts in the Australian tests its use at 2.0 lb/cu.ft. should now be recommended.

(h) Minimum Retentions by Analysis. - It was decided that the 2/3 minimum for an individual sample should apply as follows:-

(a) To the whole treated cross section of timber not intended for dressing, profiling, resawing, etc., after treatment.

(b) To the whole treated cross section of timber when sampled after dressing or profiling.

(c) To a defined core in undressed timber intended for subsequent dressing or profiling.

It was observed that to comply with (b) and (c) above, it may be necessary for the treater to increase the charge retentions given under Class 1 or even to treat as under Class 2 for Class 1 use. It was stressed that undressed timber complying with Class 1 retentions, would not necessarily comply after dressing and that the onus was on the treater either to treat after profiling or resawing or else to select timbers and adjust treatments to stand subsequent machining.

(i) Submission to Standards Association of Australia. - A full statement of all recommendations has been submitted to the Standards Association in the expectation that it will be adopted in the Standard now being prepared on "Preservation of Building Timber".

Queensland comment on Report on The Recommendations of the Preservation Committee. *

The detailed report upon the findings and recommendations of this Committee have been discussed by Mr. Tamblyn and I am in agreement with the comments expressed therein. Although a member of the Committee, I consider the results important in that they are founded on data which have been impartially assessed. The members of the Committee have had access not only to data from commercial firms but also from independent organisations such as the Division, in addition to detailed practical experience in administration and plant control under conditions which probably have no parallel elsewhere in the world in terms of range of species and variability of climate and hazard.

Before the Committee was constituted, preservation practices in Australia rested largely in the hands of commercial firms and this has, I feel, resulted in a tendency to market and recommend

* Prepared by K. V. Cokley.

formulations without a local knowledge of hazards or problems in species. In commenting upon the work of the Committee, there are three factors which I feel should be considered. These are:-

(a) Relationship of Standards. - I am in agreement with Mr. Tamblyn's action with reference to the proposed S.A.A. Specification for treated timber. As the Committee had reviewed its recommendations in terms of local hazards and usages, then, if adopted by S.A.A., I would have been prepared to recommend that the standard be adopted for the T.U.P.A.; from the administrative aspect it was intended to group several of the classes, but the retentions, penetration patterns etc. were, in my opinion, very satisfactory. However, the S.A.A. Committee has not at present adopted the recommendations although a further meeting is to be held subsequent to this conference. I do feel that this conference, after consideration of the Committee's report, should endorse the recommendations and advise S.A.A. accordingly. As the S.A.A. draft now stands, I would not feel justified in recommending its adoption to industry; among other factors the elimination of the density factor and alteration of the penetration pattern with respect to natural durability as rated by D.F.P. would impose an unnecessary economic and utilisation burden on the industry.

(b) Toxic Loadings of Arsenic Formulations Against Lyctus. - Current approvals under T.U.P.A. are 0.03% and 0.04% as arsenic pentoxide (As_2O_5) for Boliden, and Celcure and Tanalith respectively. These were set for Tanalith based on the findings of the Division. The 0.03% for Boliden was based on approvals given by New South Wales. Celcure was set upon their application at 0.04%.

Subsequent to the data submitted to the Committee, I was prepared to recommend that the requirement of 0.05% be substituted; however, it was decided to await the S.A.A. draft and the decision of this Conference before formal submission. Considerable argument has been presented by one proprietary firm to retain the 0.03% level but on present evidence I am satisfied that the recommendation of 0.05% should be adopted.

(c) New Proprietary Formulations. - Nominally on the basis of economics and to increase the toxic rating in terms of the Toxic Score developed by the Division, new formulations have been or are proposed by proprietary firms. To date our attitude has been that if such formulations were considered by the manufacturers to offer advantages then their use was justified and as a result, Tanalith CA was substituted for Tanalith C. Subsequently it has been found that the fixation is lower and Hicksons are now recommending that it should be replaced for uses such as poles and piles.

However, in place of the hydrated Tanalith C, an anhydrous form, CT 106, was supplied. The result has been unsatisfactory in that solubility is poor and variable between plants, and where mixed solutions are present e.g. CA/CT 106 hydrometric calculations are seriously in error. To date with one exception, the arsenic component has not exceeded 18% (nominal 20%) and has fallen as low as 12%.

It has been necessary for the Department to call for special samples from all treatment plants and after approximately 3 months experience, we have notified Hicksons that CT 106 is not satisfactory and should be replaced by either Tanalith C (hydrated) or CA. Confidence of certain plant operators is low and in at least one instance the operator prefers to submit a mix sample for analysis before use. In this regard I would point out that concentrations in the mix tank of up to 10% are used.

We feel that these aspects of formulation should be a function of the Committee and new salts should be examined under local conditions.

In conclusion, I would suggest that New Zealand be invited to participate in the Committee which I suggest should meet at 6 monthly intervals and if possible rotate between member states to assess developments and problems in the field of preservation.

Discussion

Tamblyn: This paper represents the culmination of a vast amount of work occupying several years, during which time the opinions, suggestions and criticisms of many people in Australia and abroad have been obtained and have been subjected to very careful scrutiny by members of the Preservation Committee. In presenting the paper for your approval, it is my pleasure to acknowledge the help and support I have received from the other members of the Committee, Mr. Edwards and Mr. Cokley. The recommendations we have made embody and extend those proposed by the Division of Forest Products at the 1961 Conference, with modifications and improvements to meet the requirements of legislation in New South Wales and Queensland.

The Committee found the problem of setting minimum penetration requirements an extremely difficult one, but the tentative solution in which the natural durability of the heartwood has been taken into consideration as well as the type of service is probably the most acceptable. The recommendations made have been forwarded to the Standards Association which is at present drafting a specification for preservative treatment of building timbers.

However, this particular Standard on building timbers is limited in its application and hence must exclude several categories of use on which at least the nominal approval of this conference is considered desirable. It is therefore asked that this conference should indicate its general approval of those recommendations of its Preservation Committee as presented in this item.

Edwards: We in New South Wales are in full agreement with the opinions of Messrs. Tamblyn and Cokley. These recommendations have been the subject of very careful consideration and discussion with all interested parties. In Australia, we have an excellent opportunity to bring forward a series of recommendations for the copper-chrome-arsenic salts which will advance the industry and which will also allow scope for the development of better and more satisfactory wood preservatives.

Note:

There was considerable discussion on this item during which the following points were raised:-

Regarding the Queensland suggestion that New Zealand be represented on the Committee, it was felt that as New Zealand's problems are different from those in Australia, it might be preferable if Mr. McQuire of the Forest Research Institute could be called on for advice when necessary. Dr. Uprichard agreed to this course.

The suggestion that Victoria should have a representative on the Committee was endorsed and will be put into effect.

Endorsement of the Committee's report was supported and it was indicated that this would help in seeking Standards Association adoption of the recommendations for incorporation in a Standard. Leaders of State delegations indicated that publication of the Toxic Score method as used by the Committee should proceed.

Item 4(e). Treatment Characteristics of New Guinea Timbers; Need for Similar Australian Tests *

The treatability of 68 New Guinea timbers with CCA waterborne preservatives has been assessed using a standard cutting and treatment plan for diametral boards from each of 5 trees.

The results have been summarized in a table giving such details as density, range of retentions, increase in retention after retreatment at 600 lb/sq.in., and finally a treatability classification ranging from 1 to 4. As well as the table, a panel showing penetration has been prepared by cross cutting each specimen, after drying, close to the sealed end. Discs from this point have been mounted on hardboard to show penetration, with and without chemical indication. Colour transparencies of these mounts have been made and can be made available at cost.

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* Prepared by F. A. Dale.

The treatability classifications were carefully considered and we believe they can be used and understood by anyone with a basic knowledge of timber. However, the actual terminology of each classification may need reviewing in the light of experience.

We believe that the treatability of Australian and other timbers should be assessed in the same way and that the D.F.P. method is at least a good basis for a standard treatability test. Queensland and New South Wales rain forest timbers would seem to be most deserving of attention although we know that commercial and laboratory treatment has given some information on the treatability of a number of species.

A report on the New Guinea series will be published as soon as possible after the treatability with creosote has been assessed.

The Necessity for Investigation into Treatment Characteristics of Australian Species. *

For approximately 15 years the principal preservative used for Australian species were boron salts - primarily borax, and under these circumstances, the characteristics of local species were well known. Since the introduction of other preservatives e.g. C.C.A. formulations, sodium fluoride and oil type preservatives, evidence has accumulated to show that indigenous species have treatment reactions which differ from overseas species. This applies particularly to rain forest species of which in Queensland there are some 150 of commercial significance, of which only a low percentage is naturally durable.

Based on many commercial and laboratory studies we consider the following are of major importance:-

(a) Differential Absorption or "Screening" of Multi-salt Components. - This condition was reported from New Zealand for P. radiata and other species and has been confirmed under local conditions. For example in pines containing resinous zones, there is rejection of the copper component. In tulip oaks in general there is again selective absorption of arsenic and chromium and differential absorption of copper; this effect

* Prepared by K. V. Cokley.

is, on present evidence, variable with origin of the tulip oak.

(b) Differential Absorption due to Structure. - In certain species e.g. yellow walnut, there occur zones of included tissue which have been termed "bony tissue" or "streak". These are difficult to treat and in general will accept arsenic but reject the copper and chromium.

(c) "Greasy" Species. - Certain species e.g. red tulip oak and yellow walnut from some areas, also highly resinous sections of pines, are sufficiently "greasy" to result in difficult wetting with C.C.A. formulations. This effect did not occur with borax. Penetration under most conditions for the C.C.A. formulations can be achieved only by the addition of a non-ionic additive to the solution.

(d) Fixation Characteristics. - For softwoods, it was generally regarded that C.C.A. formulations had a high percentage fixation. In 1961-62, it was noted by the Department that, in spotted gum, significant leaching, particularly of copper, occurred in commercially treated material. Subsequent evidence was given by Hickson's that the degree of fixation in spotted gum varied significantly from that in pines; for that reason they are now recommending Tanalith C instead of Tanalith CA for products such as poles.

Microscopic examination of local Queensland species shows that the primary concentration of salts is within the vessels, with negligible movement away from the vessels. If one accepts the postulate that copper is primarily fixed by reaction with the cellulose, a number of questions arise in the case of local species; if the postulates of workers such as McMahon, Hill and Koch (A.W.P.A. 1942) or Eadie and Wallace (Jnl. Ins. W.Sc. No. 10, Nov. 1962) are accepted viz. complex interaction of the copper, chrome and arsenic components with reducing compounds of the wood, then the relationship of local species with respect to fixation becomes more reconcilable with practical experience. Three major questions arise, viz.

The nature of the fixation mechanism in hardwoods - not only

for eucalypts but more importantly for the rain forest species.
The relationship between species and rate of fixation.
The influence of component variations within the solution and within the timber upon fixation.

From a practical aspect a project of major importance is to relate species chemical characteristics e.g. reducing power or extractive composition, along lines similar to Dr. Rudman's in his studies on durability, and percentage fixation.

Under Queensland conditions, certain species have been found to cause significant reduction of the hexavalent chromium in C.C.A. salts, also selective absorption of arsenic or alternatively partial rejection of the copper component e.g. resinous slash pine.

Unless and until these characteristics for local species are known then I consider it is invalid to nominate general retention items of service hazards without consideration and assessment of species characteristics with regard to fixation; we consider that these factors are more important than even studies of the effect of species density on toxic loadings.

Relationship between Arsenic, Copper and Chromium. - From the administrative and efficiency aspects of treatment it is necessary and desirable to be able to prescribe tolerances allowable in the ratio between components of C.C.A. formulation in solution and in the timber. This applies particularly to the arsenic-chrome ratio.

Many species e.g. spotted gum and crab apple cause significant reduction of the hexavalent chromium. For example in one plant treating veneers, the dichromate was reduced by 80%. The effect is accentuated by heat and extractives and by fine sawdust in the solution. Initial conditions at Eidsvold on pre-dried timber were such that up to 30% reduction occurred and hosing of the charges after treatment was necessary.

Whilst work such as Kamesan, Preston, Belford, and Eadie and Wallace's is valuable, it is of limited application because of the species effect.

For this reason it is also essential that the assumptions that were made in the pilot tests on North Queensland species for sugar tram sleepers in relation to liquid absorption, and consequent direct calculation on the solution strength to determine salt retention, should not be made. Many analyses of rain forest species show this to be invalid.

In summary, we feel that the previous assumptions regarding C.C.A. salts have been found in practice to be of doubtful validity e.g. fixation, selective absorption and component balance. From the plant operator's aspect, it is very necessary that he be made aware of the technical difficulties of species effects etc. rather than the present impression which is given that it is sufficient to inject a calculated weight of salt into the sapwood for effective protection against insect and fungal attack.

The Timber industry, relying on advice from organisations such as are represented at this conference and on evidence from the proprietory firms, has outlaid considerable capital on plant for C.C.A. treatment.

It is our responsibility to determine initially what species are suitable for treatment and then to determine what variation in loadings and formulations are necessary. Failure of salt treated material through any of these causes can only result in a serious financial loss to the industry and have a major effect in the maximum utilisation of our species.

Discussion

Wickett: I think it is very necessary that we should have treatability information on both Australian and imported species.

Edwards: I would support the suggestion, particularly so far as scrubwood species are concerned. It is a common problem and the only answers at this time are based on theoretical considerations.

Dale: Does the Conference as a whole recommend that a standard plan for assessing treatability be referred to the Preservation Sub-committee?

Boyd: Are the States in favour of the Committee being requested to extend its activities by advising on a plan for treatability studies on Australian timbers? (Show of hands). There is an indication that the Committee should accept this responsibility.

Edwards: If the sapwood thickness is not very great it may not matter if some differential absorption takes place and it might be worthwhile putting out an exposure test of CCA impregnated sapwood as it would come from a commercial cylinder.

Cokley: We would like to see Dr. Rudman's work on extractives extended as this could help to explain what is happening in these very difficult species. We agree also as to the necessity for an exposure test.

Tamblyn: We are very conscious of the problems of differential absorption, the effect of species on leachability of CCA preservatives and the effect of species on toxicity thresholds. We hope to investigate these points as time permits when our X-ray spectograph is operating.

Smith: While the effect of extractives on treatability is important it is not the only fundamental and we are still left with the problem of within tree variations in treatability. If any work is done on this problem particular care should be taken in the selection of specimens to ensure that no abnormal material is used.

Item 4(f). Preservative Treatments for Building Timbers with Impermeable Heartwoods *

With the rapid development of timber utilization and of preservative treatments in tropical areas, there is an urgent need to face up to the problem presented by the abundance in tropical rain forests

* Prepared by E. W. B. DaCosta.

of timbers with readily treatable sapwood but with almost impermeable heartwood of relatively low durability. Since timber which is completely treatable and mechanically suitable may not be locally available, utilization of such species wherever possible should be encouraged.

In building timbers used indoors, treatment of the sapwood will remove the major hazard of Lyctus attack and dry-wood termite attack in the sapwood. There is also some evidence that the presence of treated sapwood will reduce the likelihood of subterranean termite attack (and possibly of dry-wood termite attack) in the adjacent untreated heartwood. Moreover, it is probable that timber which cannot be treated with waterborne preservatives at 200 p.s.i. will not absorb enough water from intermittent wetting when used as weatherboards or external joinery to allow decay, especially if brush- or dip-treated with a water-repellent preservative after fabrication. If a large proportion of heavily treated sapwood is present in each piece of timber, and the preservative contains a diffusing component, diffusion may continue in service enabling substantial protection of the heartwood in timber not exposed to heavy leaching.

It thus appears that timber with impermeable heartwood may prove to be worth using as building timber, though not in ground contact. Its full possibilities could only be reliably assessed by above-ground exposure tests, preferably in tropical climates and with conditions simulating those in buildings, and collaborative tests of this nature should be arranged as soon as possible. Pending their completion, consideration should be given as to whether there are situations in which immediate use of such treated timber could be approved.

Discussion

Cokley: Unfortunately, many of our species have non-durable heartwood and are unsuited for exterior use but sawmillers would like to see them utilized. If a species is suitable on grounds other than durability our recommendations are that it can be used, provided it is treatable.

<u>Smith</u>: At the moment we cannot agree that there is any proof that impermeable heartwood in non-durable species can be permitted for exposed use such as weatherboards or external joinery, nor that <u>in situ</u> treatments of external joinery with water repellents will prevent decay which, of course, is most prevalent at end-grain.

<u>Bryant</u>: I think this whole question of durability of timbers with impermeable heartwood is a matter for the Preservation Committee.

<u>Boyd</u>: It appears there is agreement of the Conference to hand this problem over to the Preservation Committee.

<u>Item 4(g)</u>. <u>Need for a Test Fence to Compare Timbers and Finishes</u> *

Among the more disturbing enquiries received by this Division are those concerning the performance of certain timbers when exposed to the weather either unpainted, or given certain "natural" finishes, some widely advertised. Advice given in reply must often be so qualified that the enquirer becomes thoroughly confused and may decide not to use wood after all.

The unlucky advisor, drawing on hearsay, advertising and often little direct knowledge, may be as confused as the enquirer.

The growing demand, by architects in particular, for "natural" finishes cannot be denied and the obvious way to meet this is to set up an exposure test where such finishes can be properly compared. Also, at the proper time, architects and other users can see for themselves the results of different periods of weathering. This is most important as the evaluation of appearance is as subjective as the choice of colours. It is impossible for us to tell people what looks attractive and what does not. Evaluation of the physical condition of the surface and substrate is another matter.

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* Prepared by F. A. Dale.

The writer has in mind a test of materials, impregnants, non-film forming finishes and fastenings, although a very few paint finishes might be included as controls. The testing of paints and varnishes is already under way or planned by other authorities.

The test in mind would simulate a wall with some eaves overhang but would include a section of fencing to compare treatments of palings for domestic fences.

A Melbourne suburb is suggested as the site for the test but duplication in Sydney or Brisbane where weathering effects are at least very different if not more severe is envisaged soon after. Sawmillers, Forest Services and Timber Merchants would be asked to contribute materials.

Comments on the need for such a test and its scope are invited.

Discussion

Bryant: The Paint and Timber Committee set up by the AUS.T.I.S. meeting in Mount Gambier subsequently transformed itself into a T.D.C.A. Committee and on it are represented trade interests, forest interests and the Division of Forest Products. The Committee is preparing a draft Code of Practice for the painting of timber and representatives of the timber industry, namely Messrs. Barnes, Ladkin and myself, met representatives of the Australian Paint Manufacturers Federation for preliminary discussions. We think that if we limit our requests for Commonwealth Paint Committee information on the widely advertised shelf line paints, the Federation might make such information available. If we cannot get this information the New South Wales Commission has agreed to carry out shelf line testing to make available recommendations on paints which perform well. There is no legal reason why this cannot be done nor why T.D.A. cannot pass on such information.

Blomquist: As a result of good co-operation between the paint people and the timber people in America, we are now reaching the stage where this problem can be discussed amicably and with a view to a considerable amount of progress. There has been a co-operative fund established between the National Lumber Manufacturers Association and the Paint and Varnish and Lacquer Association to finance some research at Madison on the problem of better paints for timber.

Bryant: I think it should be suggested that the paint industry put up a test fence themselves. I think we have convinced them that there is a big market for clear finishes which would not cut across the market for conventional paints.

Boyd: Mr. Bryant, as a representative of this Conference, could bring this matter to the attention of the Timber Development Association Paint Committee and suggest that they take the matter up with the manufacturers to establish test fences.

Wickett: In Western Australia we have set up several test fences over the last 6 or 7 years and I think we have scared every architect in Western Australia off clear finishes for exposed exterior work.

Blomquist: If architects want a house to be clear finished, they must design houses with a much greater overhang. Generally, they are happy to do this. Exposing clear finishes directly to the weather in a test fence may well give a wrong impression. This may damage the image of wood.

Item 4(h). Dip Treatments for Joinery.

Tamblyn: Some years ago the possible use of water-repellent preservatives based on pentachlorphenol was discussed in relation to the treatment of radiata pine weatherboards. At that time most of us were opposed to it as being a treatment inferior to conventional pressure treatment. However, more recently there have been moves in the trade to popularise dip treatment of exterior joinery using rather superior water-repellent preservatives in which there is a content of alkyd resin, in addition to wax to give water-repellency. The preservative is, in fact, a varnish containing wax plus a fungicide and an insecticide. A South Australian joinery manufacturer has been using a BALM product of the above type called "Weatherprime" for some years and that has been followed by Celcure producing a similar or better product which they call "Woodzone". We feel that a dip treatment of exterior joinery does provide a reasonable use for this type of product, and would like to state our view point as follows:-

Dip treatments have merit for external joinery and, if possible, we would like to see them covered in the legislation in New South Wales and Queensland. We have defined, for exterior joinery, the particular usages which we would consider merit this treatment.

(a) The timber is naturally durable (or has been well penetrated in pressure treatment) but has the defect of absorbing water readily if wetted by rain. In this area, the water repellent effect of the dip is beneficial in reducing paint failure near end-grain surfaces which have not been primed.

(b) The timber has been well pressure treated, but contains some impermeable and hence untreated heartwood of fairly low durability. In this case dipping after fabrication of the joinery, will give useful protection to this untreated wood and will also reduce water absorption in the more permeable sapwood areas.

(c) In either of the above cases, (or even where the timber is all durable heartwood requiring no preservative treatment) dipping may still be desirable if it can take the place of a priming paint, and hence permit finishing by application of undercoat and topcoat only.

(d) Where the timber is to be clear finished, a dip treatment can be used to increase resistance to staining fungi and to keep the surface clean during handling and installation. In this use a pentachlorphenol content of 5 per cent. is desirable and a resin content sufficient to give a good clear protective film which will stand exposure for at least several weeks before clear finishing. In this particular application, there may be a reasonable case for dip treatment of weatherboards, provided their durability is not too low.

(e) Excluded from the above is the whole category of timbers which are traditionally and successfully used in Australia for external joinery without any preservative treatment. These include timbers such as jarrah, oregon, ash eucalypts etc., which give fair to good service because of some combination of good durability, low water absorption, freedom from sapwood, good methods of construction, or even service under conditions of fairly low hazard. Where these conditions still apply, there is little need for dip treatment to prevent decay or insect attack. However, where conditions are changing (more sapwood, different construction, "breathing" paints, higher termite hazard etc.), dip treatments may prove useful as most of these timbers are more or less refractory to pressure treatment. At present, however, we do generally exclude these timbers unless circumstances are unusual.

I would like to hear why there has been an apparent reluctance to accept dip treatments, particularly in N.S.W.

Bryant: It is not a matter of the legislation. We accept dip treatments, but we cannot see any point in enlarging the scope of the Timber Marketing Act to make it necessary for us to police the whole series of formulations which require complicated analyses and which in any case we approve if they are used correctly. All those areas stipulated by Mr. Tamblyn have also been stipulated by us in discussions, primarily with Celcure. Provided an attempt has been made to impregnate the non-durable material and provided the timber will not be re-cut, then we approve of a dip treatment prior to painting.

Tamblyn: I feel that if these dip treatments are used for untreated low durability timbers such as radiata pine, the service then obtained will be very inferior to that which should be obtained by pressure treatment with fixed waterborne preservatives. Legislations controlling treatment would prevent such timber being sold as preservative treated.

Edwards: We are loath to accord official Timber Marketing Act recognition to preservatives which may give good or bad protection depending upon what is done to the timber after the application of the preservative. We have sufficient powers under the Act to prevent these treatments being given to otherwise untreated radiata and sold as preservative treated. A firm in New South Wales has installed a dipping plant for water-repellent treatment of joinery and we have advised them that they may not advertise their product as being preservative treated.

Uprichard: This matter is one of considerable importance to New Zealand at the present time and we are planning to establish exposure tests of simulated joinery components. These will include preservative-cum-water repellent dips and also straight water-repellents applied to salt treated timber. The main aim is to reduce movement and any information on new or improved water-repellent formulations will be welcome.

Wickett: In the dip treatment of joinery made from non-durable and non-absorbent species such as light meranti, the glue may prevent end-grain penetration. When the joint fails, water may be absorbed and decay may start at the end-grain.

Bryant: If Mr. Tamblyn would be prepared to draft some legislation we could incorporate into our Act, we would be happy to have a look at it.

Item 4(i). In Situ Treatments *

The widespread use of adequately preservative-treated timber may eventually eliminate the need for in situ treatments but for many years to come these treatments will be needed and should be used to a far greater extent than they are at present to reduce or postpone expensive replacements. Situations in which treatments are needed include:-

(1) Decay in boats, in external joinery, weatherboards, floors and other parts of existing buildings.

(2) Treatment of existing transmission poles, including perhaps treated poles which have beem inadequately treated or mechanically damaged.

(3) Protective maintenance treatment of decking, fences, etc.

(4) Termite protection of existing structures.

Treatments available include oxy-char process and diffusing salt bandages for poles; brush or spray treatments with penetrating oil-soluble preservatives; mayonnaise type preservative coatings; concentrated diffusing salts applied by injection or surface coating to building timbers; diffusing preservatives in boat bilges; soil poisoning; heat sterilization etc.

We need to assess the extent of the need for, the effectiveness of, and the means of promoting such treatments, particularly the effectiveness of bandage treatments for inadequately treated poles; the best preservative for brush treatment of decay in boats and buildings; and the effect of treatments on cleanliness and paintability.

Edwards: The Conference may be interested to hear that D.F.P.'s recommendations regarding radiata weatherboards in War Service Homes in Sydney have been most successful. We now make similar recommendations to home owners experiencing trouble with decay in softwood weatherboards and we have had no indication that the recommendations have not been successful.

McConochie: The oxy-char process mentioned by Mr. DaCosta, was practised for some while by the Brisbane City Council but at the very

* Prepared by E.W.B.DaCosta.

high temperatures involved it appeared that drying occurred, resulting in checks at the ground-line and after moisture gets in, decay is once more a problem. The practice has been discontinued.

Item 4(j) (i). Durability in radiata pine weatherboards.

Edwards: We are concerned with the incidence of decay occurring 4 to 5 years after radiata weatherboards go into service. We are also concerned with the breakdown of paint systems on weatherboards.

Much of the decay in weatherboards is incipient wood decay which is already in the boards. Mr. Bryant has already covered the paint holding aspect in previous discussion. In the Sydney area and probably in other areas along the eastern sea-board, there is the problem of fungal attack on the paint systems. We suspect that the fungus starts on the paint surface, spreads through and gets under the surface, and then breaks down the paint film. The question of fungal attack should be given more importance than hitherto when discussing paintability.

Uprichard: Pine weatherboards have not been used extensively in New Zealand because of painting problems. This appears to have been largely overcome by the use of an aluminium primer. It is our belief that boron treated pine adequately primed with aluminium primer will be satisfactory, and we have established a service test to check this. Service life to date - approximately 2 years.

Item 4(j) (ii). Need for preservative treatment of radiata pine building timber

Beesley: This item stems from the discovery of extensive decay in a large amount of radiata pine sheathing in War Service Homes in New South Wales.

We followed this up with a survey in Victoria of houses and schools up to 25 years old. Although a certain amount of decay was present in nearly half of the houses, in each instance, the extent of decay discovered was surprisingly small, except for 3 notable cases. The technical committee of the Long-term Lending Authorities started to prepare a specification excluding radiata pine from buildings. The Division lodged a protest resulting in considerable discussions and investigations. The latest information is as follows:-

Printed copies of the new specification, which will be used by all the long-term lending authorities in Victoria, should be available for inspection by the end of July and will come into force on the 1st October this year. It will require that all radiata pine used in buildings be branded with the producer's brand which must be registered with the Timber Producers Council of South-East Australia. There is provision for colour coding of the brands to indicate the grade of the timber, which will be graded to conform to interim 377, interim 376 or SAA 072-075. If it is to be used for exterior sheathing and exterior joinery, it is to be treated and branded with details of the treatment in accordance with the regulations to be laid down under the Victorian Forests Act. It is mentioned that the untreated radiata pine will be accepted for flooring. So far as I can discover, Victoria is the only State in which the lending authorities are going to have a specification. In the other States, they have what they call "minimum acceptable proper construction standards" which are not a specification, but the document to be produced in Victoria will be a specification and can be used as part of a contract. Enquiries within the timber trade show only a very small amount of treated radiata is being demanded. One firm says that about 50 per cent. of the pine they sell is treated and they think that most of this is used for repairs and reconstruction work by weekend builders. Another major producer of pine in Victoria claims that they sell each month about 200,000 lineal feet of 6 in. flooring, 2,000 lineal feet of siding weatherboards and about 25,000 super feet of radiata framing, most of which is used for internal partitioning. The second firm claims that there is no demand for treated flooring, there is buyer

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resistance to the surcharge for treated fascia and siding and they have had difficulty in disposing of stocks of treated wood laid down some years ago when they were led to believe that treated pine would be demanded.

Bryant: We received a delegation of representatives from the lending authorities and were requested to amend the Timber Marketing Act to make it compulsory that all radiata used should be treated.

Tamblyn: In our Preservation Section, we consider there is need for treatment of radiata pine in any external use. Unfortunately our construction methods and our hazards are different from those in New Zealand where diffusion treatment for weatherboards is acceptable and we cannot expect the same results in Australia. We feel that the best interests of the industry will be served if treatment with fixed preservatives is a pre-requisite for the external use of radiata pine in Australia.

Ryley: We recommend treatment of all pine for external use.

Uprichard: The New Zealand view is that there will always be enough Anobium susceptible sapwood used in radiata pine building timber to warrant general treatment. There is still some debate as to whether minimum treatment (e.g. diffusion treatment with a non-fixed salt) is adequate for exterior joinery and weatherboards, and high retentions of fixed salts are required for barge and cover boards and similar items.

Booth: We should not give up hope for diffusion treatments on radiata pine, as New Zealand and New Guinea experience indicates that these can give an adequate level of protection. The economic advantages for the industry have been so considerable that I do not think we should, at any stage, abandon experimental work on this.

Tamblyn: If end priming could be guaranteed, we would accept diffusion preservatives for pine weatherboards.

Colwell: We like to see end priming of diffusion treated external sheathing in both hardwoods and softwoods, however, weatherboards are not at present extensively used.

Item 4(k) (i). Durability Patterns in Eucalypts and Other Timbers *

The attached graphs show some important results recently obtained by Dr. Rudman on within- and between-tree variation in decay resistance and indicate that this will have to be taken into consideration both in forest management and in timber utilization. The graphs show the percentage weight losses of small blocks $\frac{3}{4}$ in. (long.) x $\frac{3}{8}$ in. (tang.) x $\frac{1}{4}$ in. (rad.) cut at various positions along a radius of the selected tree and exposed to decay in soil-block tests with Coniophora olivacea in the case of the eucalypts and with Coniophora olivacea (solid line) and Coriolus versicolor (broken line) in the case of the New Guinea teak trees TG1, TG30 etc.

The decay resistance of eucalypt timber is now postulated to be determined by:-

(a) The amount and toxicity of fungitoxic extractives laid down while the tree is still "immature", and the duration of this "immature" period.

(b) The amount and toxicity of the fungitoxic extractives laid down by the "mature" tree.

(c) The rate of "ageing" i.e. of transformation of the toxic polyphenolic extractives into less toxic polymerized or oxidized forms.

Thus with E. sieberiana, in which it was shown by earlier work that only the less polymerized methanol-soluble extractives are toxic and that those are usually present in amounts barely adequate to prevent decay, the freshly formed heartwood is resistant to decay, but for most trees ageing rapidly causes the heartwood to become susceptible to attack. With E. camaldulensis, in which the more polymerized extractives are also toxic and in which there is a considerable "excess" of toxic material over the level necessary to prevent decay, ageing, though presumably in progress from the time the heartwood is laid down, has not reduced decay resistance sufficiently to make the wood susceptible to decay, except in the "immature zone" near the pith. E. maculata is

* Prepared by E.W.B.DaCosta.

intermediate in pattern but closer to E. sieberiana. E. wandoo tested in the same way showed no decay-susceptible wood at all, suggesting either that even the "immature " heartwood has a large "excess" of toxic extractives or that ageing in this species is very slow.

This durability pattern has considerable importance in utilization since it is clear that, except for some highly durable species such as wandoo, there will be quite a large non-durable core and that in at least some species, such as silvertop ash and jarrah, this core will become larger as the tree grows. Hence production of highly durable sawn timber may require more careful attention to the effect of position in the log than has been the case in the past. Also the presence in small sections, such as posts and poles, of a narrow zone of durable wood between the non-durable (but treatable) sapwood and the non-durable "immature" heartwood near the pith, must influence our handling of these products.

To the forester, this within-tree pattern of decay resistance is also of importance in its effects on the development of heart rots, and in tree breeding. It is believed that inter-tree differences in decay resistance pattern, as shown in silvertop ash (and also in jarrah), are largely genetic in origin. It should therefore be possible to increase the average decay resistance of the heartwood markedly by tree breeding, but selection would have to be based not on the durability of the outer heartwood but on depth of the durable heartwood band.

This applies to other timbers than eucalypts, also. The implications are shown in the graphs on New Guinea teak. These results were obtained on cores taken from standing trees which had been used as elite seed trees for the current teak breeding programme in New Guinea. It is clear that tree TC1 is likely to prove a poor parent from a durability view point (though it may be ideal in other respects), while tree TC30 should be very good. None of the New Guinea trees tested, however, showed the absence of any non-durable core, as found with wandoo and also (for Coniophora olivacea) with some older teak trees from South East Asia tested in earlier experiments. It is hoped that similar tests may eventually be made on the progeny of trees such as TG1 and TG30, to determine the mode of inheritance of this difference, but it is clear that a considerable diameter of heartwood must be available before meaningful comparisons can be made.

Discussion

Upprichard: The graphs for New Guinea teak show decrease in decay of the heartwood at some distance from the pith. Is this due to the usual increase in extractives content?

DaCosta: We have done no tests on these particular trees, but there is a tendency for extractives content to increase as you go out from the centre of the tree. However, we do not know whether the toxic extractives increase at the same rate as other extractives.

Jacobs: From the point of view of forest management, the quicker we can get trees to a reasonable commercial size, and then utilise them, so much the better.

DaCosta: The wood laid down near the pith in the young tree is not as durable as that which is laid down years later. Also, in fast grown trees, low durability is not necessarily adjacent to the pith but within a few growth rings of the pith. Thus the faster you grow the tree, the greater volume of the tree is taken up by the first few growth rings.

Bryant: In the case of blackbutt we have many old trees which have been standing for a long time. They have too much pipe for it to be worthwhile to sawmillers to bring them into the mill, and yet the wood in these trees represents perhaps the most durable blackbutt timber in the forest. These logs are now being sawn by spot mills which are breaking them down in the bush and they are harvesting material which has survived the ravages of both termites and decay.

Tamblyn: The grading for durability in some species should begin with the sawyer. In the case of a timber such as jarrah, for example, a lot of sleepers are being sold and as the durability and the reputation of the timber is important, some action should be taken to cut sleepers etc. where possible from the durable outer heartwood, and relegate scantlings to the inner heartwood where they might touch into this fairly low durability core. Has any thought been given to the education of sawyers in this regard?

Wickett: Not very systematically. You can see this effect in jarrah when you open up the log. Decay spreads fairly spasmodically through the tree and you can see gradations in the colour of the wood indicating durability. The sawyers are well aware of this and cut accordingly. Judging durability on colour is very difficult but where you can see the whole flitch it is quite possible.

Item 4(k) (ii). Relationship Between Durability Ratings and Service Results *

With the introduction of CCA formulations, particularly in Queensland and in Northern New South Wales, the position with respect to species utilization has been drastically altered particularly in regard to the rain forest species of which approximately 150 would be of commercial significance.

The building industry in North Queensland has been based to a major extent on preservation, which to date has consisted of treatment of *Lyctus* susceptible timber using boron compounds. External sheetings etc. have been limited to durable species either of local origin or hardwood species supplied from South Queensland.

With the introduction of multi-purpose treatment, the question has arisen of the application of treatment to non-durable species which to date has been confined to sapwood only.

* Prepared by K.V.Cokley.

An examination of the published durability ratings indicates three things:-

Origin of classifications of durability. - In general it would appear that classifications are related to:-

(a) Comparative resistance under laboratory test conditions to selected test fungi or insects.

(b) Correlation on a random basis of reported service life.

(c) On a very limited scale, comparative service tests which are principally "in ground".

Relationship of classification to service hazards. - As the classifications now exist, there is very little relationship of durability to service requirements other than "in ground" use. For example a species such as damson may be classified as non-durable with an expected service life of 10-15 years in North Queensland but may give adequate service in areas of low hazard. If decay were the prime cause of lack of durability, such a species may be applicable to areas such as Western Queensland where the decay hazard is much less significant than in the high rainfall-high humidity tropical coastal area.

Relationship of classifications with other physical properties. - Whilst durability against either insect or fungal attack is important, the "in service" end result may be unsatisfactory due to other physical properties which may cause failure.

For example, the tulip oaks, particularly from South Queensland, have been found unsuitable for external service not only by lack of durability but through other defects such as severe checking. In contrast, virgin hoop pine has given long service as external sheeting, particularly where unpainted, although its durability rating is low.

We consider that the present general durability classifications should be re-examined on the basis of:-

(1) Definition of durability in terms of hazard e.g. decay or termites.

(2) Definition of relative durabilities in terms of service location. For example, in Queensland primary protection of building timbers against termites is given by mechanical barriers as compared to South Australian conditions where it is understood preventive treatments are necessary. In addition to the service location, the relationship of climatic conditions should be considered.

(3) Relation of present or proposed classifications to laboratory studies. Field exposures should preferably be on the basis of structural dimensions rather than small comparative sections.

(4) In view of the developments relating physical and chemical properties of the timber to durability, further studies such as those made by Dr. Rudman should be carried out.

In this regard, present durability classifications are primarily on the basis of virgin "mature" material. In view of the relationship of present day sawmilling to small girth material, and and or regrowth material, this aspect should be included.

Durability Grave Yard Tests - Lae 1948-57 *. - Five samples each of 22 botanically authenticated New Guinea species were selected for the first grave yard trials established at Lae in December, 1951. The species are grouped below according to eventual results.

Included in the trial were 12 samples of Eucalyptus regnans and 12 samples of Douglas fir to form a basis for comparison. The experiment was carried out on a statistically sound basis.

Observations were made at 8, 12, 18, 22, 33 and 59 months after commencement. Very few of the samples survived the 33 month period as the following results indicate. A general division of species survival was made according to the following table:-

Group A Complete ground level failure within 12 months.
" B " " " " " 12-24 "

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* Prepared by J. Colwell.

Group C Complete ground level failure within 24-36 months.

" D General survival after 36 months but subject to general deterioration.

" E Survival in excess of 60 months.

On this basis the species tried were grouped as follows:-

Group A.

Octomeles sumatrana

Evodia elleryana

Pterocymbium beccarii

Terminalia

Group B.

Mangifera minor

Neonauclea clemensiae

Celtis luzonensis

Celtis nymanii

Pimelodendron

Terminalia complanata

Polyalthia

Parinari

Elaeocarpus

Eucalyptus regnans.

Douglas fir

Group C.

Cinnamomum

Syzygium buettnerianum

Ailanthus peekelii

Tristiropsis subangula

Group D.

Dysoxylum

Neonauclea maluensis

Anisoptera polyandra

Group E.

Intsia bijuga

Hopea parvifolia

At 59 months Hopea showed slight fungal decay at ground level in one species only while all five of the Intsia samples exhibited slight fungal activity.

Comments

The main objective of the experiment was achieved. This was:- general low durability of all species on Australian terms but extremely low durability for the majority.

Discussion

DaCosta: Our system of durability rating in which we classify timbers in classes 1 to 4 is very definitely a termite and decay hazard rating and is essentially a classification of timber used in the ground. It was therefore not initially intended to apply to a large proportion of building timber. It does not meet all our requirements today, where we are concerned also with durability in conditions where there is a mild decay hazard, such as in external joinery, weatherboards and external building timbers in general. We are, therefore, proposing to set up some above-ground tests. We have done extensive laboratory decay resistance tests on several New Guinea timbers but as these tests were too severe for assessing decay hazards of external joinery or weatherboards, we are proposing to set up above-ground exposure tests of these timbers in North Queensland. We hope that the Queensland Forest Department will be able to set up similar tests of their own material alongside it. Although our durability ratings were originally based on performance of timber in contact with the ground, they do give a good indication for above-ground use in the absence of anything better.

Colwell: The comparative order of durability under tropical conditions remains the same but the timbers do not last as long. As the result of the test we carried out, we found only 2 species out of 24 which would last in excess of 5 years. In Victoria they would probably last 25 years, however, further work along this line is being carried out.

DaCosta: It is interesting to compare Mr. Colwell's field tests of 24 species with our laboratory tests of 27 species. Unfortunately, only 6 or 7 species were common to both tests, but our results are in complete agreement with the exception of 1 species.

The actual form of the above-ground test has not yet been decided, however, it is possible that a vertical weatherboard test would be the best. The samples are in the form of $\frac{3}{8}$ in. thick boards which are off-cuts from our laboratory test.

Cokley: Would it be practical to issue an interim durability rating on decay on the one hand and termites on the other?

DaCosta: Most of our ratings in the past have been arrived at by a consensus of opinion rather than by actual experimental testing. While we could issue gradings for a few timbers on the basis of laboratory tests we could not do so for all timbers.

Tamblyn: Perhaps we should resurrect the durability questionnaire that we have discussed at previous conferences and see if we can get a separate indication of resistance to decay and termites.

Item 4(1). Fixation of copper pentachlorophenate *

Copper pentachlorophenate has been used in N.S.W. as a wood preservative for the "rot-proofing" of veneers, but little information appears to be available as to its fixation in wood.

A study has been made therefore of a commercial technique of rot-proofing scrubwood veneers by a two-bath process in which the veneers pass through a sodium pentachlorophenate bath controlled at a high pH and then through a copper sulphate bath. The net result was thought to be that the formation within the veneer of an insoluble copper pentachlorophenate would occur which would be resistant to leaching and act as an effective fungicide. Experimental data from a preliminary survey indicated that some additional factor was involved since, on analysis after leaching, the retention of P.C.P. bore no relation to the original uptake of copper sulphate.

A subsequent trial was carried out on sassafras (Doryphora sassafras), and coachwood (Ceratopetalum apetalum) veneers which had been treated with sodium pentachlorophenate solution to which varying amounts of sodium cabonate had been added. After a 24 hr. diffusion period the veneers were re-immersed in baths of copper sulphate solution at different concentrations. Some samples of each species of veneer

* Prepared by R.Johnstone.

were treated with sodium pentachlorophenate plus sodium carbonate and not subjected to the second dip of copper sulphate.

After analysis for copper and P.C.P. and submitting each sample of ground veneer to a standardised leaching procedure, subsequent re-analysis showed that P.C.P. in the order of 50% had been retained and no significantly increased leaching of P.C.P. occurred in the case where the veneer was not treated in the copper sulphate bath. The amount of copper leached out was extremely variable. With each species the pH condition of the timber (based on arbitrary measurements of 1:1 ground timber/water mixture) increased from the typically acid state of the timber in each case to approximately neutral.

On the evidence of these analyses the P.C.P. is retained in the veneer by some mechanism other than by the formation of the insoluble copper pentachlorophenate salt. The possibility of the pentachlorophenate ion bonding with the cellulosic or other constituents in the wood can not be completely overlooked, but it is more likely that the inherent acidic nature of the wood has resulted in the formation of pentachlorophenol. The variability and lack of retention of copper after leaching leads one to suspect that some slight formation of an insoluble carbonate has occurred in preference to any precipitation of copper pentachlorophenate.

The fact that all analyses were carried out on the cores of veneers of varying thickness indicates the possibilities of greater effective usage of sodium pentachlorophenate in conjunction with insolubilisation properties due to the acid nature of wood. Experimental work is now in progress to determine the resistance to leaching of <u>P. radiata</u> impregnated initially with sodium pentachlorophenate.

<u>No Discussion</u>

Item 4(m) (i). Effect of Timber Species on Performance of Preservatives *

With the development of new types of preservatives and modifications to existing types (both creosotes and waterborne preservatives), evaluation can no longer rest on service records but must be made on field tests and, more importantly, on laboratory tests.

Most laboratory evaluations (and most field tests), both here and overseas, have been made using pine sapwood as a substrate, but in Australia preservative treatments are applied to a range of softwoods, eucalypts and rain forest hardwoods, and it cannot safely be assumed that the minimum retentions of preservative required to prevent deterioration, or even the relative effectiveness of different preservatives, found with pine will apply to other timbers. In particular, since the air-dry density of timber treated in Australia ranges from 20 lb/cu.ft. to 70 lb/cu.ft., it is important to know whether there is an important over-all effect of density.

Laboratory tests are therefore being carried out with small treated specimens ($\frac{3}{4}$ x $\frac{5}{8}$ x $\frac{5}{8}$ in.) of eleven timbers, covering a wide range of densities and botanical types, to determine the threshold values for a typical CCA preservative and for a typical creosote. Preliminary results for the CCA salt, both unleached and after shaking for 2 weeks in distilled water at 31°C, are given in the attached table. These show a great effect of timber substrate on the amount of preservative required to prevent rapid decay, some timbers requiring 4 - 7 times as much preservative on a weight/weight basis as did others.

Examination of the detailed results shows that while there are some slight indications that, as expected on theoretical grounds, denser timbers may require a greater retention (as lb/cu.ft.) of CCA than lighter timbers, any effect of density is overshadowed by other effects. The explanation of these may lie in the chemical composition of the wood (including extractives) which would affect the fixation of CCA salts, or in the distribution of salt within the wood after treating,

* Prepared by E.W.B.DaCosta.

and further investigations on the causes of this substrate effect are being carried out. Of more immediate practical implication are further tests to determine to what extent the effect is constant within the one timber species and for different fungi and types of test. This work has however been delayed because of the difficulty of collecting sound sapwood of a wide range of species from different parts of Australia.

These laboratory results confirm previous reports from America and Germany showing substrate effects (not quite as marked as ours) and also work both here and in U.K. on effect of substrate on leaching of CCA salts. Results to date do not necessitate any immediate departure from current Australian practice in the use of these salts, but it appears possible that CCA salts may eventually prove less effective in certain hardwoods than in pine sapwood. For example, in cooling towers, where leaching is severe and where failure is usually caused by soft rot, to which hardwoods are more susceptible than softwoods, it may be hazardous to use treated hardwood filling in place of pine. Exposure tests in cooling towers to decide this point will be installed as soon as the timbers required can be obtained.

Our results to date deal only with the influence of the substrate on the effectiveness of preservatives against decay, but it is hoped that similar investigations can be carried out against termites, Lyctus borers, and other insects. Our marine borer tests also suggest that CCA salts may be less effective in some types of eucalypt than in pine and this aspect also urgently requires further investigation.

Apart from the evidence of these bioassays, there is evidence from chemical analyses of the rate of leaching of fixed waterborne preservatives that the timber species may have a decided influence. In our early leaching tests with a copper chrome arsenate preservative (Ascu type) both copper and arsenic were leached to an appreciable extent from Eucalyptus regnans sapwood by distilled water, but not from _Pinus radiata_ sapwood. Recently, extensive tests at Hickson's Timber Impregnation Company's research laboratories in England showed that leaching from spotted gum sapwood was far more rapid than from _P. radiata_. Whilst it is not clear whether these differences would be as great in full sized timbers in service as in small laboratory specimens, it is certain that a great deal of investigation is needed on this aspect before we can predict with any precision the long term efficiency of preservatives in timbers for which service experience is not available.

EFFECT OF TIMBER SPECIES ON THRESHOLD OF CCA SALT

Timber Species	Basic Density lb/cu.ft.	% Water Uptake	*Coriolus versicolor*						*Lenzites trabea*					
			Unleached			Leached			Unleached			Leached		
			Control % Wt Loss	Threshold [a] % w/w	Threshold [a] lb/cu ft.	Control % Wt Loss	Threshold [a] % w/w	Threshold [a] lb/cu ft.	Control % Wt Loss	Threshold [a] % w/w	Threshold [a] lb/cu ft.	Control % Wt Loss	Threshold [a] % w/w	Threshold [a] lb/cu ft.
Brigalow	52.2	32.9	38.0	0.40	0.21	38.6	0.45	0.24	54.0	0.39	0.20	63.6	0.63	0.33
Grey ironbark	49.6	43.8	41.2	0.09	0.04	39.6	0.20	0.10	44.6	0.14	0.07	43.8	0.19	0.09
Karri	42.2	58.0	40.8	0.38	0.16	37.9	0.38	0.16	24.2	0.19	0.08	44.1	0.37	0.16
Spotted gum	39.8	60.5	47.2	0.20	0.08	43.0	0.57	0.23	44.4	0.36	0.14	51.9	0.40	0.16
Red tulip oak	39.7	71.7	41.1	0.71	0.28	42.2	0.68	0.27	42.4	0.38	0.15	50.4	0.59	0.23
Messmate	39.0	52.6	32.8	0.28	0.11	36.4	0.37	0.14	9.2	0.20	0.08	15.4	0.39	0.15
Blackwood	30.4	114.1	50.0	0.17	0.05	49.0	0.61	0.19	58.5	0.33	0.10	66.2	0.66	0.20
Mountain ash	29.6	124.9	55.5	0.18	0.05	54.6	0.34	0.10	38.8	0.19	0.06	55.4	0.54	0.16
Cheesewood	22.8	162.9	32.1	0.47	0.11	29.4	0.46	0.11	55.8	0.70	0.16	55.6	0.79	0.18
Radiata pine	26.3	163.0	35.8	0.09	0.02	25.0	0.17	0.04	67.0	0.20	0.05	67.2	0.64	0.17
Oregon	23.8	184.3	23.5	0.09	0.02	29.8	0.17	0.04	64.1	0.19	0.05	67.8	0.65	0.16

a Retention of preservative as g anhydrous CCA salt per 100 g oven-dry wood (% w/w) and as lb/cu.ft. required to reduce decay by 90%

Discussion

Whiteside: Is the wood factor more important in sawn timbers than in round timbers where you have a complete envelope of treatment?

DaCosta: All these tests were done on the sapwood of the timbers concerned - usually the outer sapwood. It would therefore apply equally to both sawn and round which could both be exposed to severe leaching. The tests were done on unleached, leached and double leached blocks and the effect of double leaching is to increase the threshold for the brown rot fungus. This is due to the fact that these fungi do release a fair amount of acid and other extraneous materials into the wood which have apparently affected the behaviour of the preservative.

Item 4(m) (ii). Fixation of copper-chrome-arsenic preservatives in eucalypts.

It was agreed that this item would be discussed outside the Conference.

Item 4(n). Toxicity of wood waste treated with copper-chrome-arsenic salts. *

This is becoming a problem in N.S.W. and Victoria. In Defence establishments especially, the trade unions are expressing concern as to the effects of sander dusts on their members and considerable discussions have taken place between the N.S.W. State Health, Labour and Industry and Forestry authorities. The Navy and Supply Departments and the University have also contacted us regarding this problem, which may be as much one of chromium as of arsenic.

It is felt that urgent positive action is required to check union and other reaction against the processing of CCA treated wood. Conference's views are sought therefore on:-

i. What we might do by way of plant design, especially dust extraction systems.

* Prepared by D.W.Edwards.

ii. How confident can we be of current waste disposal techniques, i.e. burning or tipping, especially for arsenic?

iii. What other steps we can take to ensure the safe processing of treated wood.

It is very important to avoid creating an unfavourable image for treated wood but we have a responsibility to the user by way of our relations with Health and Labour Departments. There is no doubt that these authorities will act on union representations and unless we can present them with technical solutions they will impose their own. These may be unsuitable or technically unsatisfactory to members of Conference but once established will be very difficult to change.

Discussion

Cokley: This problem has been recognised by the Health Department in Queensland. At the moment there is a semi-official ban on the use of treated wood-waste as firewood. We have a ban also on the use of CCA treated timber anywhere in contact with food.

Willington: In South Australia the Department of Health has approached the Woods and Forests Department regarding the hazard that exists in the multi-salt treatments in Mount Gambier. They have taken samples of dust from areas surrounding preservation cylinders, and they claim that the level of arsenic is very high, that this dust could blow around in the atmosphere and affect the operatives in that area. So far, no satisfactory method of eliminating this alleged arsenic hazard has been devised.

Dale: The disposal of treated waste has undoubtedly influenced at least one operator in Melbourne to treat weatherboards and flooring in the fully machined state to avoid having to dispose of treated waste.

Boyd: This appears to be a matter for consideration by the Preservation Committee.

Tamblyn: This is still a matter for the Health Authorities in each State and I think that the correct approach is for the State Services to approach the local Health Authorities and discuss the problem with them. Each State may have somewhat different requirements and the Committee could not tell them what should be done.

Bryant: Nevertheless, I think the Preservation Committee could give a lead by pointing out what is likely to happen when this sort of waste is burned and under what conditions we are going to get arsine produced, and so on. The medical profession needs some sort of lead from people who are technically competent to advise them. Therefore, I think it is a matter for the Preservation Committee to indicate the type of hazard likely to be encountered within industry when this type of waste is burned.

Boyd: Subject referred to Preservation Committee.

Item 4(o). Incorporation of Arsenic in Creosote *

The incidence of termite attack in poles pressure treated with creosote in some areas of high termite hazard in Australia suggests that there may be merit in fortifying the preservative with a suitable termiticide. The present investigation was undertaken to determine the capacity of black coal tar creosotes and similar materials to dissolve or react with arsenic trioxide and so improve their effectiveness as wood preservatives.

At 40°C, up to 0.36 per cent. of As_2O_3 may be incorporated into black coal creosote and 2 to 4 per cent. into wood tar oils obtained from charcoal wood tar from Wundowie, W.A. Higher temperatures (60°C and 80°C) produced faster and greater incorporation of up to 0.6 per cent. of As_2O_3 in creosote. The preparations are stable and showed no significant change in As_2O_3 content on standing at room temperature for 3 months. This arsenic combines chemically with some of the creosote

* Prepared by R.Johanson.

constituents and most of it is resistant to leaching. Under pressure, arsenic in creosote penetrated into poles and gave similar values at 1ft, 2.5 ft and 5.5 ft from the butt end.

The amount of As_2O_3 that can be incorporated should be sufficient for fortification of creosotes for an area of high termite hazard. In laboratory compulsion tests as little as between 0.026 per cent. and 0.035 per cent. of As_2O_3 equivalent (as was present in various preservatives) was sufficient to protect specimens against Coptotermes acinaciformis and other termites. In addition to the laboratory tests, data were obtained from termite infested forest area at Heathcote, Victoria. During the 7 years exposure, E. regnans specimens dipped in sodium arsenite and now containing 0.02 to 0.04 per cent. of As_2O_3 below the $\frac{1}{8}$ inch surface layer were completely protected against termites.

Should the introduction of arsenic into creosote be considered desirable, then for timber with density of 40 lb/cu.ft., 0.12 per cent. As_2O_3 is needed at a creosote loading of 10 lb/cu.ft. and using a 100 per cent. safety factor this value will be 0.24 per cent.

Discussion

Unrichard: Is the arsenic easily leached and have comparisons been made between arsenic in creosote treated wood and arsenic in otherwise untreated wood as regards leachability?

Johanson: Yes, we have carried out these tests and can leach out almost 100 per cent. of the arsenic from specimens treated with an arsenic-water solution in about 4 to 5 weeks under laboratory conditions. On the other hand, we can leach out about 30 per cent. of the arsenic from the arsenic-creosote preparation. However, after the initial period leaching decreases considerably, and it is impossible to leach more than a certain amount of arsenic from samples treated with the arsenical creosote.

Bryant: This work is important because I feel that in a few years time the health authorities in various States will restrict the use of chlorinated hydrocarbons. I should like to see work on soil poisoning with creosote-arsenic mixtures carried out as well. I am well aware of the fact that creosote alone has broken down long before the chlorinated hydrocarbons, but we would ask that Mr. Gay might consider carrying out some long-term tests using this mixture.

Tamblyn: We should start commercial tests on this development. I would suggest that we start at a Victorian plant and if no early troubles develop that we ask a New South Wales plant to try the same arsenical creosote. If no troubles develop over a winter and a summer period, we should then seriously consider recommending this for general use in pole and fence post treatments without field trials. We could not easily get good field test evidence of effectiveness, as it would have to be applied to whole poles and they would have to be exposed for years in an area of high termite hazard. We should wait only until we are satisfied that arsenical creosote is safe in a plant. Are New South Wales and Queensland happy about this proposal?

Bryant: Yes.

Cokley: Yes. At the moment we have no creosote plant, although we could arrange for test poles from various parts of Queensland to go to a New South Wales plant treating with arsenical creosote.

Willington: Will this apply to all species or to hardwood only?

Tamblyn: If we decide to use arsenic in creosote we would probably make a blanket proposal for fence posts and poles irrespective of species.

Willington: Have there been any failures in cresoted treated pine poles due to termite attack?

Tamblyn: We have seen attack in a few pine poles which we treated with creosote years ago, but the penetration in these was not very good because they were only open tank treated. There have not been enough pressure-creosoted pine poles used for us to give a sound judgement, but certainly with eucalypts where we may have only ½ in. of creosote penetration there have been quite a few poles attacked by termites. We feel that the arsenic in creosote is an extra deterrent and that some of it will probably diffuse into the heartwood.

Harding: The health aspect should be looked at by the Committee.

Bryant: Is it possible for Mr. Gay to carry out some tests on arsenical creosote as a soil poison against termite attack?

Gay: Yes, we could do this if we could have the material supplied by Mr. Johanson.

Item 4(p) (i). Efficiency of the Hudsons Test-a-pole creosote method *

Much work has been carried out in the search for a suitable experimental method for the determination of creosote retention in *Eucalyptus* spp., primarily by the C.S.I.R.O. As is known, the Dean and Stark method of toluene extraction is tedious, and only reliable provided that an accurate measurement of the water content can be made. Also by its nature it is entirely unsuited to on-the-spot tests of individual poles.

A rapid method of testing has been proposed by Dr. M.S.Hudson based on the intensity of the characteristic dark creosote colouration when the creosote is extracted from an increment boring with dimethylformamide, and comparing this colour intensity with a set of solutions containing known amounts of creosote. Retentions of creosote in individual southern pine poles determined by Hudson was claimed to show a closer relationship between the Hudson "Test-A-Pole" method and actual measured uptake of creosote than between the toluene extraction method and the measured uptake.

To establish a possible correlation between the Test-a-Pole,

* Prepared by R.S.Johnstone.

and toluene extraction methods in the case of Eucalyptus spp., eight commercially treated poles, (seven of Euc. paniculata and one of Euc. microcorys) were tested at five positions along each pole. Since the basic Test-A-Pole method necessitates 0.25 in. diameter plugs, each individual sample comprised six borings for the toluene method, and five for the Test-A-Pole method. The borings for each sample were as closely grouped as possible.

The results indicated an unsatisfactory correlation between the two methods probably due to (i) the pressure of dark coloured dimethylformamide extractives in Eucalyptus spp. which results in increased creosote retention when determinations were carried out by the Hudson method, and (ii) the inherent difficulty involved in obtaining a creosote sample of colour intensity characteristic of the creosote used in treatment, and on this depends the setting up of the comparative standard.

The major problem arising out of this type of test is the wide variability of creosote retention in Eucalyptus poles, and it would appear that as yet it is not possible to determine quickly and accurately creosote retentions at the plant except by weighing the poles before and after treatment.

No Discussion

Item 4(p) (ii). Methods for Creosote Analysis

Development of methods for analysis of creosote content in poles has proceeded since the last Conference and it is now possible to obtain $\frac{3}{4}$ in. diameter plugs from poles at the treating plant or in service, rapidly and easily, and to analyse their creosote content by a gravimetric extraction method which lends itself to the processing of many samples in a short time. The overall accuracy of the method is at least to within 10 per cent., and this is adequate for most work. These methods do not require expensive apparatus and could be widely used for quality control at treatment plants and for experimental work on variation in timber treatability.

No Discussion

Item 4(g). New Preservatives

Edwards: We are concerned at the increasing variety of wood preservatives being offered to the public in Australia, and the rapid shifting of some preservation firms from one preservative to another and back again. This is causing a considerable amount of confusion in the industry. We feel that this may eventually become a policy matter for the States concerned as to whether they are going to discourage actively the use of certain wood preservatives and secondly, whether some arrangements could be made for a central organisation for the assessment of these wood preservatives.

Cokley: We are also very concerned about this. The bulk of CCA treatment in Queensland is carried out at an immunising level and until CCA preservatives came on the market, boron was quite satisfactory for building timbers. It was cheap, effective, had no health hazards, it could be estimated by the plant operator in solution, it was the optimum preservative. Some treaters have found that CCA salts are economic at the immunising level, due to large volume of sapwood. Hicksons have offered Immutan as an alternative preservative, but our recommendation is that where timber is to be used internally it is foolish and impractical to go past boron. Immutan is basically a mixture of arsenic and sodium fluoride and no claim to fixation is made. Where there is a suitable existing alternative, and where the new preservative cannot offer any advantages, we should not encourage its use. For the protection of the industry, this Conference, through the Preservation Committee, is the only unbiased assessor, and firms with new preservatives should submit such preservatives for assessment.

Bryant: I think the Committee should consult those States which are not represented as the decisions could affect such States. I agree that where there is already a particular compound that will do the job and does not represent a health hazard, we should make our opinions known to our local health authority.

Uprichard: Immutan has been approved in New Zealand for the treatment of light building timbers at a nominal loading of 0.10 lb/cu.ft. subject to the attainment of a minimum core loading of 0.06 per cent. As_2O_5.

For identification, approval has been granted for the incorporation of a red dye to the treating solution. Retentions have been specified on the basis of insect control.

Note: The States then indicated agreement that the Committee should act for the Conference in this matter, soliciting postal agreements from the States, where necessary.

Item 4(r). Report on development of a plywood preservative

Tamblyn: At previous conferences we have argued the case for preservative treatment of plywood. We would like to see this as a mandatory requirement for all plywood sold as exterior or marine grade. We have pointed out in the past that most of the timbers used for plywood are of a very low durability and *Lyctus* immunisation with boron or fluorine compounds is not a general purpose preservative treatment. Our convictions that some treatment is urgently needed have been reinforced since the last Conference by the numerous complaints we have received from irate boat owners because of rotting plywood in their craft. I think it is fair to say that there are probably thousands of boat owners in Australia who are having, or will have, costly repairs to make because in good faith they bought and used a material which proved to be unsuitable for the purpose. At the last conference we offered to try to develop a preservative for plywood which would remove some of those objections raised when present proprietary formulations are used. I am now able to report that this work is under way and we have developed several formulations which are under test. In the first group we have developed some modified metal-chrome-arsenic formulations. These are oxide formulations with very low arsenic content and very high metal content. They readily make cold concentrated solutions and hence should be suitable for dip-treatment of green veneer even if quite high loadings are required. We have developed some automatic leaching equipment which will cope with 250 specimens in a simulated soxhlet leach. We have completed the leaching of the first several formulations and should soon be able to proceed to gluing tests, which will be done by our Plywood and Gluing Section. If we succeed in developing a suitable preservative we believe that it could be made available to the industry through the Australian Plywood Board. We have informed Hicksons and Celcure of our intentions and I believe they are now also looking at better class preservatives.

Cokley: For years we have tried to glue satisfactorily veneers treated with CCA salts. We have found it impossible to provide a guaranteed glue bond at loadings above 0.35 lb/cu.ft., we have also found great difficulty in treating plywood, particularly in ensuring adequate penetration in the core species. There are also major problems of re-drying.

Edwards: We think the results of this work on a plywood preservative will be utilised very swiftly by industry. We have analysed various samples of plywood pressure-treated with CCA preservative and in New South Wales species, at any rate, we have found little difficulty in attaining retentions of 1 to 1½ lb/cu.ft., and even in the centre of the sheets the inner veneer retentions are of the order of 0.75 lb/cu.ft.

Smith: If treatment of marine plywood is made mandatory, presumably this would involve incorporation of any such recommendation in the relative Australian Standard Specification because relatively durable species are allowed and used in exterior plywood. I suggest that the treatment of plywood constructed completely of relatively durable species should not be required.

Bryant: I am completely opposed to treatment being made mandatory. If industry wants to adopt it, let them do so.

Wickett: Will this work cover the relatively non-absorptive species such as the merantis?

Tamblyn: Dip treatment of green veneer has a much better chance of giving protection to impermeable timbers than if it is bonded into plywood before treatment. Dipping puts a good film on both sides of the veneer, it goes into peeling checks and there is small amount of diffusion before the preservative fixes.

Beesley: In the Australian Standard for marine grade plywood there is no requirement for durability. Could we not express concern to the Standards Association that there is no provision for durability in this particular Standard.

Boyd: I think this could be premature as this new preservative may eventually affect the Standard.

Whiteside: Results of tests in New Zealand on treatment of plywood have been unsatisfactory due to uneven distribution and the problems associated with drying after treatment. We feel that treatment of the assembled panel may be impracticable and the dip treatment of green veneers will be considered in the future.

Turnbull: If the early breakdown of marine grade plywood is as common as has been indicated, action is definitely necessary to bring it to the attention of the Standards Committee.

Bryant: When this preservative is ready I have no doubt that it will be accepted unanimously.

Item 4(s). Hot and cold bath preservative treatments - Warnervale, N.S.W. *

The commercial creosote treatment of poles by the hot and cold bath process was approved in terms of the N.S.W. Timber Marketing Act in November 1963. Subsequently this approval was amended (January, 1964) to cover the proposed new standard for creosote which included a minimum of 16% tar acids. This firm, P.I.Poles Pty. Ltd., has been treating poles over the ensuing period and has now found it necessary to extend its plant to meet increased demand.

The general cycle of operations is well-known and involves heating the creosote in the bath at a temperature of 80-120°C for 2 hrs and either allowing the creosote to cool overnight or alternatively pumping the hot creosote out and flooding with cold creosote. The obvious limitation of the overnight cooling cycle is that only one charge can be carried out per day.

Temperature Gradient in the Pole. - To determine an effective time schedule for the heating and cooling cycle it was considered a useful approximation to trace the temperature gradient within the pole. This was carried out on several occasions and in each case the pattern was similar. A typical set of temperature readings is shown in the table on the following page:-

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* Prepared by R.S.Johnstone.

Euc. pilularis - 30 ft - Sapwood M/C 22%

	Sap'wd depth	Hot bath (°C)					Cold bath (°C)	
		1 hr	1½ hr	2 Hr	2½ hr		½ hr	1 hr
3 ft from butt	⅜"	94½	99	102½	107½	Drained and re-filled 2 hr 40 mins.	65	60
	½"	88	93	97	101		67½	62
	⅝"	83½	89½	93½	97½		67	65
6 ft	⅜"	93½	98	102½	106		61½	58
	½"	89½	95	99	103		66½	61½
	⅝"	85	90	94½	98		67½	61½
9 ft	⅜"	96	98½	104½	107		62	59
	½"	91	93	98½	101½		65	61
	⅝"	89	92	97	101		66½	64
12 ft	⅜"	95	99½	105	108		61	61
	½"	90	96	100	104½		64½	64
	⅝"	81½	88	91	94½		79	75
15 ft	⅜"	97	101	105½	109		59½	62
	½"	94½	100	104½	108		60½	64½
	⅝"	88	93½	97	101		64	64½
Bath temp. (°C)		114½	115	116	117		59	-

It is possible that the creosote follows this pattern as regards uptake since visual evidence indicated that at the peak of a two-hour heating cycle penetration was negligible, while after ½ hour in the cold bath most, if not all, penetration had occurred. Certainly at this stage creosote penetration had been obtained through the entire sapwood band.

Actual Creosote Uptake. - Estimates of creosote retention showed a fairly high degree of variation between treated poles. Using the toluene extraction method on a batch of eight poles (Euc. pilularis), creosote retentions were obtained as follows:-

10.2, 10.4, 11.0, 11.6, 11.9, 12.8, 14.3, 14.4 lbs/cu.ft.

Each result was obtained from samples of 20-30 increment borings throughout the pole. While the variation is fairly high, it is considered that the problems associated with sampling techniques and the limitations of the method itself would account for some of the variation obtained. These possibilities have been substantiated in tests in which the retention of individual poles were determined by four separate methods, viz. weighing before and after treatment, charge usage (gauge retention), Dr. M.S.Hudson's "Test-A-Pole" method, and the toluene extraction method.

Since the process of treatment is somewhat empirical by nature, relying on internal characteristics as well as external factors, it becomes necessary to adjust such properties as moisture content etc, and to allow for sapwood thickness and inter-species variation to a much greater extent than for the conventional pressure treatments.

Discussion

Wickett: Were poles dipped full length or was it a butt treatment?

Edwards: It is a full length treatment, essentially a hot and cold bath where the poles are held under the solution. It is a small-scale operation, the tank holds a dozen or 18 transmission poles at one time, and it works on the basis of 1 charge every 24 hr.

Whiteside: This type of treatment is approved by the Timber Preservation Authority in New Zealand.

Item 4(t) (i). Need for Post-mortem on all Cases of Early Failure of Treated wood *

Over the last 3 or 4 years the Division has investigated a number of early failures of treated wood. Most of these have been poles, the rest have been fence posts except for 1 or 2 cases where sawn timber was involved.

In practically every case the failure was clearly the result of improper treatment and this fact has been most valuable in

* Prepared by F.A.Dale.

impressing plant operators, and others connected with pole treatment, with the need to improve quality control.

Compared with the number of posts and poles in service these failures represent only a minute fraction of the numbers treated, but they will increase and we cannot be expected to keep track of all of them.

There is a clear need for a standard system of reporting early failures so that their incidence can be studied and, as far as possible, their causes determined correctly. The majority of treated poles are tagged with species, plant and date of origin and this information is essential if proper records of failure are to be kept. When early failure occurs other information such as site, soil type, known insect or decay hazard and the date of removal must be recorded. Where the cause of failure is not certain from inspection, samples such as discs or plugs should be taken and sent with all the above data to whichever authority is responsible for analysing the failure.

The work of analysing failures has been shared so far by various laboratories and this will have to continue unless a separate laboratory is to be set up at least partly for this purpose. By standardising the reporting and sampling of failures the time and cost of post-mortems can be kept to a minimum. If this is not done arbitrary selection of failures for thorough examination will become the rule and the average quality of information obtained from all failures will suffer accordingly.

Item 4(t) (ii). The need for checking in-service behaviour of treated timber. *

With the development of general purpose preservation, there arises a need to assess, under local conditions, the influence of treatment upon service behaviour of timber. Concurrently, there is

* Prepared by K.V.Cokley.

the necessity to determine, by exposure of treated timber under actual service conditions, whether the retentions now required are satisfactory or whether modifications are necessary. Combined with this is the requirement to determine the effect of treatment upon other factors such as paintability. The following facts illustrate the need for this study.

The effect of treated sapwood in sawn timber of mixed heartwood-sapwood cross-section. - Where building timbers, e.g. 3 in x 2 in, from many eucalypt species contain mixed heartwood/treated sapwood, bowing often occurs due to the sapwood drying at a faster rate than the heartwood. This effect also occurs in chamferboards, particularly if exposed to service in very hot dry areas.

The effect of treatment upon paintability. - Studies on the effect of treatment upon painting have been in progress for several years in Queensland. Taubmans have service trials in progress at Brisbane and to date there appears to be no detrimental effect. However, variable results compared to those from overseas have been obtained with slash pine chamfers treated with borax compounds and water repellant formulations and exposed in a departmental building at Beerwah.

Although New Zealand reported that boron did reduce the service life of painted timber, our experience after 4 years gives no evidence of any significant effect compared to untreated controls. A linseed oil based formulation was used. Although certain American reports indicate that water repellent treatment enhanced paint life, in this study there has been no significant effect.

It should be pointed out that chemical analyses now in progress are giving strong indications of marked depletion of boron from the treated chamferboards.

Splitting of pressure treated poles in hot dry climates. - With major utilisation by Queensland pole authorities, some concern was felt at the incidence of splitting in poles exposed to dry western climates. In one area approximately 2% of the poles were affected. Subsequent evidence strongly indicated that post-treatment seasoning of the poles was necessary. A recent examination of approximately 500 poles in the Barcaldine district showed that only 3 poles viz. 0.6% were affected.

Evidence has been accumulated indicating that certain species such as grey box are prone to split and hence their use in these areas does not appear desirable.

In an attempt to study the "in service" behaviour of treated timber, the Department has employed such material, particularly treated plantation species, in departmental construction and National Parks etc. Preliminary examination of treatment is made and subsequent "in service" records are to be maintained. In these studies, where practicable, loadings at and below the present specification are used.

Discussion (Item 4(t) (i) & (ii)).

Edwards: We would strongly support Mr. Dale on this item and we will certainly report information in the terms he has requested. I assume the co-ordinating body for this will be the Timber Preservation Sub-committee.

Dale: The Wood Pole Co-ordination Committee should also be advised as they could take some action. The State authorities will be advised through the Pole Committee or the E.S.A.A.

DaCosta: Failure in the untreated portion of a treated pole and failure in the actual treated portion should be clearly differentiated. This is a source of confusion commonly arising with reports on poles.

Item 4(u) Proposed branding systems for treated wood *

Timber merchants, timber users, and Forest Authorities are faced with a number of unrelated branding systems for treated wood. In the interests of orderly marketing and effective legal supervision of the sale of such treated wood a uniform Australasian timber branding scheme is proposed.

Obstacles to such a scheme are formidable but similar problems have been met and solved elsewhere. Certainly if we do not tackle the matter now it will become increasingly difficult in future years. Conference's views are therefore sought on the feasibility of such a scheme and whether it would be desirable to recommend further consideration by other interested parties.

To assist discussion the following points are submitted:-

(1) Legal control of brands for treated timber exist in New Zealand, Queensland and New South Wales. Similar controls are likely in Victoria. In N.S.W. for example there are some 200 registered brands under the N.S.W. Timber Marketing Act.

(2) There is a steady increase in the importation of treated wood into N. S.W. from other States, and from overseas; and into Queensland from N.S.W.

(3) Treated N.Z. grown radiata pine could become an important part of Australia's future imports of softwoods.

(4) The costs of changing current timber branding schemes would be considerable but could possibly be shared by government and industry.

(5) Any such scheme would not be enforceable in South Australia, Tasmania and Western Australia without legislation.

(6) The complexity and number of preservative treatments now in use in Australia suggest to us that a uniform branding system might be based on the addition of a simple letter plus numeral code attached to existing brands.

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* Prepared by D.W.Edwards.

Discussion

Whiteside: Branding regulations are under review in New Zealand at the present time. What is obviously required is that the name of the treating firm, the preservative and the specification appear on every piece of treated timber. One of the complications has been the processing after treatment by firms other than the treater. It has not yet been resolved satisfactorily as to how the timber should be branded for this processing.

Ryley: In the recent amendment to our Act, we can now give brands to indicate loadings and we are investigating the legal aspect of branding to get uniformity. Any other State contemplating branding should discuss it with New South Wales and Queensland to ensure that from now on we get uniformity throughout Australia.

Uprichard: I would point out that a system which is realistic and can be understood by the consumer is desirable. Most of our CCA treated timber which has failed in service was treated to building timber retentions but used in contact with the ground.

Bryant: The point raised by Dr. Uprichard regarding the consumer is an important one and if the Standards Committee has not considered it, they should do so.

Beesley: The Long-Term Lending Authorities' Technical Committee has prepared a new specification which will be applicable in Victoria. This specification required the branding of all radiata pine used for structural purposes and the requirements of that specification have been adopted by the Timber Producers' Council of south-eastern Australia, which includes representatives of South Australia, Victoria and New South Wales. We have here a new set of standard brandings coming into force, which will be required and used. I think urgent action is required to bring all these branding systems into uniformity.

Boyd: This matter should be brought to the notice of the Standards Association and some co-operation sought. I propose that Mr. Turnbull bring this to their notice.

Item 4(v). The Fire Resistance of Treated Fence Posts *

Following the fires in South Australia and Victoria early this year, statements have been made at field days that the production of copper-chrome-arsenic treated posts be prohibited by legislation "because of their certain destruction by fire".

Since then this Division has been trying to collect sufficient information to combat this ridiculous propaganda by putting the facts in their true perspective. It is our belief that fire is only responsible for the ultimate destruction of a very small proportion of fence posts and this is borne out by the results of our 1955 fence post survey by Wynond, in which only 3 per cent. of answers in South Australia and 1 per cent. in Victoria gave fire as the main cause of failure. Information on the behaviour of treated posts in fires is coming in slowly; that which is available so far is contradictory because it does not yet cover duration and fuel supply although temperature and wind speed were recorded in some cases. Only one thing is certain and that is that no fence post is completely fire-proof. Creosote-treated posts however, are remarkably fire resistant. Although they appear to ignite readily they almost always extinguish themselves once the fire has passed. Copper-chrome-arsenic treated posts do tend to keep on burning but they are almost certainly harder to ignite than untreated posts. Any untreated post more than a year or two old has a zone of readily ignited decayed wood at groundline and the older they are the more likely they are to ignite and stay alight.

We believe that fire resistance is much less important than continued resistance to decay and insect attack which is the main attribute of CCA treated posts. Much more information is required and this is being assembled with the help of such bodies as Chemical Research Laboratory's Fire Section, the Country Fire Authority (Victoria), the Bushfire Research Committee of South Australia and others.

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* Prepared by F.A.Dale.

Until this has been obtained, any experimental work may be made along the wrong lines, although useful indications have been obtained from field tests at Mt. Gambier and near Adelaide.

Information from all States on the degree of hazard which fire represents would be welcomed.

Discussion

Uprichard: The fact that creosoted poles appear to be fire-resistant, can be related to the fact that the cells of the wood contain creosote and there is less air for combustion. I think that experimental work comparing radiata pine untreated, treated with CCA preservatives, and treated with creosote would be worth doing experimentally.

Boyd: This is a live political issue at the moment and is of some concern to this Division. A good deal of pressure is being put on us and other Divisions and Sections of C.S.I.R.O. to do experimental work in relation to the fire hazard of treated posts, and at this stage we do not consider that this is justified until we have a lot more information. We would therefore like co-operation to get as much information as we can on the real significance of fire hazard in fence posts.

Item 4(w). Round Fence Posts - Is More Promotion Needed?

Dale: There is no doubt now about the popularity of treated round fence posts in South Australia, Victoria and Tasmania. How much of this is due to promotion by ourselves and State Departments is impossible to say.

Do any of the States feel that more promotion of low-pressure treatment or 200 p.s.i. treatment is needed to popularize fence post treatment e.g. in the brigalow areas of Queensland or around Esperance in Western Australia? We have now virtually closed down our own fence post promotion work except that we lend our portable fence post treatment plant to any interested enquirer. However, we can provide help to a limited extent if this is required.

Boyd: We have spent a tremendous amount of time over a number of years in round post promotion. It is of particular value to the Forest Services and I would like to see them take the initiative in promoting the more efficient use of their timbers.

Bryant: In New South Wales a new plant will shortly be operating near Tumut using about 2 million feet of radiata annually for fence posts, and a similar one is planned near Wagga.

Edwards: We receive several hundred enquiries from farmers every year. We have an article in preparation for publication in the Agricultural Journal and we have done a few demonstrations for government authorities. At least one commercial firm has done a considerable amount of promotion throughout New South Wales. The commercial interests should be prepared to share in this sort of promotion.

Willington: Our experience in South Australia is that if each Forest Service could get the Department of Agriculture, stock and station agents and the more enlightened fencing contractors interested in treated material there is no difficulty in getting it established.

Cokley: In Queensland, this situation is being adequately looked after by the different treatment plants who are doing their own promotion. I do not think we should do any more.

Wickett: There is room for a lot more post promotion in parts of Western Australia but promotion requires a lot of time and effort.

Dale: Plants operating at 50 lb/sq.in. would probably find favour in Western Australia on sites removed about 150 or 200 miles from Perth, particularly where new land is being taken up. The most economic place to treat this material is right in the scrub so that minimum handling is required.

Item 4(x). Marine Borer Tests *

A summary of the condition of specimens after five years exposure is given in the table on the following page. As in previous Laboratory Reports on this project, comparison between the various preservatives has been simplified by using a scoring system. Each specimen has been awarded points to a maximum of 100, in the ratio of 3 for each specimen unattacked, 2 for light attack, 1 for heavier attack and 0 for each specimen destroyed. A close study of the table, particularly the scores for the waterborne treated eucalypt specimens at the Port Hedland site, will show the unreliability of comparing preservative effectiveness only on the basis of the mean for all specimens at all sites combined. The severe teredo hazard at Port Hedland and the very poor performance of round eucalypt specimens treated with waterborne preservatives at that site has underlined the necessity for further sample tests to be made around the Northern coastline in order to determine the comparable degree of hazard in those waters.

* Prepared by C.D.Howick.

Item 4(x). MARINE TESTS OF PRESSURE-TREATED TIMBER IN FOUR AUSTRALIAN PORTS

FIVE-YEAR SUMMARY OF CONDITION OF SPECIMENS AT ALL SITES *

Preservative and Nominal Retention (lb/cu.ft.)		Scores to a Maximum of 100 Showing Preservative Effectiveness														
		Sawn P.radiata					Round Eucalypt					Mean Scores				
		Brisbane	Sydney	Kwinana	Port Hedland	All	Brisbane	Sydney	Kwinana	Port Hedland	All	Brisbane	Sydney	Kwinana	Port Hedland	All
Creosote K.55	10	60	77.8	13.3	46.7	46.3	0	77.8	100	66.7	66.7	30	77.8	56.7	56.7	56.5
	20	83.3	100	46.7	73.3	74.5	50	100	100	77.8	84.8	66.7	100	73.4	75.1	79.6
Creosote, Heavy	10	53.3	60	46.7	66.7	61.7	66.7	88.9	100	88.9	86.1	60	74.5	73.4	77.8	73.9
	20	75	100	80	86.7	86	66.7	100	100	100	91.7	70.9	100	90	93.4	88.8
Creosote and Tar	20	77.8	93.3	40	53.3	64.8	50	100	100	100	90.9	63.9	96.7	70	76.7	77.8
Boliden S.25	1.5	77.8	100	100	93.3	94.4	44.5	88.9	77.8	11.1	55.6	61.2	94.5	88.9	52.2	75.0
Celcure Old	1.5	100	100	93.3	93.3	96.1	66.7	88.9	77.8	11.1	61.1	83.4	94.5	85.6	52.2	78.6
Celcure A	1.5	100	100	100	86.7	96.5	33.3	88.9	88.9	22.2	69.7	66.7	94.5	94.5	54.5	83.1
Tanalith C	1.5	100	100	100	93.3	98.2	66.7	88.9	100	0	63.6	83.4	94.5	100	46.7	80.9
Boliden K.33	1.5	100	100	100	100	100	88.9	100	88.9	22.2	75	94.5	100	94.5	61.1	87.5
Copper-Silica	1.5	-	-	33.3	0	16.7	-	-	0	0	0	-	-	16.7	0	8.4
Untreated Radiata Pine		0	0	0	0	0	-	-	-	-	-	0	0	0	0	0
Red Stringy-bark		-	-	-	-	-	0	0	0	0	0	0	0	0	0	0
Turpentine		0	87.5	83.3	41.7	58.6	-	-	-	-	-	0	87.5	83.3	41.7	58.6
Jarrah		-	-	37.5	16.7	27.1	-	-	-	-	-	-	-	37.5	16.7	27.1

* Prepared by C.D.Howick.

Discussion

Howick: Reports of this test have been issued but at the 5-yr inspections some of the previous indications have been tempered by results at Port Hedland.

Smith: Does the scoring system relate only to the treated sapwood in the case of the hardwoods? In the hardwood specimens, the ends are not protected and therefore the test samples do not simulate actual service conditions, hence, we may not get a true indication of the service life to be expected from these preservatives. I presume that the identity of the attacking organisms will be indicated in the final report.

Howick: The scoring system ignores all attack in the heartwood of hardwood specimens. While there is untreated heartwood exposed, there is also a certain amount of skin penetration on the end-grain. The point we wish to make is the difference in performance at Port Hedland from all other ports, rather than the over-all performance of the treated specimens.

Smith: Until further tests are conducted using protected end samples, we should not place too much reliance on the comparative results of these experiments.

Beesley: We have considered this point and from the condition of the specimens at the four different sites, it is obvious that while attack has occurred from the untreated ends of hardwood specimens, it does not account for the major failure at Port Hedland, and does not alter the validity of the conclusions we are now reaching. We are quite aware that the damage that has occurred in the treated sapwood may be tied up with the fact that the mature marine borers may be able to tolerate a higher loading of preservative if they work from the heartwood out into the treated sapwood, but the fact is that they have still been able to get in through the surface of the treated sapwood.

Edwards: In relation to the scoring system and its effect on this report, we feel that at either the 6 or 7-yr inspections, it would be very desirable if one observer from the Division of Forest Products could take an active part in the inspection at all sites. This may improve uniformity in the interpretation of results. Is there any marked difference in salinity between the Port Hedland site and the Sydney site?

<u>Beesley</u>: At Port Hedland, Sydney and Kwinana, the specimens are exposed to full salinity. There is an abundance of marine fouling as well as teredine type attack. The Brisbane River site is the only one in less than full salinity conditions, and therefore it has restricted the information to some extent. In Brisbane, <u>Nausitoria</u> is the only organism of any consequence. In Sydney and Port Hedland, it is <u>Teredo</u>.

At Port Hedland we have a tide of 18 or 20 ft and the specimens are suspended just below low-water. In Brisbane, there is no tide and the specimens are only a few ft below water-level. In Sydney, the tide is about 2 to 3 ft, possibly up to 4 and the specimens are at all times in the water. At Kwinana the tide is about 2 ft and the specimens are always below water-level.

<u>Wickett</u>: At low-water springs, the bottoms of the specimens at Port Hedland are about 18 in. above water-level and the tide is about 18 ft. They are completely exposed to the atmosphere for a short period of their life.

<u>Colwell</u>: I suggest that total salt content and sodium chloride content of water should be measured in all these localities, also the temperature, as there appears to be a definite correlation between temperature, salinity and attack. In New Guinea, we have been working on natural resistance to marine borers for 4 or 5 yr without much success, as everything we try lasts only 3 or 4 months, with the exception of the <u>Neonauclea</u> species which appear to be virtually immune to <u>Teredo</u> and <u>Nausitoria</u>. We have exposed untreated specimens in streams which were so far away

from the sea that we thought the tide would have no effect and even where we could not detect any salinity at all, we still got quite serious Nausitoria attack. Our problem is not so much with piles as with boats. In our New Guinea tests we have found indications that attack appears to be controlled by the amount of light. On the question of end penetration, we appear to get very little attack in the end-grain. We would like to see the above information recorded with the aim of being able to forecast attack.

Uprichard: Mr. McGuire says that there are 2 recent publications on marine borer tests in New Zealand. These are "Accelerated Tests on the Efficacy of Preservatives Against Marine Borers" and "A Note on the Occurrence of Marine Borers in New Zealand". As a result of these tests a draft specification has been proposed for the treatment of marine piling which requires that with an approved CCA salt, the penetration shall be 75 per cent. of the sapwood depth, a minimum of $1\frac{1}{2}$ in., and the zone between $\frac{1}{2}$ in. - $1\frac{1}{2}$ in. from the surface shall contain at least 5 per cent. copper oxide equivalent on the basis of oven-dry weight. Two service tests are now using these formulations.

Tamblyn: There may be a slight misapprehension as to one aspect of this test. The radiata pine specimens have performed very well in all ports including Port Hedland. Our problem is that our eucalypt species have failed when the pine has not. We have obviously to test the effect of these preservatives on different timber species as well as in different geographical locations. We will not recommend CCA treatments for marine piling north of Perth or Brisbane until we have done further tests or until further information comes in from service installations which may have gone beyond these areas.

Smith: We feel that the major cause of the difference between radiata pine and hardwood is the lack of end protection, despite the sincere attempts to segregate the effects of end infestation and side infestation. In view of this we should not condemn CCA treatment of eucalypt marine piling until further tests are done providing end protection. In subsequent tests, information should be obtained on salinity at the test sites.

Wickett: I agree that it is unfortunate that these eucalypt specimens were not covered on the ends with copper sheathing but I wish to support the statement that there is no difficulty at all when examining these specimens in deciding that sufficient attack has come from the side of the specimen to result in its destruction.

Beesley: We did a chemical analysis on the sapwood of the infested hardwood specimens from Port Hedland and we found the figures for copper to be as follows:-

Celcure A:	After	treatment	0.26 Cu,	analysis	after	exposure	0.26 Cu
Tanalith C:	"	"	0.31 Cu,	"	"	"	0.14 Cu
Boliden K33:	"	"	0.41 Cu,	"	"	"	0.07 Cu
Boliden S25:	"	"	0.12 Cu,	"	"	"	nil Cu

The after-treatment figures were based on uptake of individual specimens.

Although the leaching of the copper probably contributed to the problem, the Celcure treated specimens were still totally destroyed, even though there was no copper loss. There was no detectable difference in the condition of specimens treated with the 4 CCA salts.

Gay: Is detailed and precise information available on the identity and distribution of the various marine borers in all Australian coastal waters and if not, is any action being taken, or contemplated, to remedy this lack of fundamental information?

Beesley: Complete information is not available, but a considerable amount of collecting has been done along the north and west coasts of Western Australia. The collected material is at present in the National Museum in Victoria. The zoologist concerned is now prepared to work part-time on examination and identification of this material, but the suggestion has been made that this should be in some way subsidized.

Smith: A considerable amount of work has been done by Mr. Watson and a New South Wales authority to determine the types of organisms and their incidence along the coastline of New South Wales, Queensland and, to a lesser degree, in New Guinea. I understand also that there is a current project initiated by a marine biologist from the Queensland University to supplement this information.

Item 4(y). Termite Investigations *

The termite investigations carried out by the Division of Entomology which are of direct interest to this Conference can be considered under two headings - laboratory testing and field studies.

In our laboratory testing programme the projects which are of special interest are those relating to (i) natural resistance or durability (ii) building boards, and (iii) chemical or preservative treatments for termite protection. Each of these will be considered briefly.

Because of the large amount of brigalow available as a result of clearing operations in Queensland, precise information on the natural durability of this timber appeared desirable. Samples of six trees were tested, and compared with tallowwood, spotted gum, messmate (E. obliqua) and mountain ash. Three termite species were used in this evaluation which showed that brigalow is superior in termite resistance to tallowwood, messmate and mountain ash, and equal to the most resistant examples of spotted gum.

The Forest Research Institute, which is establishing plantations of Callitris intratropica in the Northern Territory and Melville Island, have been concerned at the possibility of appreciable differences in natural resistance to termite attack between plantation grown and naturally grown trees. Samples from 11 plantation grown and 12 natural grown trees were tested, using two species of Coptotermes as test insects. The results showed that there was no significant

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* Prepared by F.J.Gay.

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* Prepared by F.J.Gay.

difference in the natural durability of the hardwood from both sources and that it was consistently high.

In co-operation with the Preservation Section of D.F.P. we have been looking at the pattern of termite durability within and between trees of jarrah and New Guinea teak. The latter tests are not yet complete, but in the jarrah tests involving some 30 trees the most obvious feature which has emerged is the consistent increase in termite resistance of heartwood as one proceeds outwards from the pith towards the sapwood.

A small scale test which may be of some interest relates to scaly ash (Ganophyllum falcatum). The attention of one of our entomologists was drawn to this timber whilst on a recent visit to Queensland. A small sample of the timber was obtained, and in two tests so far it has proved to be extremely resistant to termite attack.

Turning now to building boards, we have recently completed the evaluation of experimental Burnieboard containing nominal additions of heptachlor - a chemical closely allied to chlordane. Three species of termites were used as test insects and the results showed that additions of heptachlor as low as 0.025% (nominal) produce a highly resistant hardboard, which is also markedly toxic to the termites.

We have also tested "Wunderflex" and "Durabestos", two products which are basically of asbestos cement composition, although the former also contains about 5% unbleached kraft. Neither board suffered any detectable damage in our laboratory tests.

There appears to have been some interest recently in the use of compressed cork for use in expansion joints between concrete flooring slabs. This compressed cork, which is resin-bonded, is termite susceptible, and attempts have been made to overcome this by incorporating dieldrin in the bonding resin. Compressed cork treated in this way, and showing, by analysis, a dieldrin concentration of approximately 0.03% W., was highly resistant to termite attack, and completely resistant to penetration.

The third group of laboratory tests is concerned with chemical treatments of timber, and in this field one of the most interesting studies has been concerned with the addition of toxicants to the glue line of klinki pine plywood. Sample panels were supplied by Commonwealth - New Guinea Timbers Ltd., and by D.F.P, and the additives included "Kaurit T" emulsion (composition unknown to us), arsenic trioxide, chlordane, pentachlorphenol, dieldrin, and rotenone. Treated panels were tested in the freshly-prepared condition, and also after two different weathering processes - one involving volatilization effects only, and the other including leaching as well. The outstanding additive was arsenic trioxide, which even at the rate of 1% addition to the glueline, and after the dual weathering processes, still produced a highly resistant plywood, with a high toxicity to termites.

In co-operation with the Preservation Section of D.F.P. a comparative evaluation of four different creosote formulations is being made. The first test, using P.radiata blocks which were weathered after treatment, showed that against C.lacteus a nominal retention of 1.7 lb/cu.ft. of K.55 creosote was needed to reduce weight loss due to termite attack to less than 5%. Comparable figures for the other creosotes were : 1.9 lb/cu.ft. from brown coal creosote, 2.9 lb/cu.ft. for Union Carbide creosote 2435/F; and 2.5 lb/cu.ft. for Union Carbide creosote plus 3% pentachlorphenol. Similar tests are practically complete with C.acinaciformis and a repeat test with double-weathered samples against C.lacteus.

In field studies, the results of immediate interest to this Conference are, firstly, our small specimen test of Western Australian timbers, which is being conducted in the Riverina, where there is a termite complex present, dominated by C. acinaciformis. After 7 years exposure two of the original twenty specimens of jam (A. acuminata) are still sound, and this is the most resistant timber, followed by wandoo (E. redunca), jarrah (E. marginata), W.A. blackbutt (E. patens), red tingle (E. jacksoni), marri (E. calophylla), brown mallet (E. astringens), yellow tingle (E. guilfoylei), tuart (E. gomphocephala), karri (E. diversicolor) in that order.

Secondly, our soil treatment evaluations at three different sites in N.S.W. and the A.C.T., which have been in progress for more than 15 years are yielding results of considerable value. Without going into much detail, the following results are of interest: against N. exitiosus both 1 and 2 per cent. chlordane are still completely effective after 10 years, and 0.5 per cent. aldrin and dieldrin after 8 years; against C. lacteus, 2 per cent. chlordane is still completely effective after 11 years, and 0.5 per cent. aldrin after 8 years; against the complex of termites present in the Riverina, 2 per cent. chlordane is still effective after 12 years, while 1 per cent. chlordane, 0.5 per cent. aldrin, dieldrin, and lindane have so far given complete protection for 9 years.

One feature which has shown up in the field evaluation of soil treatments is the high rate of decay in wood samples installed in some of the chemically-treated soil blocks. This is particularly apparent, from the accompanying Table, for lindane, aldrin, dieldrin and chlordane treatments, in comparison with tetrachlorbenzene treatments (and the carriers for TCB). It is believed that the broad spectrum insecticidal (or arthropod) activity of these hydrocarbons results in the destruction of most of the saprophytic animals from the soil - animals which in the normal course of events act as a controlling influence on wood-destroying fungi present in the soil. If this is so, then it may be necessary to add a small amount of a fungicide (e.g. pentachlorphenol) to soil treating solutions or emulsions which are used to protect timber in direct contact with the soil.

Summary of instances of decay on billets of untreated wood used in evaluation of soil treatments against termites.

TERMITE	Treatment of soil	Test duration years	No. of samples expressed as factor (No. per test x time in years)	Samples affected by decay No.	Samples affected by decay %(approx.)
Nasutitermes exitiosus	tetrachlorbenzene-creosote	10	160	0	0
	tetrachlorbenzene-distillate	10	160	5	3
	creosote	10	160	5	3
	diesel distillate	10	160	25	15
	lindane 0.1%	10	160	83	52
	lindane 0.2%	10	160	59	37
	aldrin 0.1%	10	160	44	27
	aldrin 0.2%	10	160	59	37
	dieldrin 0.1%	10	160	46	29
	dieldrin 0.2%	10	160	45	28
	chlordane 1.0%	10	160	40	25
	chlordane 2.0%	10	160	35	22
	aldrin 0.5%	8	144	66	39
	dieldrin 0.5%	8	144	89	62
Coptotermes lacteus	tetrachlorbenzene-creosote	10	160	4	2.5
	tetrachlorbenzene-distillate	10	160	0	0
	creosote	10	160	4	2.5
	diesel distillate	10	160	12	7.5
	lindane 0.1%	10	160	61	38
	lindane 0.2%	10	160	64	40
	aldrin 0.1%	10	160	49	30
	aldrin 0.2%	10	160	69	43
	aldrin 0.5%	8	144	66	39
	dieldrin 0.5%	8	144	48	33

Discussion

Howick: In April 1964, we commenced a survey to determine the incidence of termite attack in Melbourne and environs, by plotting known termite infestations on a map, so that areas of high hazard could be recognised and the comparative density of certain species observed.

Co-operation was sought from the larger pest control companies engaged in termite eradication, and the three main companies operating in the Melbourne area agreed to furnish quarterly reports. These companies initially supplied details of eradications carried out since January 1962, and the addresses, together with those of infestations for which advice was sought directly from the Division in that period, have been plotted.

For the 3-year period to December 31st, 1964 covered by the survey, 600 separate cases of termite attack have been reported, of which the majority have been in domestic dwellings. Of the 600, some 400 have been identified as being caused by Coptotermes species, whereas in 160 cases the termite species was not identified, and a further 40 were reported variously and probably erroneously as other species.

Some conclusions may be drawn at this stage regarding those areas where the hazard cannot be ignored and where termite-proofing is to be recommended for new buildings. This survey has proved to be of great assistance in advising architects, builders etc. regarding the comparative hazards in various areas. We expect to publish the results of the survey in a suitable form to be accessible to architects and city and shire engineers. We suggest that similar surveys in other capital cities and country areas would supply useful knowledge, which may eventually be combined into an Australia-wide infestation summary. Comments from other States will be welcomed.

Bryant: In the soil tests what amount of creosote or tetrachlorbenzene was used?

Gay: All these treatments are ½ gal. to a cubic foot of soil.

Hanson: There has been a move against chlorinated hydrocarbons in the agricultural field, and yet Mr. Gay is recommending them as a soil poison for termites. Do you think that the move against chlorinated hydrocarbons is likely to negate all this work?

Beesley: That can be answered fairly well by saying that a Committee of the Standards Association is at present engaged in preparing a standard code of practice for the prevention of termite attack by the use of treated soil barriers. All the poisons recommended in this code are the chlorinated hydrocarbons. The code has been examined and commented on by an officer of the New South Wales Department of Health. I think that the difference between the use of chlorinated hydrocarbons for termite control and their use in normal agricultural practice is one of the duration of the protection. In termite control we seek long-term protection, preferably without maintenance. In most agricultural uses the protection required is only seasonal. I think this accounts for the difference. Secondly, the difference is in the method of application. With soil barriers for protection against termites, the chemical is actually worked into the soil and becomes fairly well locked into the soil, it is not broadcast.

Harding: In relation to dieldrin, Mr. Beesley's remarks are substantially correct, but there is an agricultural veto on dieldrin for a period of some 7 or 8 weeks. If this sort of preventive were used in the vicinity of farms, particularly adjacent to pastures, there would be considerable objection to it which might necessitate stock being kept away from the vicinity for 6 or 7 weeks.

Beesley: Where these chemicals are used as a soil poison for termite control there is considerable disturbance of the soil. It would probably be 7 weeks before anything would grow there in any case.

Cokley: In determining the effectiveness of various chemicals against termites, it would be more suitable if the species of termite against which they are effective were mentioned rather than a general statement that they may be used as a termite barrier.

Boyd: I would like to record the thanks of this Conference for Mr. Gay's report and for his co-operation with the research groups represented here.

Item 4(z). Report on Hylotrupes bajulus. (N.S.W.) *

Since the 1963 Conference, the following additional occurrences of suspected Hylotrupes attack have been recorded by this Division.

Date	Location	Remarks
Jan-March 1964	Snowy Mountains Authority Cooma, N.S.W.	305 Houses were inspected by S.M.A. inspectors. Fumigation with methyl bromide followed detection of live infestations.
Sept. 1964	Mosman, Sydney, N.S.W.	Private Home. Fittings attacked. No live infestation found.
Jan - 1965	Beauty Point, Mosman, Sydney, N.S.W.	2 House inspections carried out. Italian ornamental table, showed attack. No live infestation found. Table fumigated with methyl bromide.

* Prepared by D. E. Edwards and J. French.

As reported at the last meeting a third inspection of the N.S.W. imported prefabricated houses was continued and completed. The position in N.S.W. regarding these and other inspections is as follows:-

Type of Building		Inspection	1956	1959 New	1959 ** Reinspection	1963 New	1963 Reinspection
Imported Prefabricated Houses		1st	151	-	-	258	-
Housing Commission -	835	2nd	-	127	23	-	30
Central West County Council -	5	3rd	-	5	-	-	5
	840	Totals	151	155		293	
Private Houses + and		1st	58	2	-	-	
Miscellaneous items		2nd	-	-	-	-	
		3rd	-	-	50	5	52
			58	52		57	
Box factories resawing imported softwoods.			33	34	33	-	-

** These figures amended slightly from 1963 Conference report.

\+ These houses contained timber from a shipment of Rumanian whitewood in which Hylotrupes infestation was suspected.

GENERAL COMMENTS ON INSPECTIONS.

1. HOUSING COMMISSION - The 1959 and 1963 inspections are on a statistically randomised basis. 60 of these homes have been inspected twice, and 6, three times.

2. PRIVATE HOUSES - These include a few items of imported furniture, musical instruments and packing cases.

3. FACTORY VISITS - These visits were made to acquaint case resawing firms and importers with the potential threat of *Hylotrupes*. Present quarantine requirements for the pretreatment of imported softwood cases have reduced the danger from this source.

Although no evidence of *Hylotrupes* infestation has been detected during the Housing Commission and Central West Council inspections, active attack was detected by Commonwealth Authorities in a number of Snowy Mountains prefabricated buildings (305 inspected). These buildings have subsequently been fumigated with methyl bromide.

The Commonwealth Works Dept. and the N.S.W. Water Conservation and Irrigation Commission also own large numbers of imported prefabs in which *Hylotrupes* attack is likely. Regular inspections have been promised by these Departments and we have offered to make urgent confirmatory tests wherever doubt exists.

This Conference will realise the tremendous threat posed by *Hylotrupes* and of course, *Anobium* and other insects, to radiata pine building timbers. We feel it is quite unrealistic to continue to use this and other softwoods without some form of treatment, for nothing is more certain than the eventual establishment of *Hylotrupes* in Australia.

Discussion

Ryley: Some 2,600 houses fumigated in 1959, together with another 1,500 surrounding the Housing Commission estates were inspected between 1960 and 1963. No evidence of live larvae was found. We have just completed another inspection in which we inspected every home, about 750, which previously had live larvae reported in it. To date we have not found any further live larvae.

Bryant: Although the Snowy Mountains Authority have, in fact, fumigated almost all the buildings which were attacked, they have not fumigated the administrative building, presumably because it is a large building.

Tamblyn: I agree that the time is coming when we will have to look more seriously at the question of treating all pine building timber. Since I first raised this question some years ago, the inevitability of Hylotrupes introduction into this country has become apparent to most of us. Unfortunately, regarding treatment, we are still in the same dilemma that we were in several years ago. I think it would be interesting at this stage to test the opinions of the Conference on the desirability of treatment of pine building timber.

Ryley: We sent samples of hoop and kauri pines to South Africa and managed to get Hylotrupes established in hoop pine and after some difficulty, in kauri pine after 2 or 3 yr. At present, the indications are that hoop pine is far less susceptible than radiata pine.

Irvine: I regretfully agree that Hylotrupes will eventually become established. I have reached that opinion because of the known incidence of Hylotrupes here and also because of the virtual impossibility for the plant quarantine inspectors to look at every piece of timber. At the recent Forest Products session of the Commonwealth Plant Quarantine Conference not one of the Chief Quarantine Officers (Plants) in the various States was able to say that he was happy with the timber inspection service. They have reached the absurd situation where a quarantine inspector passes as clean anything up to a million super ft of sawn timber per day.

Howick: The situation regarding Hylotrupes in Victoria may be summarized by saying that the great majority of our 6,200 imported pre-fabricated softwood houses have now been inspected at least once expressly for Hylotrupes infestation. Since the last Conference, a further 20 infestations have been discovered making a total of 45 infested houses in Victoria. All infestations discovered have been on the larger Victorian Housing Commission estates. Comparative figures being: for the Norlane Estate near Geelong which has 1,250 houses, there were 11 infestations in which were found 32 flight-holes. At Reservoir, of 350 houses, 13 were found to be infested, 49 flight-holes. On the Maidstone Estate, 553 houses, 21 infestations and 64 flight-holes.

Leaving this for a moment, we were faced with the situation in January of this year when an infested cupboard was inspected in a house at Warragul, Victoria, and damage was identified as being caused by Hylotrupes. The cupboard contained timber with 18 emergence holes and subsequent dissection revealed 7 live Hylotrupes adults ready to emerge and 19 larvae. Investigations made by the Victorian Department of Agriculture for Plant Quarantine, revealed that the cupboard was constructed in 1952 as a school project with timber supplied by the local high school. The timber was identified as European fir (Abies sp.) and had probably arrived at the school as packing cases. It was considered that the infestation was not of Australian origin. The house was fumigated and subsequently, the majority of the members of the school wood-work class of 1952 were located, and articles made by them were inspected, or in some cases traced to new owners and then inspected. A further two infested items were found and all items including those showing no attack have now been fumigated. In addition an experienced team of inspectors was seconded from the Victorian Housing Commission to the Department of Agriculture. This team inspected several houses including those adjacent to the Warragul address and also other houses in various parts of Victoria, where owners of the other two infested items had lived since 1952. This highlights the inevitability of this insect becoming established in Australia. This packing case should not have got in, or should have been destroyed and not used. It was purely chance that we found out about this particular one at all. This kind of thing is probably going on far more often than we would care to think.

In view of the very high cost of overall fumigation of fumigation of entire estates, we are forced to accept the current practice of fumigating individual houses where infestation is discovered, provided this is supplemented by regular inspections. The fact that 145 emergence holes were present in the infested timber in these imported houses in Victoria at the time of discovery, means that the possibility of subsequent infestation is too strong to be ignored and this will be picked up only by regular re-inspection of the houses on the estates concerned. This Conference may consider recommending regular re-inspection of the houses that have been fumigated and the perimeter houses. There is at present no indication that the Housing Commission or any other authority intends to re-inspect any of those infested houses or the houses close to them.

Beesley: The life cycle of this insect in South-East Australia appears to be of the order of 13-16 yr in European timber, it might have a much shorter life cycle in timbers like radiata pine.

Bryant: Have we any positive information of re-infestation within this country?

Howick: There are a couple of cases in Victoria in pre-fabricated houses where we suspect that re-infestation might have occurred, but as yet we have no definite proof.

Boyd: We would be rash to say that re-infestation is certain when we have no evidence. If this were done, the consequent handicap would impose a heavy burden of cost on a developing pine industry. This may not be justified at all and the incurring of such cost at this stage would appear at best to be premature. On the other hand, it is quite clear that there is a very substantial risk that re-infestation may be occurring. It would seem necessary, therefore, to keep a very careful watch and I feel the subject should be in the hands of the

Preservation Committee to co-ordinate enquiries.

Bryant: New South Wales raised the question of Hylotrupes at the Executive Committee Meeting of AUS.T.I.S. recently. We think it is a matter which the timber industry in Australia should discuss not with the idea of immediately introducing treatment to these species, but with the idea of looking into the problem, not only to treat material that is being sawn, but also to try to devise a method of coping with the millions of feet that are already in use throughout Australia.

Harding: How much radiata scantling material is actually in use? I am of the opinion that there is not very much.

Bryant: There is a lot of radiata being used for truss construction now in New South Wales. In Canberra almost all houses use radiata pine trusses at the moment. Douglas fir, of course, is readily attacked by Hylotrupes.

Upricharda: In New Zealand the preservation industry with dip diffusion treatment helped to sell pine for house framing and many other uses. Now people will buy pine in preference to a lot of our very good quality indigenous timbers, because they are buying treated timber and are willing to pay for it.

Bryant: I feel that we should make some official attempt to bring this matter to the attention of the industry. The AUS.T.I.S. Conference next year would be a very appropriate place to submit a paper.

After considerable further discussion on this topic, it was finally left to the Preservation Committee to give the matter detailed consideration and to prepare material for presentation. This then to be circulated to all States for a decision as to the avenue of presentation i.e. AUS.T.I.S.

On the matter of a recommendation from the Conference to the Victorian Housing Commission, as suggested by Mr. Howick, there was unanimous agreement that the Conference Secretary convey to the Commission the recommendation that the action be taken to re-inspect the fumigated houses and those surrounding them.

Item 4(aa). New South Wales developments in relation to the pest control industry. *

Since the last Conference, far reaching changes have occurred in the N.S.W. Pest Control industry. Following severe public criticism of the activities of certain firms a major section of the trade formed the United Pest Control Association.

One of the aims of this association is the establishment of a Code of Practice for pest control operators. Subsequently a joint committee of Forestry Commission and U.P.C.A. representatives met to discuss in situ Lyctus treatments and agreed on the following procedures, subject to review after twelve months.

LYCTIDS.

Lyctid(s) - Insect(s) belonging to the family Lyctidae.

1. Lyctid shall only be designated or described as "active in the sapwood of susceptible pored timbers (hardwood)" if:-

Live insects are seen in either larval or adult form on exterior surfaces or within susceptible timbers if opened.

2. Lyctid shall be presumed to be causing damage or be present to or in the sapwood of susceptible pored timbers (hardwood) if:-

(a) timbers show characteristic flight holes in surface :

(b) there is evidence of frass which has been ejected from flight holes, and if in either of these instances no history of a recent previous chemical treatment by a Qualified Pest Control Operator can be substantiated.

(For the purpose of this reference, "recent" shall mean not more than three months prior to the date of inspection).

NOTE: In normal circumstances lyctid damage in the susceptible member can be presumed to have reached the fullest extent within the first 10 years of service.

3. If any or all of these conditions pertain to sapwood of susceptible pored timbers (hardwood), treatment shall not be advised for control of lyctid incidence and protection against future attack except as follows:-

* Prepared by D.W.Edwards.

(a) Where treatment is required as an essential condition by a lending body.

(b) Where active lyctus attack in any load bearing member, which cannot be supported or replaced, is considered to be of such extent that, if untreated, it would cause loss of strength in the member in excess of that permitted by the appropriate Grading Rule of the Standards Association of Australia.

NOTE: The extent of susceptible sapwood shall be determined by the Iodine Test.

(c) Where treatment would minimise disfigurement or nuisance due to flight holes and/or frass.

(d) In any case of lyctid attack where the property owner or his representative shall require treatment to be carried out after having been given full information pertaining to lyctid attack.

Treatment:

Treatment shall consist of either a "recommended" chemical application in situ, or removal of susceptible sapwood.

"Recommended" chemical treatment shall involve the use only of such chemicals or combination of chemicals as shall be recommended from time to time by recognised authorities.

Where failure of a timber member has taken place due to lyctid attack replacement or re-inforcement using immune, immunised, resistant or treated timber shall be recommended.

(A timber member shall be deemed to have failed if it ceases to perform its intended original function.)

The Joint Committee also agreed to the establishment of a refresher course in pest control to supplement the present trade course. The U.P.C.A. of its own volition has organised also a series of six lectures for branch managers, at which the lecturers will be Commission officers.

Relations with the trade are now much improved, there being a very marked reduction in unnecessary treatments and a willingness on the part of the U.P.C.A. to investigate complaints against its members. Trade representatives have been active also in the production of the new standard for chemical soil poisoning and are being quite co-operative in helping the Division in a current Anobium survey.

Discussion

Bryant: This is a compromise, of course, we do not necessarily agree with everything stated in the code of practice.

Threader: How many members of the larger pest control firms are members of the UPCA?

Edwards: The majority of the major pest control firms in New South Wales are active members. When we receive a complaint about the activity of a pest control firm which is a member of the Association, we refer this complaint to the UPCA and follow it up to make sure that action has been taken. The response so far has been quite satisfactory.

The treatments recommended are either an application of dichloroethyl ether with a contact insecticide; or a contact insecticide in diesel distillate. We were anxious to discourage the campaign which many pest control firms were conducting of house to house inspection followed up by a team of pest control operators which sprayed everything in sight. This practice was giving building timber a bad reputation and there has been a satisfactory reduction in these activities.

Howick: I understand that UPCA is considering forming a branch in Victoria. At the moment we are still faced with these spraying campaigns and we hope to see as much success as has been evident in New South Wales in reducing this problem.

Item 4(ab). Lyctus Toxicity Tests *

The threshold toxicities of the two chemicals under consideration, namely fluorine and arsenic, are being re-investigated, in the first case because the previous work on fluorine was done so long ago and in the case of arsenic because the present controversy regarding the loading of this chemical in association with copper-chrome-arsenic preservative formulations.

In these threshold tests it is proposed to use three timbers over the density range 25 to 50 lb/cu.ft. The timbers chosen, in order of density are:-

1. Flame kurrajong — Brachychiton acerfolium
2. White birch — Schizomeria ovata

and 3. Spotted gum — Eucalyptus maculata

Three copper-chrome-arsenic preservatives containing (relatively) low, medium and high percentages of arsenic in their respective formulations will be tested.

Six concentrations will be tested, these concentrations being arranged about the expected threshold for each preservative under test.

Finally, the test will be carried out against two or possibly three test insects, viz, Lyctus brunneus, Lyctus discedens and Minthea rugicollis. We are, at present negotiating for importation of cultures of Lyctus planicollis from the United States.

As most delegates are aware, this species is probably not established here and it is thought that in view of the plywood export market, information on the toxicity threshold for one Lyctid other than those at present active in Australia would be desirable, and should, with the other species mentioned, provide information which at present is lacking on this subject.

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* Prepared by A. Rosel.

Discussion

Cokley: We requested Mr. Tamblyn to conduct these tests on fluoride due to damage by Lyctus brunneus and Lyctus discedens in several thousand square feet of veneer dipped in sodium fluoride and containing concentrations equal to and above the 0.05 toxicity level. We have two other unconfirmed reports of Lyctus attacking fluoride treated veneers. The veneer in question was treated in December, 1961, and involved a number of species including silky oak, candlenut, tulip oak and white cheesewood, and there are some 6 - 8 crates severely attacked. They were sent to us through our local forest officers in October, 1963. We subsequently surveyed treating practice in North Queensland veneer mills and found that approximately 40 per cent. of the veneers treated did not pass the 0.1 specification. We find that the diffusion of sodium fluoride through the veneers is much lower than the boron compounds. We are anxious that this question of the fluoride toxicity to Lyctus and the relationship of species be investigated.

Rosel: We will treat this as an urgent project to re-assess and re-investigate the toxicity of sodium fluoride.

Booth: We have had no trouble with many thousands of square feet of treated veneer supplied to New South Wales from the same source, neither have we had any trouble in our own State. Trouble could be due to low purity fluoride having been used or to poor control in the dipping operation. In view of the undoubted benefits which sodium fluoride has conferred on the plywood industry, I would strongly suggest that Queensland re-double their efforts to make the fluoride treatment work.

Item 4. - General comment on the Preservation Committee

Boyd: It has been suggested that it might be of value for this Conference to consider endorsing a statement setting out the aims of the Preservation Committee as a Standing Committee, so that its existence and significance will be known and understood by such bodies as the Timber Preservers Association, T.D.C.A. and S.A.A. This also will facilitate communications from these bodies on relevant matters knowing that the Committee is substantially representative of the technical opinion of this Conference. A statement of this might be given publicity, perhaps in the Timber Journal, the Newsletter and similar avenues. A draft statement should be prepared by the Committee, on the basis of instructions given to it by this Conference, and this will have to be approved by the various delegations before it is published.

ITEM 5. - TIMBER MECHANICS

Item 5(a). Review of research activities

I. DIVISION OF FOREST PRODUCTS *

Standard tests

The standard testing of 80 New Guinea species in both the dry and green condition has been completed, the results analysed and tabulated for forwarding to the New Guinea Forests Department. It is proposed preparing the data for publication in the Technological Paper series. Testing of material supplied by the Fiji Department of Forestry is proceeding; the tabulated results for 26 species in the green condition have been sent to that Department. At present, the results of a further 10 species are being processed and the dry material from all 36 species is in the process of being tested.

Eight North Queensland species are also currently being tested. The timbers involved are those in fairly common use for plywood production but for which little or no reliable information on strength properties is available.

At the request of the Forestry and Timber Bureau, the properties of Callitris intratropica are being determined on a sample of 21 logs supplied by the Bureau from three localities in the Northern Territory.

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* Prepared by H. Kloot.

<u>Joints</u>. - A considerable amount of testing has been done on joints of various types under both short- and long-duration loading. Two significant features of the work are firstly the progress being made on the analytical side with nailed joints, progress which is expected to lead to a more rational approach in the design of these joints and, secondly, the commencement of an intensive series of tests to study the characteristics of joints made with toothed plate connectors.

<u>Scantlings</u>. - The results of an extensive review of scantling tests made both here and overseas have been published in Technological Paper No. 35, together with a proposed revision of the strength grouping system. The present system devised some 30 years ago was based on the limited species data available at that time. Making use of the vast amount of information now available on Australian timbers, the proposed new schedule of strength grouping is intended to eliminate faults in the older system and rationalize the relationship between strength groups and timber grades. No firm decision has yet been made as to when the new system will be introduced but it is already being used in the preparation of tables of member sizes for the code of practice for light timber framing.

<u>Poles</u>. - Tests on radiata pine in pole form have been reported in the fourth of a series of publications arising from the pole research programme.

<u>Timber engineering developmental studies</u>. - For some time past, the main attention in this field has been directed towards the development of a direct method of design for roof trusses using specified deflections under permanent loading as the criterion of design.

<u>Long-duration tests on members and structures</u>. - Long-duration testing of model columns has continued and some analysis of the information obtained has been attempted. Similar testing of trusses has been temporarily discontinued, the 38 trusses originally erected under long-duration loading having been unloaded and retested under short-

duration loading. Analysis of the results obtained is proceeding.

A number of glued-laminated radiata pine specimens were installed 3 years ago under long-duration loading in six cooling towers located in various parts of Australia. Regular inspections of these have been made and an analysis of the information on the performance of these experimental members over a period of 2 years has been given in an interim report.

Proof tests for planks and ladders. - To assist the Scaffolding Regulations Committee of the Local Government Department, a scheme for proof-testing scaffold planks was recently devised. Advice from the Committee as to the practicability of the scheme has not yet been received but no doubt some modifications will require to be made in the light of practical experience. Assistance has also been given to the State Electricity Commission in regard to the proof-testing of ladders both at the initial stage of purchase and as a means of regularly checking to ensure an adequate margin of safety. Here again the matter is in the early investigation stage and it could well be some time before final acceptable recommendations are made.

Other activities. - Assistance in the preparation of standards, particularly those concerning design loads in buildings and the code of practice for light timber framing, continues to be given to the Standards Association.

Lectures in timber engineering at both undergraduate and postgraduate level are being given at the Melbourne University.

The new timber-framed laboratory is now virtually complete and assistance to the C.S.I.R.O. Film Unit was provided to prepare a short film for the use of the Timber Development Associations outlining the construction of the building.

II. NEW ZEALAND. *

Douglas fir beams. - Tests of 6 x 2, 8 x 2 and 10 x 2 in. beams of N.Z. material at about 15% M.C. yielded quite satisfactory correlations between M. of E. both as a plank and as a beam, and M. of R. as a beam. In an Appendix to the report (F.P. Branch No. 150) factors to be considered in establishing an experimental basis for a system of stress grading by machine are discussed with reference to overseas work.

The Local Stresses Associated with Holes in Timber Beams. - A series of small matched laminated beams of radiata pine was prepared. Halfway along each beam one rectangular hole of standard size was introduced and the position of the hole in the cross section varied from near the neutral plane to near the outside edge on the tension side. The strains adjacent to these holes were measured by strain gauges while the beams were loaded in static bending.

Stress concentrations were confined to the laminations adjacent to the holes. In one beam the local stress was 43.6% above the theoretical value and the maximum fibre stress of the mean was substantially reduced.

Recently an opportunity arose to measure the local stresses in large commercial beams, adjacent to 1 in. diam. holes drilled through the beams near to the tension face. Local stresses exceeded the predicted values by about 20%, and gluing plugs in the holes did not ameliorate this. These results cast a serious doubt on the adequacy of the current design procedure whereby the moment of inertia is reduced to take account of holes.

The Strength of Radiata Pine Columns. - The study of the properties of long columns showing buckling under axial loading is in progress; the programme for short columns has been completed. In both sections columns of the largest feasible cross-sectional area are used, and the material contains defects permitted by the grading rules for structural columns. Matched small clear specimens, free of defects,

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* Prepared by C.R.Hellawell and A.G.Stanger.

were tested according to the standard procedure.

For the short columns:-

(a) The failure was almost invariably associated with a defect, usually the largest defect.

(b) The max. crushing stress decreases as the size of the defects increases; modulus of elasticity is not affected.

(c) The strength of the columns containing defects allowed by the grading rules exceeded 60% of that of clear material; this was the design assumption of the grading rules.

Poles. - Forest Service Tech. Paper No. 26 on tests of radiata pine poles was published this year, and a report (F.P. Branch No. 145) on practical applications of the results of pole studies is also available (for restricted circulation).

The N.Z. Post Office is being pressed by producers to accept machine-shaved pine poles. As we are not able to undertake tests for them, we are assisting their engineers to determine whether an acceptance test can be included in their specification - they already have one for concrete poles. This has provided an excellent opportunity to promote cognisance of recent developments in design methods and stresses, thanks largely to the D.F.P. Further, the Electrical Supply Regulations are being revised, so with the collaboration of Forest Service Utilisation Development Division, some improvement in pole usage and design should be effected in this field.

Mechanical Fasteners. - Recent standardised tests of the withdrawal resistance of plain nails in N.Z. Douglas fir, and comparative tests of plain and modified roofing nails and other nails and screws in this timber have been briefly reported in a paper to the TRADA Symposium on Joints in Timber Structures. This paper also presents unpublished test results for joints in seasoned radiata pine with plain and threaded nails, split rings, and toothed plates. Some tables did not appear in the preprints, but publication in N.Z. is expected.

Panel Products. - Equipment for almost the full range of methods for testing plywood etc., in large and small sizes, has been acquired and will be put to use initially on investigations of radiata pine plywood. In this work, provision for two-rail shear tests has not yet been made, and the requirements for bending tests of large panels are still under study. The A.P.A. Flexure Machine (Materials Research and Standards 5(2), 1965: 64-70) is impressive, but it is thought that a relatively crude method may suffice for structural plywood, at least for comparative tests to study the effect of veneer grade. Further, the minimum size of panel suitable for such tests is of interest - considering that intermediate supports are generally used in practice, panel $\frac{1}{4}$ full size may be adequate if cut with regard to the position of defects. Comments from the Conference would be welcome.

In collaboration with F.R.I. one Company has made a series of modulus of elasticity tests on specimens of three sizes from the same sheets of $\frac{5}{8}$ in. radiata plywood. This is to be analysed for differences within and between sheets and mill runs.

Species Testing. - The major project has been a survey of Pondorosa pine covering 10 forests in the South Island. The results have been calculated by conventional means, but an electronic computer will be used for the statistical analyses.

Miscellaneous. - Scaffold planks. Following on the studies mentioned at the last conference, an effort is being made to overcome problems in the supply of very high grade local or imported material for single planks over long spans by laminating. Several designs of laminated plank utilising ungraded Douglas fir and European larch are to be tested shortly, and there may be an opportunity to put them through our "Microstress" grader.

Discussion

Threader: Is the programme of pole testing still in progress?

Kloot: I believe there are two more reports to be written, and some work to be done on the effect of various treatments on pole strength.

McConochie: Pole plants in Brisbane are finding that while treated poles leave the yard at the size specified, subsequent shrinkage below the specified girth, particularly in the western areas of the State is causing poles to be rejected on the job. Does this mean that they would be below the strength required?

Boyd: The reports to date clearly indicate that they would not be under strength.

Wickett: With respect to strength groups, has anything new been proposed?

Kloot: Technological Paper No. 35 sets out, in a theoretical manner, the stress classes we are thinking of, although no final decision has been made. Use is being made of these new strength classes in the preparation of tables for the code of practice, but finalization of plans for introducing these as a substitute for the old strength groups has not been reached.

Uprichard: Mr. Hamilton of our Institute made the comment that he is interested in the work on nailed joints, and he thinks that figures for optimum and minimum levels for nailed joints would be most useful. He also made the same comment on toothed plate connectors.

Kloot: As far as toothed plate connectors are concerned, we have started with one particular type of plate and as we gain experience with the testing technique and, as we build up information, we will be extending the work to any others that are available.

McConochie: Is any work envisaged on the revision of strength groups of scantling which contain a large volume of sapwood that has been pressure-treated?

Booth: It can be generally regarded that treated sapwood has the same strength as heartwood. We have also done some work on scaffold planks and ladders with our machine-grader and this does seem to be a simple way of sorting this type of material.

Kloot: We are attempting to formulate a means of proof-testing scaffold planks to assist the Scaffolding Regulations Committee.

Booth: We have carried out some work on the use of nail plates to transmit bending moments, i.e. to join short material together to make a beam. We have established that using hardwood shorts it is possible to make satisfactory structural joints using nail plates to transmit full design bending stresses. We have set up long-term loading tests of these, and have confirmed their apparent suitability for this purpose. Such joints in radiata pine have also proved satisfactory. It is possible to build up beams and joists, provided they are not wider than 6 or 7 in., which have the same equivalent properties as the solid continuous member of either standard or select grade.

McConochie: Wilkinson's of Brisbane are investigating the manufacture of studs by this method, but have not progressed very far yet.

Item 5(b). Acceptance tests for flooring and other timber products *

At the last Conference, a review of the C.E.B.S. acceptance test for flooring was foreshadowed. This has now been done together with a fairly exhaustive analysis of data from flooring tests conducted by this Division over many years. The results of this investigation are published in Technological Paper No. 34. It was considered desirable also to lay the foundations for an acceptable method of testing the structural adequacy of flooring - in particular for domestic use - and so an appendix was added to Tech. Paper 34 in the format of a specification. It is anticipated that when sufficient experience has been gained in the use of this floor test specification and any necessary modifications made, the Standards Association will be approached to consider it for promulgation as an Australian standard. It should then be possible for a N.A.T.A. registered laboratory to carry out certain

* Prepared by H. Kloot.

tests on conventional or newly devised flooring materials to a consistent standard to the advantage of all concerned, including this Division.

Subsequent to the publication of Tech. Paper 34, an S.A.A. committee reviewing the standard for jarrah, karri, and wandoo flooring felt the need of a test procedure for determining whether a parcel of flooring, in particular finger-jointed flooring, was up to specification. What was clearly needed was a suitable field test by means of which interested parties such as the purchaser, lending authority and building surveyor could satisfy themselves that a particular batch of material was acceptable without the need for recourse to expensive laboratory testing. Such a test was devised and although for various reasons, it will not appear in the revised standard for jarrah flooring, it has been accepted in principle by the Standards Association and will appear in the Code of Practice for Light Timber Framing. The test is simple to conduct and provides for the loading of individual pieces of flooring with materials readily available on a building site, such as bags of cement and/or bricks.

The point which it is desired to emphasize is that this field test, as with the more elaborate tests specified in Tech. Paper 34, is a performance test and as such is independent of the type of flooring, whether it is normal T & G, end-matched or finger-jointed flooring or, for that matter, any other type of flooring material.

The purpose in bringing this item to attention is two-fold: firstly, to report progress in a field of considerable general interest and, secondly, to clarify the Division's present philosophy regarding the development of certain kinds of standards.

The process of finger-jointing, for example, would appear at first thought to be a suitable matter for specification and such a standard has recently been prepared by the South African Standards Association. The Division, however, does not agree with this and is not likely, except under certain circumstances, to support such an approach. It is considered that when the desired performance of the end-product can be reasonably closely defined, then there is little merit in specifying the particular techniques used to manufacture the end-product. In some cases such as finger-jointing, it could well be bad practice to do so. In recent times, the Division has been called on to counter the reluctance in some quarters to accept finger-jointed and also end-matched flooring. Basically, this reluctance would seem to revolve about the fact that these types of flooring have joints and therefore cannot be as strong and as stiff as normal flooring. The question "Is finger-jointed flooring or end-matched flooring capable of performing satisfactorily in service?" always seems to be overlooked in such cases. The drawing up of a standard specifying precisely how finger-jointing should be done would, in the Division's view, tend to perpetuate the often unwarranted suspicion associated with new developments. Demonstration that finger-jointing or any other method of manufacture is capable of producing an end-product that will meet the required standard of performance is probably the only way of overcoming this sort of reaction.

It should be clearly understood that the Division is not advocating any relaxation in standards. Rather it is maintaining a view consistent with that expressed time and again over a period of many years in regard to demands for the supply of timber for structural purposes "free of all defects". Such demands are neither realistic nor economic.

No Discussion

Item 5(c). Mechanical stress grading of timber (NSW) *

Since the research reported to the last conference on our work on machine grading there have been a number of developments. These are summarised as follows:-

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* Prepared by H. Booth.

(a). Machine Development. - Our grading machine has proved an unqualified success and is now available as a commercial product. About twelve machines have been sold so far including a number exported to New Zealand and South Africa. It will also be made under license overseas.

The machine has proved itself accurate and rugged and the grading system using a colour code is most acceptable throughout the industry. The present machine as available will accept up to 12 in. x 3 in. timber and can be operated with proven accuracy up to 200 feet per min.

A new model with 500 fpm speed is under development. We also have developed an all solid state electronic control system which enables grading to be carried out on a single pass.

(b). Control and Calibration. - The machine accurately sorts material into stiffness grades and can be easily calibrated.

We have carried out a number of test runs using radiata pine and have proved by breaking tests on graded material that the grades are accurate and reproducible.

We have instituted a sampling quality control system for N.S.W. operators and this is operating very well on radiata, oregon (Douglas fir) and hardwood.

(c). Species. - We have established satisfactory regression lines for grading radiata pine, Euc. pilularis and E. saligna. Commercial grading is being carried out using a common regression line for the sake of simplicity although it appears that there are differences between pines and eucalypt timbers.

We are also using with success the same regression for Douglas fir and it has been shown so far to follow closely radiata pine.

(d). Industrial Results. - It is of special interest that we commended machine grading in the toughest situation possible, namely truss making from radiata pine, and in that period.

a) Not one call back has occurred with radiata machine graded trusses.

b) The trusses made of machine graded radiata have become the top truss on the market whereas before radiata was regarded as unsuited for truss making.

Control tests on machine graded radiata and Douglas fir (oregon) and hardwood in 3 in, 4 in. and 5 in. x 2 section have not yielded a single piece having a modulus of rupture below the value given by the regression line for the particular grade.

(e). Standardisation. - Together with DFP we have drafted a joint set of rules for operation of grading machines for submission for endorsement by the SAA.

Mechanical stress grading of timber (N.Z).*- We have acquired a microstress grader from N.S.W. and have some questions on the derivation of working stresses for timber so graded. The basis of such grading lies in the determination of the regression equation giving modulus of rupture as a joist in terms of the modulus of elasticity as a plank. The establishment of a lower exclusion limit depends on the variability and application of suitable factors to this lower exclusion limit to give working stresses.

The British use the 1%, D.W.T. the 2½% and the Americans the 5% lower probability points for the exclusion limits and there is general agreement on the use of 9/16 as the long duration loading factor.

D.W.T. use only this, stating that their regression equation is very conservatively derived from tests placing the worst defects in the most vulnerable position. M. of R. was determined by 4 point loading on edge after determining M. of E. by loading on the flat in 3 point bending (as in the microstress machine).

Sunley & Hudson suggest a dividing factor of 3 which is equivalent to the multiplying factors 9/16 and approx. 3/5.

The Americans (A.S.T.M. Spec. Tech. Pub. 353) use either the dividing factor 2.96 (McKean & Hoyle), i.e. the same as the British, or the dividing factor 2.66 advocated by Senft Suddarth and Angleton of Purdue University. The latter is equivalent to the multiplying factors 9/16 and 2/3.

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* Prepared by M. Wilson.

The "safety factors" suggested are therefore, none, 3/5 or 2/3.

The N.Z. opinion is that the British safety factor is too large in view of the use of the 1% exclusion level, and that the American exclusion level is too generous but probably works out satisfactorily with the use of a large safety factor. We favour the 1% exclusion level and a safety factor of /5.

In this connection we note that Miller of Canada in F.P.J. April 1964 considers the 5% exclusion limit is justified in view of the greater efficiency in use of material and the reduction of risk which follows from the use of a multiplying safety factor of 3/5. His contention is that a realistic compromise must be reached between selection efficiency and tolerance.

Another question concerns the application of regression equations derived from tests at one moisture content to grading carried out at another, for use at possibly yet another moisture content.

Work by McKean & Hoyle shows that regressions established at one m.c. give an additional margin of safety when used for material at lower m.c.'s since the gain in M. of E. and even more, in M. of R., more than offsets the decrease in I = moment of inertia and depends on dimensions due to shrinkage. This implies that it is undesirable to grade and use timber at a higher m.c. than that of the material tested to establish the regression equation.

There is also need for care in applying regression equations established for one size to other sizes.

Such a conference as this seems to offer a suitable opportunity to discuss the basic principles involved in establishing a new and attractive method of providing timber for structural uses.

Discussion

Mr. Booth presented a chart indicating the recovery after machine-grading of material of 1100f grade and better in radiata from a number of localities including New Zealand, and in two markedly different qualities of imported oregon. In answer to questions, he stated that all of the radiata pine had been reasonably graded beforehand to SAA Interim 377 and that the oregon was of a quality that the supplier was happy to sell as select merchantable oregon.

Smith: We feel that machine-grading, while undoubtedly highly desirable and the most accurate method of assessing strength of material, is going to be applied only by larger firms not limited by the cost. Smaller sawmillers will not be influenced to install machines, hence there is definitely a need for visual grades. I feel that the results of this research on machine-grading can be utilized to enable us to prepare visual grades which are capable of being applied with a greater degree of confidence. We sent two small parcels of Araucaria cunninghamii and P. patula to the Division of Wood Technology who ran them through their machine for us. These were pre-graded to a preliminary specification intended to cover, as far as practicable, all eastern Australian softwoods. This material (which we visually pre-graded mostly into a grade which was generally considered to be of a fairly low standard, that is the lowest grade specified for structural material) tended to be slightly upgraded on re-examination after stress-grading. In other words, the visual grade was, in general, a slightly conservative estimate of the actual strength of that material. The difficulty in assessing the effect of various defects is a real one, and that was where the machine showed to advantage. It also showed us that too much emphasis can be placed on certain defects such as pith. On re-examination we found that whereas we had tended to put in the lowest grade any material with pith in it, some of this was, in the odd case, upgraded to A grade on the stress-rating.

Turnbull: Was the radiata pine, in general, close to the

1100f limit or was a significant proportion of it well above that limit?

Booth: The New Zealand export material gave about 10%, 1900f; 20%, 1500f; 40%, 1100f; 8%, 800f; 8%, 500f; 8%, 300f; 5%, structurally rejected.

Whiteside: I think the official attitude of New Zealand would be that while there is no intention of abandoning visual grading, both visual and machine-grading are necessary, probably for all time, for a number of reasons. As far as most of our building timbers are concerned, we use them in the green state. Before the timber is machine-graded it has to be dry so some form of visual grading is necessary before it gets to the machine, otherwise we would be processing obviously unsuitable timber at unnecessary expense. There is a certain percentage of the timber that, by visual grading, would be deemed definitely unsuitable.

McConochie: Can the material be graded successfully in the rough and is it safe to assume that the same setting would be used for all species?

Booth: Provided it is not roughly sawn with bumps in it, it can be graded, but with some loss of precision. In general the same setting can be used, but you tend to waste the higher strength of the stronger timbers.

Smith: Pines in general have a tendency to dry out fairly quickly once they leave the saw and before the load is actually applied to the structural components of the building. You usually find that the pines have an advantage over the hardwoods, in that you can afford to design on part-seasoned pine, whereas in the case of hardwoods you have to design on the basis of green stock.

Boyd: In relation to the standard for radiata, dry material is specified as necessary for certain structural uses. On the other hand, as far as the grading machine is concerned, it does not need to have a prescribed moisture content. It will grade at the moisture content of the material passed through it and indicate a strength at that moisture content. Any subsequent drying out provides an extra margin of safety.

Kloot: The Division of Wood Technology and ourselves are very conscious of the fact that machine stress-grading can have a tremendous impact on the structural use of stress-graded timber in Australia. At the same time, we think it undesirable to allow stress-grading to start in Australia without some sort of control and have decided that there should be rules to guide users of stress-grading machines. These rules recognize the fact that at present we know of only one principle of machine stress-grading - that is by the bending method. In the future, another method may be evolved and so the rules are not intended to preclude any innovation. It is visualized that there will be some sort of controlling authority that will grant approval for the operation of grading machines. Who this body will be is yet to be decided. We expect that it will be an association within the timber trade itself. The rules we have suggested set out preferred stress grades for the operation of any machine. It is envisaged that every piece of timber passed through the machine will be marked in some way with the grade and that the controlling authority will require the operator of the machine to employ a satisfactory system of quality control, quite apart from verifying the machine at regular and frequent intervals.

Booth: The Institute of Timber Engineering is proposing to accept responsibility as the controlling body referred to in the draft rules to arrange for testing to be carried out by N.A.T.A. approved authorities. Grades would be set up after consultation with all States and with the S.A.A.

McConochie: The Machinery and Scaffolding Department in Queensland may want to have some say regarding the checking of grading machines.

Boyd: Various authorities in the States should be canvassed by the Forest Services for their initial comments on the draft.

Item 5(d). Re-appraising the long term research needs of timber as a structural material *

Development of machine grading has brought to the surface a number of problems in the structural use of wood on which we feel more research should be carried out. We offer the following points for discussion at the conference.

Machine grading enables us to adopt a different approach to the appraisal of the structural potential of various timbers. We are now able to sort rapidly enormous quantities of structural timber either at the laboratory or, because our grading machine is quite portable, if necessary within the sawmills. Furthermore we can now determine a satisfactory grading regression for an "unknown" timber in the laboratory within three weeks. This enables us to re-appraise the wisdom of viewing the structural use of timber from the standpoint of the results of so-called clear sample testing.

Grey gum for example is regarded as a group A species on the basis of clear sample tests carried out many years ago. However, the type of grey gum now sawn is in no sense of the same overall quality as that cut years ago. Now we can adopt an alternative approach and machine grade grey gum as it is now being produced.

Likewise we are able to sort radiata from different areas quickly and meaningfully and note subtle differences in the proportions of various strength grades brought about by factors such as average log size, sawing practices and pruning policy.

Therefore we now believe that the most fruitful guide in assessing a 'new' structural timber is not to carry out the normal type of clear tests but to saw structural material, machine grade it, select a sample and determine its strength regression.

Subsequent data from machine grading runs quickly determine any shift in the properties of the population sample.

All this adds up to the need for a fresh look at timber mechanics problems. Points we should consider under this heading

* Prepared by H. Booth.

include the following:-

(a) Determination of the probable pattern of structural timber available in the future in Australian centres of consumption and plan work which is in line with this pattern. This means even more emphasis on radiata and on eucalypts of lower strength.

(b) Careful evaluation under local conditions of the effect of sustained loading on timber strength both practically and particularly theoretically. This is a factor of major importance to the economics of timber and as at present formulated, the concept is contradictory. This must involve careful research into theories of failure in timber, and be related to wood's behaviour as a high polymer.

(c) Machine grading in addition to giving us high strength wood will yield us a lot of low strength and stiffness material. We must carry out tests on full size building components such as stud walls made of this material to prove that by load sharing the structural unit as a whole will perform satisfactorily. Utilisation of this type of timber is essential in the proper development of machine graded structural timber.

There are other factors which could be added but the above points are put forward to stimulate discussion of the topic in order to clarify future policy.

Discussion

Booth: It is possible to use the grading machine as a testing machine of great versatility in a timber mechanics laboratory. The method of grading timber for strength on the basis of so-called clear sample testing has many things against it. By adopting an alternative approach, that is by machine-grading timber, and then breaking it and establishing the M.of E.v M.of R.regression, a much more positive evaluation of the structural properties is obtained. For example, we had a problem with E. obliqua from very stained over-mature logs in New South Wales which normally could not be used as structural timber when graded by visual means. Yet by machine-grading the sawn product of this particular forest, and then breaking the timber and establishing a regression for it, we were able to show in 3 weeks just what its structural potential was and to ascertain very precisely to which strength group it should be assigned. By machine-grading parcels of such timber from time to time it is possible to see whether it is undergoing any long-term shift in its proportions of various strength grades and in that way the position appears to be under more rational control than can necessarily be expected from so-called clear sample tests. Clear sample tests have lost a lot of their meaning in relation to the changing pattern of sawn timber and the lower quality of logs accepted today. We feel that with proper organization the regression line for any unknown species in normal structural sizes can be obtained in 3 weeks. Machine-grading can be used to study factors such as site quality, sawing practice, and position in log. Also it is time we looked very carefully at the 9/16 long-time loading factor, because if it is too low it penalizes wood as a structural material, and if it is not large enough then we are doing something which is essentially dangerous. We have set up long-term loading tests on radiata pine of various strength grades to prove that we are at least on the safe side. This is something which the Division of Forest Products could look at in relation to our own species of structural importance, and I particularly emphasize radiata pine with defects. This is tremendously important to the industry as a whole. Tied in with all this is the question of long-term deflection.

Visual grading has succeeded in the past in structural work because the structural demands put on the timber in a building frame have not been very demanding. If we adopt machine-grading on a large scale, high strength material will be skimmed off and used for other purposes. Quite substantial amounts of low but predictable strength material will be available. Our laboratory should start work on finding the right way to use this low strength material in building frames. I would like to see the Division of Forest Products give consideration to this problem.

Kloot: We are in full agreement with most of the remarks Mr. Booth has made.

Pearson: We have proposed setting up tests on scantling sizes. We have in mind setting up a number of species of different structural grades, and it might be desirable to get species from several States.

Smith: In the past, 45 per cent. grade has been considered the lowest to which you can go but in Queensland we are considering the introduction of a 30 per cent. grade for use in low stressed wall components. We feel that sorting by machine could help us in the utilization of such material.

ITEM 6. TIMBER SEASONING

Item 6(a). Review of Research Activities

I. DIVISION OF FOREST PRODUCTS *

General. - The basic seasoning programme comprises research on (i) air seasoning, (ii) pole drying, (iii) collapse and reconditioning, (iv) the clarification of drying behaviour, (v) the dimensional stabilization of wood, (vi) the control of surface checking, and (vii) the fundamentals of moisture movement in wood; however, work on this latter has only recently been resumed. Investigations on (viii) the influence of climatic conditions on the moisture content of seasoned wood, a major project over the past several years, have been completed.

Some of the above are subjects of separate items for the Conference and so will be mentioned only briefly in the following Review,

* Prepared by G. W. Wright.

mainly to indicate the present broad stage of development.

Air Seasoning Studies. - As indicated in the previous Review, work in this area comprises two inter-dependent investigations, one to examine the effects of stack parameters on drying rate and uniformity under field conditions, and the other to determine basic principles for seasoning yard design.

Particular aspects for examination include the relation between wind direction and stack orientation, the influence of stack design and placement pattern on wind movement within a yard, the effects of site factors e.g. the natural topography, earth works and associated buildings, and the combined effects of these factors on the pressure changes which cause air movement around and within individual drying stacks. The end objective of this research is a major improvement in Australian seasoning practice in terms of dried quality, productivity, and seasoning economics.

For the time being, work on stack variables has been largely suspended; this is partly because some of the more important aspects have been clarified (e.g. the influence of stack covering on drying rate, optimum sticker thickness, and the value of board spacing in the stack), partly because some may be best examined under laboratory conditions (e.g. stack foundation height), and partly to accelerate the work on yard evaluation.

For this latter purpose a large, low-speed wind tunnel has been installed and instrumentation, air flow visualization techniques, and drying rate indicators developed for it; these latter depend on the evaporation characteristics of water-filled porous bulbs, or the sublimation behaviour of paradichlorbenzine. A special value of this chemical is that it can be cast to fit model stacks, and its distribution through a test area gives an integrated measure of within-stack air movement under wind flow conditions.

A major problem has been the establishment of aerodynamic similitude between stack models and those of commercial size, but close correlation in performance has now been obtained - for this purpose, model sticker thickness needs to be proportionally about twice that used for commercial purposes. Two model sizes are proving useful; the smaller - one-sixteenth scale - is used in measuring mass air movement through yard arrangements, and the larger - one-tenth scale - is for measuring within-stack air movement, and for testing the influence of stack spacing. Present conclusions are that an unequal spacing between stacks gives best results, as the venturi effect obtained causes a pressure gradient across the stack width.

Wind tunnel performance and ancillary testing have now been largely completed and, as foreshadowed in the previous Review, the next step is the determination of wind movement and evaluation patterns for a wide range of yard arrangements and conditions, due consideration being given to measures which might re-direct air movement, and to the accessibility and material holding capacity of the drying area.

Collapse and Reconditioning. - Good progress has been made with research on collapse and its recovery. Two studies to confirm the liquid tension theory of collapse formation were completed: (i) by drying sawn specimens of a collapse-susceptible species in a range of lengths - in this case the volumetric collapse in specimens 4 in. long approximated 15 per cent. of the green volume of the wood, but was less than 1 per cent. in specimens of a length(1) statistically less than the mean fibre length(2) of the species; and (ii) by replacing the free water in collapse-prone stock with liquids of low surface tension before drying - with alcohol as the absorbate instead of water, volumetric collapse was reduced by some 11 per cent. This liquid replacement technique clearly offers a means of collapse control; presumably the hydrostatic tension developed in the coarse capillary system remains less than the fibre stress in the cell walls at the limit of proportionality.

Investigations to relate collapse susceptibility - or alternatively, the causes of collapse fixation - with corresponding changes in wood constituents, or functional groups, were carried out, but

(1) Approximately 0.87 m.m.
(2) Fibre length range approximately 0.6 to 1.3 mm.

a full analysis of the data obtained has not been completed. The experimental approach has been to acid hydrolyse collapse-prone and non-susceptible material, measure the corresponding collapse, and examine the wood constituents (i.e. the methoxyl and acetyl groups, uronic acid, the cellulose, the non-cellulosic polysaccharides, the lignin, and the water solubles) before and after treatment.

Work to clarify the influence of temperature and time-of-heating on collapse development, and their effects on recoverability by reconditioning, was also completed. The data confirmed that these have supplemental effects, e.g. the effects of heating at approximately 100°F. for 256 hours, at 200°F. for 8 hours, and 300°F. for 2 hours, were found to be about equal in terms of induced collapse and shrinkage (about 40 per cent. of the green wood volume in the case of alpine ash), and in the amount of recovery obtained by reconditioning (about 20 per cent. of the green volume). With increasing time and temperature an increasing proportion of collapse became 'fixed' i.e. heating at approximately 200°F. for just over 2½ days almost entirely 'fixed' 40 per cent. of collapsed wood volume.

Heating collapse-prone wood specimens at 300°F. for a period of 10 days reduced the wood pH by 0.64, increased the apparent lignin content by 20 per cent. of the total wood weight, and reduced the pentosans by 15 per cent. of total wood weight. These induced changes are consistent with a reduction in the elastic properties of cellulose, and a strong cross-linkage and polymerisation of apparent lignin, both of which reduce the effectiveness of recovery-inducing forces.

A useful mathematical relation between cross shrinkage (collapse and normal shrinkage), temperature, and time of drying was also established for alpine ash of Tasmanian origin.

Further work should include an examination of methods of inducing cavitation in the free water system of collapse-prone species, possibly by gas induction (other than CO_2), by ultra sonic pretreatment, by high-frequency pretreatment, or by gamma-ray pretreatment.

The Drying Behaviour of Australian and Pacific-Area Timbers. - As part of an agreement between Australian and Fijian authorities the drying behaviour of some 30 Fijian species has been examined, and appropriate kiln schedules developed for 1- and 2 in. stock of each.

Studies were also completed on 1 in., $1\frac{1}{2}$ in., 2 in., and 3 in. thicknesses of four Malayan-grown meranti species, and on similar thicknesses of Malayan-, Sarawak-, and Sabah-grown kapur and selangan batu, all species of importance to the Australian wood-using industries. Some proved sufficiently difficult to warrant quarter-sawing and, in some cases, considerable benefit was obtained by presteaming.

Fairly comprehensive seasoning studies were carried out on both brush box and satinay. These showed that presteaming did not assist drying rate but did improve dried quality, and that this was also improved by drying at combinations of low temperature and low humidity.

Pre-surfacing and pre-coating the green material of some species were also found to improve dried quality; the results obtained by pre-surfacing have since been confirmed by overseas work. A more detailed report on pre-coating is the subject of Agenda Item 6(i).

Equilibrium Moisture Content. - All field work and analyses of data concerned with the 3-year, Australia-wide investigation set up to relate wood moisture content and weather conditions have been completed, and a series of regression equations have been developed for the prediction of moisture content from meteorological data.

The tabulation of monthly and seasonal moisture content values for timber exposed at some 110 sites throughout Australia and New Guinea has been largely completed, and should be ready for publication shortly; values for many other sites could be derived from the appropriate equations if required. This subject will be covered more fully under Item 6(b)(i).

Pole Drying. - The main objectives of work in this area are to determine best conditions for air drying pole timbers, to find methods of satisfactorily seasoning pole timbers of species unacceptable to pole-using authorities because of excessive degrade during seasoning, and to determine the suitability of accelerated drying methods.

Research on the first two of these is well advanced - in some areas almost completed - and a start has been made on the third. The present status of all phases will be given under Agenda Item 6(c).

Predrying. - Predrying has become thoroughly established for the sawn hardwoods of south-east Australia. The most recent commercial installation has the extremely large capacity of 700,000 super feet.

Consideration has now been given to the predrying of the slower-drying hardwoods. Laboratory studies have shown that 1 in. thick backsawn brush box may be predried over the moisture content range 62 per cent. to 20 per cent. in some 18 days at a temperature of 120°F. and wet bulb depression of 10°F., and that following preliminary air drying to 30 per cent. it may be predried to 20 per cent. in some 7 days under these conditions.

Consideration has also been given to the predrying of sawn softwoods, and this has lead to the installation of a prototype 4-line unit in New South Wales for the drying of 2 in. thick radiata pine; reports indicate that plant management is fully satisfied with performance.

The predrying of short-length green round softwoods in the 4 in. to 11 in. diameter range to give a 50 per cent. moisture content drop in 24 hours has also been examined. Preliminary estimates indicate that for a drying task of some 100,000 sup. ft. per day, under the conditions applying at the site concerned, predrying costs will be less than current air drying charges.

Dryer Design and Kiln Aerodynamics. - Continuing attention has been given to the development of drying equipment and the suitability of various kiln heating media, particularly oil-derived furnace gases. It is clear that industrial designs so far developed for this method do not have adequate provision for the production of steam for kiln humidification or other steam-requiring purposes e.g. reconditioning or presteaming.

In general, the economic application appears to be limited to the smaller installations drying the less critical products, particularly for drying tasks where the heat demand is low and the drying rate fairly slow, rather than to the bigger installations or where the heat demand is high and drying rates fast e.g. green softwood.

Estimates of the effect of plant size on cost to kiln dry radiata pine poles and posts have been prepared; and the influence of kiln fan size on power demand, and the economics of fan operation within the range normally used in kiln drying have been examined.

The need for research on aspects of kiln aerodynamics has become particularly evident as industrial conditions demand improved dried quality and greater productivity from increasingly costly drying equipment; unfortunately, little basic design criteria are available in this area. A special section of a skeltonized kiln, having provision for a rapid alteration of kiln dimensions, stack dimensions, fan size and spacings, and other auxiliaries has been designed, and most of the materials for its construction obtained. Its installation and the commencement of work on the project awaits only the provision of suitable covered space. It is understood that this will be made available during the 1965-66 period.

Dimensional Stabilisation. - Research to determine the feasibility and economics of dimensionally stabilising Australian wood has been continued. Progress will be reported under Item 6(i) of the Conference Agenda.

Moisture Movement. - Despite the considerable amount of overseas research already done on moisture transport in wood, comparatively little has been reported on its movement in the unsaturated state, particularly for hardwoods. Experimental information in this area on the mechanisms of movement, and on their interaction with the heat conduction and rheological properties of wood is basic to an understanding of drying phenomena, including the development of drying degrade and collapse.

Research in this area is, therefore, being resumed with the return of Dr. W. G. Kauman to the Section. The equipment to be used permits continuous adjustment of the humidity applied on both up-stream and down-stream sides of specimens, and has already been designed and largely built.

This research is complementary to the work on sorption kinetics being carried out by the Section of Timber Physics, and to studies on glue lines and the movement of solutes.

<u>The Control of Blue Stain During Log Storage</u>. - The results of studies carried out on the storage of hardwood and softwood logs to reduce drying degrade and stain during holding were reported at the last Conference. A supplementary analysis of data has shown that the development of blue stain in radiata pine logs is more effectively controlled by first de-barking and dipping in a prophylatic solution (say, 2 per cent. pentachlorphenate plus $2\frac{1}{2}$ per cent. borax), than by holding in the unbarked condition, either treated or untreated.

The results showed that 63 per cent. of the unbarked, undipped logs and 60 per cent. of the de-barked undipped logs were blue stain infected after seven months' storage, compared with 55 per cent. of the unbarked dipped logs but only 16 per cent. of de-barked dipped logs.

<u>Training in Forest Products</u>. - Since the last Review to this Conference the Section has completed comprehensive seasoning programmes, ranging in length from 6 to 16 months, for professional staff from the Forest Services of the Philippines, Burma, Ghana, the United Arab Republic, Sarawak, and Chile under the terms of F.A.O., Colombo Plan, or Australian Fellowships or Awards. In addition, some five nominees from Malayan, Fijian and Australian wood-using

industries were accommodated for training periods ranging from one to several weeks.

Two Seasoning Classes, each of one week's duration, were held in Tasmania and Victoria, and the Correspondence Seasoning Courses were continued for the benefit of industry. Some 55 students were enrolled for the latter, and some 21 completed the Preliminary Part and 9 the advanced Kiln Operator's Course.

Responsibility was accepted for the preparation of 28 lessons on timber seasoning for Stage II of the subject "Wood, The Material", and Stage III of the subject "Timber Production", for the Timber Production Management Course of the Correspondence Tuition Department of the Tasmanian Education Department.

II. NEW SOUTH WALES *

1. High Temperature Drying i.e. below steam temperatures. - Several species of N.S.W. hardwoods can be dried from green at temperatures of 160°F to 180°F e.g. blackbutt and blue gum in 7-8 days, flooded gum in 4½ days.

However, moisture contents of the charge vary by 6-8%, principally due to the different drying rates of back and quarter-sawn timber. It has been found that heavy condensation occurs in commercial kilns when starting from cold due to the low wet bulb depressions used.

Degrade is very small, and reconditioning is necessary, but successful. The process has not been successful with brush box or tallowwood.

2. E.M.C. Investigations. - A direct reading moisture content indicator has been developed. It consists of a wood specimen of known oven dry weight suspended on a fine spring, in the form of a spring balance.

It is sensitive to 0.2% moisture content, and is accurate to within 0.5% moisture content when compared to other sample

* Prepared by P. Marshall.

boards which is sufficiently accurate for practical applications.

The construction and calibration is simple and the springs supplied by a Sydney firm are quite consistent. One has been observed for over 2 years and is still operating satisfactorily.

The instruments are being used in a study of the e.m.c. of various N.S.W. areas.

3. Chemical Seasoning. - A preliminary study has shown that tulip oak can be dried in scantling sizes free of degrade by using saturated urea as a chemical seasoning agent.

Because of the prominent rays in this timber it is difficult to prevent surface checking even in one inch thick stock. Further work is planned for this species.

4. Brush box for Scantling. - Because of the frequent occurrence of cross grain, brush box is not preferred for use as scantling in house construction. This is due to warping resulting from the shrinkage of this cross grain, as the timber dries out.

If the timber were partly seasoned before use, warping should be correspondingly lessened. Also, if severe warp were to occur, such timber could be culled out before being dispatched.

Accordingly, parcels of 4 inch by $1\frac{1}{2}$ inch brush box were dried to 40%, 30% and 20% moisture contents and three room sized frames were constructed of the different parcels.

The frames have dried out to below 15% moisture content, and the movement has been negligible in all cases.

Discussion

Bryant: We are glad to see Dr. Kauman is back again and would like to record our appreciation of the efforts of Mr. Wright and his staff, particularly on the fundamental side. We are very hopeful Dr. Kauman will be able to get back to this work.

McConachie: Some of the mills in Queensland have made extensive improvements in their seasoning yards with appreciable improvement in drying but no figures are yet available. At our experimental sawmill site we have a 3,000 super ft steam heated and automatically controlled kiln in operation. The fan system is coupled to an infinitely variable motor over a speed range of 200 to 800 r.p.m. We have done some work on drying schedules for North Queensland species, where, because of the multiplicity of species, it is not possible to dry one species per charge, so the schedules were developed on the basis of density and colour, and subsequent experiments show the method to be practicable.

We have conducted two seasoning courses in the last 12 months, one in North Queensland and one in South Queensland. Unfortunately, they were not as well patronized as we would have liked, particularly the one in South Queensland, where we are concerned with the very poor state of seasoning. There was good representation from the better mills but not from the poorer mills.

Wickett: Concerning the article in Newsletter No. 319 on laboratory bench tops, there is a most unsatisfactory feature in the list which shows species, air dry density and shrinkage. When dealing with laboratory bench tops we are not concerned with shrinkage at all, we are working with dry timber and are concerned with movement, which is a combination of shrinkage and swelling, and to head that table "shrinkage" is very misleading. For example, the backsawn shrinkage of jarrah is 7.4% before reconditioning, and the movement, i.e. the change per 1 per cent change in moisture content is 0.30% tangentially and 0.24% radially. This is not in proportion to the shrinkage at all. Jarrah is considered to have a medium shrinkage, but wandoo, for instance, which has the lowest shrinkage of all the eucalypts, has a tangential shrinkage of 4.2% but a tangential movement of 0.34% per 1% moisture content change, which is greater than jarrah. The radial shrinkage of wandoo is 2.6% but the movement (0.24%) is the same as jarrah. I think it is wrong to discuss shrinkage in a subject such as bench tops when movement is meant. The Western Australian sawmilling industry is based on back-sawing, and

I have tried to convince architects it is not necessary to specify quartersawn timber for table and bench tops because of the difficulties and delays thereby occasioned. There is not much difference between movement values in the tangential and radial directions and I think this point should be made clear in an article such as this to the people who are concerned with the specifications for these materials.

Wright: The facts under discussion are well known and Princes Risborough has done quite a lot of work on the effect of changing moisture content conditions on dry wood dimensions. We have not yet been able to start a project of this nature and, in the absence of better information, have given values for total or unit shrinkage as the next best thing, shrinkage being a generic term for both shrinkage and swelling.

Boyd: In the absence of precise data on likely dimensional changes in service, it would seem desirable to take a little more care in the presentation of statements such as made in the Newsletter article referred to when such timber will be used in the seasoned condition. Even without the precise information we should be able to cover most of Mr. Wickett's objections by the way in which the data are presented.

Marshall: We are concerned with movement in flooring. We feel movement in timber is almost as important as shrinkage but it is not a very simple figure to determine. Related to the e.m.c. investigations carried out for C.S.I.R.O., I calculated unit movement figures for the species used but the results were anomalous. The movement depends on the rate of change in moisture content and the movement figures from the outdoor studies were different from those obtained from the indoor studies. In the outdoor studies the moisture content changed fairly rapidly resulting in a differential movement between core and case. In the indoor timbers the e.m.c. changed very slowly and we did not get the same proportional differential between the core and the case, resulting in entirely different movements. In the indoor timbers there was far greater movement or greater unit movement than in matched outdoor specimens. I feel that the Princes Risborough figures are a guide, but I do not think they are necessarily representative. We now propose to try to obtain backsawn unit movement figures.

Campbell: Are there any results on the operation of the forced air dryer reported at the last Conference by Queensland?

McConochie: One has been built and has been used for pine to a limited extent. It has been found to work well in the dry months, but the firm concerned is not prepared to restrict their stack sizes to suit the capacity of the fans and I feel if they did, quite profitable results would be obtained.

Unrichard: Experimental work in New Zealand on forced air drying shows that it is very economical for the preliminary drying of commercial timbers prior to kiln drying but complete drying can only be considered if the air is heated. This is referred to as heated forced air drying, the air being heated an extra 5° to 10°F. above ambient and this method is finding considerable application in industry.

Willington: The South Australian firm using the forced air drying method also found it necessary to add a measure of heating and humidification thus getting more to the basic concepts of a drying kiln.

Wright: The contention that additional heating is required for this type of dryer is supported in the U.S.A. and New Zealand as well as by our own experience. We would recommend forced air dryers only in exceptional circumstances such as found in the Queensland or other similar climates, but for many parts of Australia forced air drying is unsuitable - particularly for our more impervious species. For 1 in. thick timber the drying of radiata pine in kilns is so economical that there is nothing to approach it; however for thicker sizes, predryers or forced air dryers can have a good application. We believe predryers are the better choice, and this has been confirmed by the use of predryers for softwoods in the thicker sizes in the Tumut area.

Smith: With regard to brush box scantling, New South Wales material would seem to be of better quality with less tendency to distort than the average run of Queensland material. We recommend the use of brush box with certain reservations, these being that it should be used away from openings, partly seasoned, and not used for sub-floor framing because of its plasticity which causes it to drop a little in service.

Marshall: I have seen many buildings built using brush box without a great deal of trouble. However, sawmillers tend to use increasingly more material containing wavy or sloping grain, but if logs are selected, there is no trouble. I am surprised at the Queensland comment that it is not recommended for sub-floor framing as we regard this as its best use in New South Wales, mainly because of its termite resistance, and the fact that it can season slowly in the sub-floor area where it does not misbehave as much as it would as a roof member. Brush box in New South Wales is predominantly backsawn, and we consider that for scantling, it should be given some preliminary air drying as this produces two effects - (i) it reduces the warping of the material and (ii) it provides an opportunity to cull out any material with excessive movement.

Uprichard: The following notes have been prepared by Mr. Kininmonth:-

A major part of the New Zealand research programme of the last two years has been concerned with completing our projects on the drying of radiata pine treated with preservatives. This has involved both established preservation processes for impregnation with water-borne preservatives - diffusion and vacuum/pressure - and also the alternative and new processes - Lowry (empty cell) treatment and the oscillating pressure method. The salient points that emerged from these studies are in course of publication and will be covered in agenda item (d).

Another long standing project that has been stimulated recently in the drying of our *Nothofagus* sp., the beeches. With the rapid expansion of timber processing on the West Coast of the South Island has come the demand for increased utilisation of these species. Silver beech is unlike the other species in that it dries readily with little degrade. Red and hard beech are the troublesome species; they are very slow drying (slower than most eucalypts for example) and are liable to warp and collapse. When dry they are very stable timbers of fine, even texture and have a wide range of potential speciality uses.

A range of drying methods and combinations of methods have been tried but current recommendations for industry rest on preliminary air drying to about 40 per cent. moisture content, then predrying and kiln drying. Steaming hastens drying but cannot be used for green timber as it causes severe checking; degrade is avoided if the steaming is delayed.

A start has been made on a critical re-appraisal of currently recommended kiln schedules for major commercial species. Indications are that faster drying is possible without sacrifice of quality.

Results of earlier tests on the effects of certain variables on warping in 1 in. radiata pine were analysed. These covered the variables, drying temperature, final moisture content, stack weighting and position in the stem. All except drying temperature had a bearing on twist and cup. It is intended to extend this work to framing sizes.

Pick-up of moisture after kiln drying can be serious where the timber is required for critical uses. Rates of pick-up have been determined in various parts of block stacks exposed at different times of the year. As might be expected, the bulk of the stack is slow to respond to a high atmospheric e.m.c. but the exposed boards pick-up moisture rapidly.

Marshall: Is there any interest in the chemical seasoning of beech in New Zealand?

Uprichard: As far as I am aware there is no true chemical seasoning being done and I feel that these species that are hard to season would also be hard to impregnate.

Marshall: Our beech is somewhat similar in characteristics to brush box and we find that in brush box heartwood, after chemical seasoning the particular chemical we are concentrating on, i.e. urea, has penetrated right through to the centre, even in 4 in. thick material.

Uprichard: Drying of beech is a costly business and I would like to hear comments as to how effective chemical seasoning would be.

Marshall: Chemical seasoning depends largely on economics. We have estimated it to cost in the order of 12/- to 15/- per 100 super ft.

Kauman: The Austral University, Valdivia, Chile, in co-operation with the Forestry Institute, has carried out a comprehensive project on the drying of Nothofagus dombeyi, a notoriously difficult species. Preliminary air drying was found to be advisable and this species responded very well to reconditioning. We think that reconditioning should also be considered in the drying of other Nothofagus species. In Chile we carried out air drying of Nothofagus in an open shed which had louvred walls. Whereas it was reported that it took 2 years to dry 1 in. stock down to fibre saturation point in a typical yard, we found that with experimental stacks we could dry this material in about 8 months from 90 per cent. to about 25 to 30 per cent., even during winter.

McConochie: We carried out tests on drying under cover in the Atherton area. The stacks were not in sheds, but were provided with simple roof covers without side protection and drying continued at a very satisfactory rate. However, we have not yet been able to convince the Queensland sawmillers of the value of this method.

Whiteside: Other seasoning studies going on in New Zealand outside the Forest Research Institute, include air seasoning of radiata posts in various parts of the country to investigate a number of variables. These are the effect of delay in extraction, the effect of protective chemical treatments, roofing of stacks, and the effect of different seasons of cutting. These studies will assist in making recommendations to our Timber Preservation Authority on specifications for treatment. We are also working on air seasoning of southern rata, air and kiln seasoning of kohekohe timber (which is finding application at present as a substitute for imported mahogany), and a seasoning study and methods of production of skew cut weatherboards from indigenous softwoods.

Item 6(b). Australia - New Guinea E.M.C. Survey *

Processing of field data from the main Australian study is now completed and combined prediction equations of the type -

$$\text{m.c.} = b_o + \sum_{i=o}^{i=n} \left(b_{1i}\, H_i + b_{2i}\, T_i + b_{3i}\, H_i^{2} + b_{4i}\, T_i H_i + b_{5i}\, H_i^{2} T_i \right) \%$$

where H_i and T_i are derived from the monthly mean relative humidity and temperature respectively - have been developed for each of the eight species and three thicknesses tested.

The combined equations were verified by deriving moisture contents using the study-period weather data and comparing these with observed moisture contents. The accuracy is very good for all sites except Alice Springs and Broken Hill. For reasons which are not quite clear at this stage, the data from these two stations did not combine well with data from the coastal stations, and the resulting accuracy of the combined equations for this specimen thickness i.e. 3/4 in. is somewhat less than that obtained for the 1/4 in. and 1-3/4 in. specimens. However, when Alice Springs and Broken Hill data were omitted from the

* Prepared by R. Finighan.

combined equation the accuracy of predictions at the remaining stations rose considerably. Local equations were derived for each measuring site and in all cases, including Alice Springs and Broken Hill, the accuracy is also very good.

Because of the above difficulties, the combined equations prediction area has been confined largely to the Eastern and South-Eastern coastal strip together with a small area in the South-West of Western Australia. The local equations have been used to provide values for Alice Springs and Broken Hill areas but the extent of application around these towns is not known. At the moment, monthly and yearly mean moisture contents for eight species and three thicknesses are available at 108 localities in the area described above. This is being prepared for publication as a Technological Paper.

The moisture content study for unheated indoor conditions was completed and analysed with rather variable results. In Melbourne and Como (W.A.) fairly similar behaviour was observed between measuring sites, but in Sydney there was a considerable variation between localities. In general, moisture contents for indoor unheated conditions range from 1 to 4 per cent. lower than outdoor values depending on locality and site factors; for example, a correction factor of -2 per cent. would seem acceptable, for practical purposes, in most temperate areas of Australia. In areas close to the sea, the correction could be smaller while in houses which tend to have high indoor temperatures (e.g. large glassed-in areas) the correction may tend to be larger. Small studies on the influence of surface finish and direction of growth rings on e.m.c. have been completed but the results have yet to be analysed fully. A long term study has been completed in Perth on a wide range of West Australian timbers, and a similar study using New Guinea material is still in progress at Port Moresby. Results of these surveys will be available in the near future.

Discussion

Whiteside: A similar survey was carried out in New Zealand some time ago and we obtained a considerable amount of information on a number of species for indoors and outdoors under cover. What we now require are accurate correction factors for timber in other uses, such as indoors and centrally heated conditions, rooms with open fires or without heat of any kind, southern or northern aspects, etc. Due to a lack of this knowledge we are incapable of dealing with all the day-to-day problems which crop up. Is any work of this nature contemplated here?

Wright: In the course of the study under sheltered outdoor conditions, which was carried out at major capital cities and other areas in Australia and New Guinea, we also carried out concurrent indoor studies in individual homes in New South Wales, Victoria and Western Australia. Matched material was put in these homes and e.m.c. values obtained at the same time. We did, therefore, examine the correlation between sheltered external and internal conditions.

Finighan: The above report covers, basically, the work we have done in detail in this area. We have found that site factors have a great effect and also the location and structure of the house, its proximity to the sea or other water masses, and various other factors which produce a large variation in indoor moisture content. In Sydney indoor values generally range from 1 to 4 per cent. lower than outdoor values at all times, whereas in Melbourne a much smaller range was found. We have found that it is very hard to give an exact correction value for indoor values but within practical limits a correction of -2 per cent. on the outdoor values would seem to be satisfactory.

Marshall: When following the development of the e.m.c. indicator, we found it was a very simple method of checking some of the factors discussed previously, e.g. e.m.c. under indoor conditions. We can get quite accurate and representative results. In regard to glassed areas, we recently examined a floor in Sydney. Whereas the normal moisture content would be 12 to 14 per cent., this floor was down to 9 per cent. because it had large glassed areas facing west. We have recently completed a survey of air conditioned buildings in Sydney.

Item 6(c). Pole Drying *

Investigations on the air drying behaviour of poles from three reputedly fissile eucalypt species have been completed, but work is still in progress with karri. Studies on accelerated methods have been commenced.

Studies on "Ash" Type Eucalypts. - Pre-felling treatments such as sap-ringing or arsenical poisoning were given to trees of mountain ash and manna gum some 5 or 12 months before felling. These pre-treatments did not cause sufficient pre-drying in the tree, or give sufficient improvement in either pole drying rate or dried quality to justify these practices; in fact, poles from sap-ringed manna gum trees showed an increase in barrel degrade.

Untreated(1) poles of these species felled in December (for summer drying) air dried to 30 per cent. moisture content in 6 to 8 weeks in both open-piled stacks in the drying yard, and while lying at stump in the forest. However, mountain ash poles felled in May (for winter drying) required some 12 weeks to air dry to that stage in open-piled stacks under cover; virtually no drying occurred in matched material left lying in the forest over this period. Neither pole diameter nor sapwood thickness significantly influenced drying rate.

Some 300 poles of alpine ash, mountain ash and manna gum were air dried during the course of the studies, but rejection for barrel splitting did not exceed one per cent. The extent of splitting at the butt and top ends was comparable, but more was cut back at the top so as to eliminate all splitting at this end. Cutback varied

* Prepared by F.J.Christensen and J.E.Barnacle.

(1) In the sense of having been given no pretreatment.

from about 2 per cent. of total pole length for manna gum, to about 5 per cent. for mountain ash.

As indicated, during wet periods stack covering permitted relatively rapid drying and prevented re-wetting, and this would ensure continuity of commercial operations throughout the year. However, during dry weather it did not significantly influence either drying rate or degrade development.

Work on the accelerated drying of manna gum and messmate stringybark poles by the Boulton process, and on manna gum by the steam-and-vacuum process is in progress. Indications are that these species can be dried satisfactorily by the former method, but that the drying conditions imposed by the latter are too severe for hardwoods.

Studies on Karri. - End splitting in karri poles has been controlled to acceptable limits by using C-irons or end-banding and an end-coating.

Treatments given to restrain barrel checking were not effective e.g. soaking in sodium chloride solution delayed the onset of checking and resulted in fewer but wider checks. Recently, more promising results have been obtained by deliberately inducing numerous fine checks either by incising in the green condition or by accelerating drying with the Boulton process.

A proposed use of large karri poles in the horizontal position e.g. as crossarms for high-voltage power lines, has recently been raised; this introduces problems which may justify specific investigation.

Post-Treatment Splitting. - Treated poles and/or stubs of all species dried to date have been installed in either graveyard or service tests in Melbourne and north-east Victoria to determine the extent of post-treatment splitting.

General Considerations. - In general, barrel checking - which unlike end-splitting cannot be removed by cutback - will be the main factor determining whether a particular species can be considered as an acceptable pole timber. Complete elimination of barrel checking may not necessarily be the ideal condition when considered in terms of preservative distribution.

Observations suggest that unnecessarily prolonged storage of dried poles may result in the extension of drying degrade beyond acceptable limits. In view of this, poles should be preservative treated as soon as possible after the sapwood has dried to recommended moisture content values.

Results indicated that factors other than growth rate are responsible for the extent of end-splitting in poles dried ready for preservative treatment. Further it is suggested that, for manna gum at least, site of growth has a greater influence on end-splitting than growth rate.

Current Investigations. - Confirmation of the effects of small-scale tests of open-and close-piled methods of stacking on the dried quality of manna gum, messmate stringybark, and mountain ash poles will be sought later this year, when this Division will supervise a semi-commercial drying trial comprising 500 poles of the above species.

Greatest emphasis is at present being given to the drying of karri and messmate stringybark poles by the Boulton process. It is planned to follow these with studies by vapour drying.

Seasoning Slash Pine Poles*

The purpose of this work was to examine the seasoning characteristics of slash pine poles. Four hundred poles were dried and prepared for pressure treatment, 100 being dried every 3 months. Twenty-seven poles in each group were selected at random for sample poles. Electrodes were fitted to the poles 2 ft from the top and at the mid-point with leads carried to the outside for connection to a moisture meter.

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*Prepared by N. C. McConochie.

Blue stain occurred in all sprayed and untreated poles. Barrel checking was more evident on some poles than others. Moisture meter results were considered inaccurate in the high moisture content range. The use of a $\frac{1}{8}$ in. increment borer was also found to be inaccurate but the reason for this is not clear.

It would appear that for Queensland conditions it would be possible to prepare pine poles for treatment within 2 months of being debarked. Little benefit is gained by anti-blue stain spray. The use of the moisture meter would be of little benefit at the high moisture content. If it is considered necessary to have very accurate moisture assessment a sampling method similar to that used for sawn material would be necessary. Several poles would have to be cut up to give a sample approximately 3 ft long. The ends of the samples would need to be coated with a sealing compound to prevent end drying and the samples then placed in the stack. On the size of the stack used in this experiment four samples would be required in the stack.

The use of an increment borer would not be necessary because the sample section would give the moisture content of poles in that section of the stack.

Discussion

Barnacle: The Division was recently approached by the Timber Development Association, Western Australia, regarding the possible use of 42 ft long round karri poles as cross-arms on shielded and unshielded double pole construction in Western Australia. I would be interested in further information on this possible use of karri.

Wickett: We are interested in any use that can be made of karri poles of that type, because we have plenty of them. I cannot tell you at this stage whether an official enquiry will be made involving us in investigatory work.

Uprichard: Some kiln drying of radiata pine poles is being carried out in New Zealand. Experience is that rapid drying conditions are advantageous because they give a pattern a fine checks rather than a few major checks.

McConochie: During the period our slash pine poles were drying we had an abnormally dry year in Brisbane with practically no rain, and the drying conditions were excellent. To get more accurate results, tests would need to be done during a normal year.

Barnacle: What was the diameter of the poles used in this study?

Cokley: The average butt diameter under bark would be about 14 in., the head diameter about 6 to 8 in., with a D-line diameter of about 10 in.

Barnacle: Did stack covers have any effect?

McConochie: No, probably because the stack was under cover during the dry part of the year.

Christensen: For manna gum poles dried during the summer months, stack covers had absolutely no effect on either the drying rate or drying degrade. However, mountain ash poles set out to dry under covers in June dried almost as quickly as those which commenced drying during summer.

Item 6(d). Seasoning of Preservative Treated Timber

I. QUEENSLAND

To date very little research has been carried out on the drying of timber after pressure treatment. Some observations have been made with small samples dried at the experimental yard at and one mill in Brisbane.

Pressure treatment had no effect on the drying of 1 in. pine boards and did not cause any degrade. Two inch material did check more on redrying. The sample observed was dried to 18 per cent. prior to treatment and contained surface checks. These checks opened further on redrying. On the other hand, 1 in. hardwood boards have been found to dry more quickly.

It was observed that stripped stacks with moisture content of 35-40 per cent. required 3 weeks' air seasoning to 20-25 per cent. before kiln drying. There was no evidence of degrading.

Further detailed studies are proposed and experiments are being planned at present.

II. NEW SOUTH WALES

It had been observed in the trade that timber immunized by the hot and cold bath method dried much faster than unimmunized timber of the same species.

Investigation of this showed that the drying rate was much faster down to about 20 per cent. moisture content. It was observed that the checking in immunized timber was much greater, which could account partly for the faster drying.

Subsequent investigation showed that if species which are prone to checking, such as tulip oak, spotted gum, tallowwood and yellow carabeen are partly air dried before immunizing, then face checking is facilitated by the immunizing treatment.

The air drying causes a tension stress in the case of the timber. Wetting causes the case to expand, introducing a slight compression stress which, on redrying, causes the case to shrink slightly more than previously, which is often sufficient to cause appreciable checking in the case section.

This should also happen with pressure treatment using waterborne salts, but the major part of such timber treated is radiata pine and meranti, which are not prone to surface checking.

Discussion

Marshall: Our investigations have indicated that if you immunize timber with boron while it is still green you obtain better immunization. If any air drying occurs before immunization, there is a tendency to get surface checking. Faster drying has been observed with immunized timber, and this may be similar to the effect due to presteaming.

Smith: It is interesting to note that Mr. Marshall refers to spotted gum and tallowwood as being prone to checking, and places them in the same category as yellow carabeen and tulip oak. In Queensland, we find that spotted gum and tallowwood do not generally check badly and would not be placed in this category. This may be due to locality differences. In relation to meranti, this species is not particularly prone to checking during seasoning but, like tulip oak, it checks rather badly on exposure.

Uprichard: Mr. Kininmonth has reported as follows.

New Zealand experience is that radiata pine treated by vacuum-pressure (the normally recommended method of pressure treatment with waterborne preservatives) takes longer to dry than "green-off-saw". In 1 in. timber the difference in drying time might be 24 hr (3-4 days instead of 2-3) but in 2 in. the drying time might be doubled. Quartersawn pieces dry slower than flat-sawn which gives a clue as to the cause.

In experiments designed to track down the cause it has been found that:

degree of saturation is not critical, i.e. drying of timber 92 per cent. saturated is no more difficult than 95-98 per cent.;

pretreatment drying to low moisture content (12 per cent.) is worse than drying to 25 per cent. before treatment;

treatment with water is almost as bad as with preservative solution but increase in preservative loading tends to retard drying to an increased extent;

application of pressure has an independent effect in retarding drying.

The available evidence suggests that pretreatment drying below fibre saturation points aspirates all the bordered pits (probably blocks the simple and half bordered pits as well). The pits remain aspirated or blocked after treatment thus retarding drying. Microscopic examination shows all the bordered pits to be aspirated after treatment. Drying of quartersawn boards is affected more than flat-sawn but both are retarded.

Subsequent work on the Lowry empty cell process and oscillating pressure method has provided interesting corroboratory evidence. In the Lowry process pit aspiration or blockage is offset by a low net retention of solution (50 per cent. instead of 90-100 per cent.). Despite high net saturation drying is only very slightly impeded in O.P.M. Here the timber is not dried before treatment and the bordered pits remain open.

Cokley: Although we have carried out no planned experiments in this field, reports from commercial operators confirm what Mr. Kininmonth has found. Our degrade loss and time of drying have been markedly reduced by treatment above fibre saturation point. We have a serious problem when freshly treated material, either sawn or poles, is sent into the drier areas of western Queensland. Unless material, especially chamfer boards, is either kiln dried or air dried before being sent to a location such as Longreach, where the e.m.c. is of the order of 8 per cent., some checking will occur, particularly in the heartwood.

Wright: We have been worried with the same problem, particularly in regard to poles. For this reason we have had poles treated in Melbourne with waterborne preservative and then installed in Mildura, which has a hot, dry climate, to determine after-treatment degrade in such material. This test has been in progress for approximately 12 months.

Cokley: Has the Division carried out any comparison of the seasoning degrade arising from the use of the various CCA salts which are on the market, or is such work proposed?

Wright: No.

Marshall: As this problem is due to the need to season poles and timber before preservation, it would appear desirable to intensify work on the preservation of material in the green condition.

Barnacle: I would question the wisdom of trying to get the preservative into poles of fissile species before you know how they will dry. The cost of a pole before treatment is much lower than after treatment.

Item 6(c). The Rational Use of Pole Timbers*

Studies carried out by this Division on poles of two species, namely, E. regnans and E. viminalis, that are currently not acceptable to the power distributing authority in Victoria, indicate that this material, from some areas at least, degrades only slightly in the barrel during a normal seasoning period, and that end-splitting is not likely to cause a loss of more than 3 ft of the pole length, i.e. where cut-back is necessary. Although this is a relatively small amount of cut-back, it would, however, exceed the excess length allowance of 11 in. currently permitted by the Forests Commission of Victoria. Since the

*Prepared by J. E. Barnacle.

State Electricity Commission uses poles in increments of 5 ft between 30 and 75 ft, any end split greater than 1 ft but less than 5 ft would result in a loss of 5 ft of paid-for pole length.

Whether such losses would be incurred more frequently in poles of E. regnans and E. viminalis than are at present incurred in those of preferred species is not known at this stage. However, if it is assumed that such would be the case, and that poles of all available pole species were approximately equidistant from the preservation plant, then the pole consumer would incur greater financial losses if he elected to use poles of the two species referred to above. Clearly, so long as an economic disadvantage such as this (real or assumed) pertains to the use of any species, it will obviously be difficult - regardless of experimental evidence - to convince the pole consumer that such species should be used.

It can be shown, however, that as preferred species are cut out from areas adjacent to, say, a preservation plant, and their source of supply becomes increasingly distant from it, then any disadvantage due to cut-back in the less preferred or "unacceptable" species can quickly be offset by the increased cartage cost of the preferred species from the more distant source. When this situation develops, it is likely that poles of the rejected species will become acceptable, particularly if the weight of experimental evidence shows they can be used, or a satisfactory improvement in behaviour can be obtained by the adoption of certain practices.

Once even a small difference in cartage distance is established between the sources of preferred and not-acceptable species, the process of acceptance of the latter may be made financially attractive to the pole consumer (and less wasteful of timber resources generally) if the pole consumer can be assured on two factors, namely:

(i) that the barrels of the poles dry to a satisfactory quality, and

(ii) that he will not be financially embarrassed by excessive end splitting in them.

Assuming (i) above, then (ii) would result if the supplier permitted the necessary cut-back allowance on poles of the currently not-accepted species.

If this is done, the loss incurred by the pole supplier is negligible, and the increased consumer cost of cartage per pole (due to increased volume per pole) is readily offset by reduced cartage distance.

Discussion

McConochie: The practice in most pole yards in Queensland at present is not to use end-coating, but to bring in poles 2 to 3 ft over-length. After seasoning, the poles are taken to the processing area where they are scarfed and prebored and then inspected and docked to length before being taken to the treatment cylinder. At present, a 35 ft pole is cut to approximately 37 ft. The firms have to carry that extra stock, since they are still only being paid for a 35 ft pole, but they find it economic to do this. The 2 ft off-cuts are disposed of to firewood merchants.

Wright: The reason for the approach outlined by Mr. Barnacle is that our local pole-supplying authorities stipulate that a pole shall not exceed its nominal length by more than 11 in. At the same time, these poles are only used in 5 ft multiples of length. Thus, if a drying check longer than 11 in. develops, it becomes necessary to cut back the whole 5 ft. This is a very expensive practice, therefore this question is very relevant at least to pole-using authorities in Victoria and possibly Tasmania. There appears to be a need for the lifting of restrictions on over-cutting of length to make it economic to use those species which are available in abundance and which are at present excluded where this problem arises.

Elsey: This is the first time this problem has come to my notice. It is possible that the 11 in. arises from the fact that royalty is charged to the nearest lower footage, and 11 in. is the longest distance you can go. I think that this matter could well be looked into and I will take it up. I envisage that there are quite a number of poles in which an extra 2 or 3 ft of length would be available at the head, so that it would really mean no loss to us if we were to give the additional length, but the main consideration to the contractor would probably be the cartage cost of that extra length.

Wright: The cost of carting the extra length should be considerably less than that involved in carting shorter poles of approved species a greater distance.

Barnacle: With regard to mountain ash poles, we have expended a lot of energy on work to control end splitting, which we expected to get because of its reputation. As a result of our experiments, which cover about 200 poles, we think that if an over-length of 3 ft was allowed on mountain ash poles, there would only be the odd pole which would split a greater amount than this. The question of whether you may use messmate, but may not use mountain ash appears to revolve around this 2 ft of extra length.

Item 6(f). Moisture Content Sampling of Poles*

In all pole drying and degrade-control studies made at this Division in recent years, moisture content values have been determined by the oven-dry method, since most of the moisture content values encountered in this work lie outside the accurate range of electrical

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*Prepared by F. J. Christensen.

moisture meters. Even within this range, the effects of rain wetting particularly, must be avoided.

Moisture content determinations have been made on standing trees, on trees at time of felling, and on poles both at stump and in air drying yards. In the case of standing trees and poles, two plugs - either $1\frac{1}{2}$ in. or $\frac{7}{8}$ in. in diameter - were removed from each specimen. Both plugs were removed at breast height in the standing tree, but near the butt and top ends of the pole during subsequent drying. At time of felling, plugs were removed from trees at breast height, and 2 in. long discs from the butt and top ends of poles.

It has been established statistically for the species considered, that there is a decreasing moisture content with height in the tree, both in the sapwood and adjacent heartwood. Consequently, sampling at breast height will not give a good estimate of average moisture content in the tree, but one which may be 10 to 20 per cent. higher than average.

Good correlation was obtained - both in green and partially dried trees - between moisture content values determined from $1\frac{1}{2}$ in. diameter plugs removed with a hand operated cutter, and from peripheral strips cut from adjacent discs. A similar result was obtained with samples cut from poles air dried to a stage suitable for preservative treatment. In most cases, the initial longitudinal moisture gradient along a pole disappeared within a month of commencing air drying.

Within the limits investigated, the method used in sampling and the size of the sample did not significantly influence moisture contents obtained. Experimental results showed that with trees and poles in the near-green condition, close agreement in average moisture content (for groups of six trees or poles) was obtained from both sizes of moisture content plug - $\frac{7}{8}$ in. and $1\frac{1}{2}$ in. diameter - although individual variations of up to 15 per cent. were obtained for plugs taken from adjacent positions in the same tree or pole. Such differences largely disappeared at lower moisture contents, indicating the effect was due to inherent variations originally present in the tree or pole; for example, tests made with poles at an average sapwood moisture content of 25 per cent. gave individual values within 2 per cent. of one another, when matched samples of similar size were removed either by means of a bandsaw or a $\frac{7}{8}$ in. diameter plug cutter powered by a 400 r.p.m. electric drill. For peripheral strips cut from the immediate vicinity with a bandsaw, individual values were within 4 per cent. of those obtained above. Weights of the above specimens varied from 3 to 300 g.

No significant difference in moisture content was obtained for $1\frac{1}{2}$ in. diameter plugs containing moisture in either the normal or frozen condition when these were removed with a hand operated cutter.

Discussion

Wright: Great care is necessary when using moisture meters for measuring the moisture content of poles. After a wet period followed by two fine days we found that with an uncovered stack, whereas on the exposed upper surface of the poles moisture meter readings gave values in excess of 40 per cent., the true (O.D.) values for the inner sapwood ranged from about 24 to 36 per cent. In other words, the moisture meter gave a very high value. Marked differences in moisture content may also occur on the upper and lower surfaces and, undoubtedly, stack covering will prevent this sort of problem.

Marshall: Moisture meters are just not satisfactory for use in pole drying, although they are in common use in New South Wales. Has any thought been given to the determination of moisture content in poles during drying without taking plugs or borings?

Barnacle: We have not yet found a satisfactory alternative. If borings or plugs were taken, would it be possible in New South Wales for treated dummy plugs to be inserted in their place?

Marshall: I do not know if the pole-using authorities would allow that.

Barnacle: The alpine ash poles referred to in the report given earlier have been installed as service poles in the north-western area of Victoria and also in the metropolitan area of Melbourne. These have been bored by us and plugged, and accepted by the authorities.

McConochie: The use of increment borers, particularly the small hand-type machine for moisture samples, produces considerable error, especially in the higher moisture content range.

Wright: We have standardized on a plug size of 1½ in. in diameter. We realised the possibility of errors in taking plugs, so we compared plugs with sawn specimens and peripheral rings and we even froze timber, in case there was any movement of moisture due to pressure or temperature effects; in all cases there were virtually no differences in results obtained from these methods of sampling but this may not be so with the smaller increment borer. The plug size of about 1½ in. would also lend itself to refilling the hole very easily.

McConochie: What type of increment borer did you originally use?

Barnacle: We have used both hand and machine operated "trepanning" type cutters, also the hand and machine operated smaller diameter plug cutter developed by Mr. Dale, on both standing trees and poles. An extensive comparison has also been made between sawn-out plugs, quadrants cut from discs, and plugs of the two sizes; there is very little difference between any of the methods used.

McConochie: We have not had much success with the Dale type of plug cutter, except where very short plugs are being removed, say up to 1 in. in depth. We have found that plugs cannot be extracted satisfactorily beyond this depth. The cutters bell out at the end and will no longer clear the chips.

Christensen: It is very difficult to estimate the average moisture content of a parcel of green poles by taking one or two samples from one pole, but a satisfactory average is obtained by using up to six poles and taking two plugs from each. We have also found that moisture contents of plugs taken by hand and by machine give substantially the same average moisture content, although individual plugs may differ by up to 20 per cent. We consider this is due to inherent variations in the tree. Once the pole has dried to about 40 per cent., the moisture content gradient is substantially reduced and accurate readings can be obtained by taking only two plugs from one pole.

Barnacle: Mr. Dale has obtained two large cutters from Germany. Mr. Eldridge, of the Forestry and Timber Bureau, has recently modified one of these cutters and is using it to extract samples from right across the diameter of standing trees of radiata pine.

Cokley: I agree that multiple plug cutting is desirable. However, the most practical method of sampling poles for moisture content is to remove a sample with an axe cut from the area to be scarfed for cross-arms. We cannot expect a plant operator to take more than one sample per pole and in view of the variation between poles and drying yards, this is as close an accuracy as we can reasonably expect.

Item 6(g). Types of Kiln at Present in Use*

At present in Queensland there are steam, electric, direct and indirect oil fired and hot water heated kilns.

The steam kilns are either cross or longshaft, they are usually poorly maintained and operate inefficiently. Tests recently carried out in North Queensland showed this and, following advice to sawmillers, repairs have been affected, in some cases with marked

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*Prepared by N. C. McConachie.

increases in kiln efficiency. One mill reports reducing drying time on large size silky oak and maple by 33-1/3 per cent. since improvement and repairs were carried out.

Electric. - There are only two mills using electric kilns at present.

Direct and indirect oil fired kilns. - At present there are 16 sets of this type of kiln in use all over the State. The size varies from 15,000 to 3,000 super ft, average size being 5,000. In some kilns it has been difficult to obtain close control over humidity using water sprays.

Hot water. - Only one unit has been built to date and at first there were some problems, particularly with the pump. This was due to wrong information being given by the pump supplier. The kiln is 6,000 super ft capacity. The water is heated to 240°F in a colonial boiler. The boiler is fired automatically with sawdust. The sawdust is injected by means of a blower into the furnace and is burnt in suspension. To date it has not been possible to check the fuel consumption. The burner operates for approximately 10 min in each hour, <u>i.e.</u> 5 min on 25 min off when the kiln is at operating temperature.

It has been found that when using ordinary black pipe, hot water requires more piping than does steam and for future designs gilled tubing will be recommended.

The reason hot water is used in preference to steam is that an attendant is not required to operate the boiler under Queensland Machinery Acts. This allows the plant to run unattended outside mill hours and at weekends.

Air seasoning is still badly neglected in most mills. The degrade due to bad practices is still high.

In an endeavour to improve practices in seasoning, schools were held in Atherton and Brisbane but were not well patronized.

Unfortunately the mills with bad practices did not see fit to be represented at either of those schools.

Schedules have been prepared for North Queensland species and will be published shortly. The tendency is for mills to use milder schedules with much better results.

No Discussion

Item 6(h). Kiln Schedules for Local and Imported Timbers

Marshall: Frequently we obtain enquiries for drying schedules for a large number of species of timber. Unfortunately, we have nothing printed on this subject and any recommendations made are based on Boas' work. I was pleased to hear that Queensland intend publishing some of their schedules. I was wondering whether D.F.P. had a similar intention in mind at some future date?

Wright: I think it would be a good idea if we could get together a small sub-committee, and produce some form of document, such as we recently recommended to IUFRO on a world scale, on this subject.

Item 6(i). Surface Treatments to Control Surface Checking*

Recent research has shown that for some non-collapsing species, surface checking can be prevented or controlled by the application of a coating of a micro-crystalline wax emulsion to the green timber.

In one experiment, using 3-3/16 in. thick backsawn Malayan kapur (Dryobalanops aromatica), uncoated specimens which were kiln dried from the green condition under a fairly mild kiln schedule

*Prepared by G. S. Campbell.

developed face checks up to $1\frac{1}{2}$ in. deep, whereas end-matched, coated specimens were kiln dried under a much more severe schedule completely free of checking.

Although the boards were "tacky" to touch in the early stages of kiln drying, they were quite clean to handle by the end of kiln drying and presented no problem to the wood machinist in obtaining a clean surface. A gluing test on the machined surfaces of these previously coated specimens produced a satisfactory result.

The value of various types of surface coatings for the prevention of checking is currently being investigated on 1 in. thick backsawn Tasmanian alpine ash (*E. delegatensis*), a highly check- and collapse-susceptible species. The hardwood timber industry in Tasmania and Victoria particularly, would welcome a change in sawmilling practice from quartersawing to backsawing, for a number of reasons, if it could be demonstrated that it is practical to dry backsawn material on a commercial scale reasonably free from the surface checking to which the tangential face of the ash-type eucalypts is normally prone.

At this stage, the results for alpine ash are not particularly promising, mainly because of the severe collapse which develops during drying; it is considered that the pronounced face checking being experienced is largely initiated by collapse-inducing forces. Further work is planned to examine the effect of presteaming treatments prior to coating.

Discussion

Marshall: The effectiveness of some commercial preparations which are highly recommended for the control of surface checking, and which do impart some preservation to the timber, have already been mentioned under the section on preservation. Have D.F.P. any comments on these materials, which consist mainly of some type of wax or resin, and which usually incorporate PCP or copper naphthenate?

Campbell: We are currently investigating several different types of coatings, including those supplied by various oil companies, the Celcure product "Woodzone", "Vaporlex", which is a synthetic resin-latex, and also a butyl-latex. Indications are that substances such as "Woodzone" and "Vaporlex" do not control checking during the drying of green material.

Smith: This work is particularly interesting in view of the possibility of using it for the in situ treatment of dressed material such as tulip oak chamfer boards and for other species which at present we cannot allow in exposed situations. Are there any indications yet that the use of surface treatments will be effective in reducing surface checking?

Campbell: To date, we have only been interested in using this material to control checking during seasoning. It is intended that this waxy type of coating, which does not penetrate into the wood, should be machined off when seasoning is complete and this can be done quite easily. As an example, some ramin which had been air dried to a moisture content of about 20 per cent. was coated with a micro-crystalline wax, and was then exposed during summer, together with some untreated material, for a period of approximately 6 months. The coated material did not alter or change from its original condition, whereas the uncoated controls continued to degrade quite considerably.

Bryant: What would be the cost of coating, say, 100 cu.ft of sawn timber?

Campbell: We have no idea of costs at present but this is the same sort of material which is used for end-coating boards.

Marshall: Is there anything known about the use of these materials for timber being air dried?

Campbell: Under air-drying conditions it certainly does tend to slow down the drying rate. However, we have found that presteaming tends to compensate for that. With coated material, it is also possible to use a more severe kiln schedule, and this also helps to compensate for the effect of the coating on drying rate.

Willington: In the drying of large section radiata pine we have encountered a significant amount of degrade due to checking. It is very largely due to the differences in the quartersawn and backsawn characteristics of the faces. Would the wax emulsion have any application in this situation, and has any work been done in this area?

Campbell: No work has been done on softwoods yet, but I feel it could have application in this instance.

Wright: I would like to report on the work which we have been doing on shrinkage control by dimensional stabilization using bulking agents. We have had quite a degree of success with glycerol, although polyethylene glycol has also proved effective. For example, by soaking coachwood which has a normal volumetric shrinkage of about 12 per cent. in a 33 per cent. solution of glycerol, shrinkage was reduced to about 3 per cent.; treatment with a 50 per cent. solution reduced the shrinkage to about 1 per cent. With radiata pine, which has a volumetric shrinkage of 7 to 8 per cent., this was reduced to 1 per cent. with a 33 per cent. solution, and to virtually nil with a 50 per cent. solution. Karri came down from about 17 per cent. to about 3 per cent. with a 50 per cent. solution. This is as far as we have gone at the moment, but this reduction in movement would be of immeasurable value in wood utilization.

There are two main problems - cost and fixing the chemical in the wood. We are doing a little work with the Australian Atomic Energy Commission to see whether irradiation with gamma rays will help to fix the glycerol. However, this may be commercially impracticable on account of cost.

The approximate amount of chemical required is 25 to 30 per cent. of the oven-dried weight of the wood. The cheapest price for glycerol is about 2/- a lb, but this is for double distilled, chemically pure material from overseas. However, one would not need to use chemically pure material if a lower commercial grade were available.

Marshall: We have been following this work with great interest, but we regard the cost of the glycerol as being too high and are using urea in some of our experiments. We have found that brush box still shrinks and collapses to a certain extent after treatment with urea. Does the use of glycerol affect the finished surface in any way?

Wright: The problem of fixing or polymerizing is one which we are trying to solve. The surface is not too bad at the lower concentration.

Item 6(j). The Behaviour of Wooden Flooring Under Impervious Coverings*

The use of impervious floor coverings in recent years has, in many cases, been accompanied by movement in the timber floor in the form of cupping and ridging. In particular, vinyl covered floors appear to highlight such defects and the vinyl manufacturers now recommend that hardboard be laid over a wooden floor prior to the laying of vinyl.

Their specification states that the ¼ in. tempered hardboard should be nailed at 6 in. centres - 3 in. centres around the edges - and that expansion gaps be left between sheets and around walls. The cost of this is approximately £1 a square yard, and for the average home adds £28 to the cost of laying vinyl tiles on the floor.

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*Prepared by G. S. Campbell,

Unsatisfactory building practice in regard to sub-floor ventilation is undoubtedly an important contributing factor in the development of cupping in such floors. Ventilation is frequently inadequate - some builders are now dispensing with metal vents and substituting narrow slots ($\frac{3}{8}$ in. in one case) between three bricks on end - and the low minimum ground clearance allowed by Building Regulations (6 in. in Victoria) may be contributing to this problem.

However, there have been cases reported where sub-floor conditions have been satisfactory and yet board cupping still develops and shows through the vinyl covering, especially under conditions of oblique lighting. It has been suggested that a vinyl covering, especially if glued directly to the floor, creates an unbalanced structure, and that the normal e.m.c. changes which affect the bottom face are sufficient to cause such movement.

Current interest on the problem centres on whether it is necessary to specify hardboard for laying on floors in multi-storey buildings at levels clear of the influence of the ground. For large areas, the cost of laying hardboard would be considerable, and one contractor claims the hardboard is not necessary provided that the existing timber floor is reasonably smooth and has been allowed to "settle" for a period between sanding and the laying of the tiles, and that the underfelt is glued to the floor.

It appears that there are several points requiring clarification other than the effect of poor sub-floor construction in private homes. These include the need for underfelt and, if needed, whether it should be glued to the floor; the suitability of various types of underfelt; the effect of sanding (i.e. are residual drying stresses still in the timber disturbed by sanding?); and the influence of the materials used in sub-floors in multi-storey buildings. Coating the under-face of timber floors with a moisture resistant coating in lieu of laying hardboard on the top surfaces in private dwellings may be worth investigating. It would be of value to learn if similar problems with impervious coverings on floors are experienced in other States.

Discussion

Marshall: We are particularly concerned with this problem in New South Wales. We have also experienced some trouble with inverse cupping. This appears to be due to the effect of temperature and a reversal of moisture content. With normal cupping the underside of the floor increases in moisture content. When any impervious surface is placed over the floor the temperature effect becomes important and apparently there is a higher moisture content on the top side of the board. I am on the Committee which is concerned with the problem arising from the use of vinyl tiles on wooden floors. Although an underlay adds substantially to the cost, it appears to be necessary to obtain a satisfactory floor.

Smith: We have experienced this trouble in Queensland and have investigated many cases. Inadequate sub-flooring ventilation will certainly cause cupping convex to the underside, but we have also found that concave cupping may occur even under well ventilated conditions. We have recommended some form of protective coating on the undersurface of the floor to retard the change in moisture content arising from variations in the e.m.c. A coat of the cheapest paint has been found effective to some degree. We have also had trouble in multi-storey air-conditioned buildings. It would be good practice to defer laying of the floor covering in such buildings until the air-conditioning system is installed and in operation, so that the floor is allowed to settle down.

Wright: All the problems mentioned may not be due solely to moisture content changes, but there may also be thermal changes. Clearly, when tiles are stuck on to a wood surface we get an unbalanced construction and any stress arising from this is transferred to the wood through the tiles. With change in temperature a difference in expansion could easily cause a pull around. Consideration of the thermal effects as well as moisture content may perhaps help to solve this problem.

Whiteside: Numerous cases of cupping in wooden floors under vinyl coverings have come to notice in New Zealand. In most cases, sub-floor ventilation has been inadequate or the flooring timber has been laid at too low a moisture content.

Item 6(k). Moisture Content of Timber for Boatbuilding

Marshall: With the current high interest in boats and boatbuilding, enquiries are often received by the Division on suitable moisture contents for the timber used in different parts of boats. The size of the craft range from rowing boats up to quite large passenger vessels or trawlers.

Information is requested for suitable moisture contents for the hull, for framing and other timbers below the water line, and the optimum value for boats which are often slipped, or left out of the water for some time.

Have any members of the Conference investigated any of the above points?

Wright: Many years ago we produced a report on the moisture contents of timbers for the larger type boats. It was mainly a review of the literature, but some recommendations were made.

Smith: Some recommendations were prepared in Queensland during the war years and the information could be made available on request. I was under the impression that a draft Interim Standard had been prepared for small craft construction. Our recommendations would be for above-water work, the moisture content conditions should be the same as for normal building finishing purposes. For below-water construction, pine planking can be fixed air-dried and tight, in which case there is some crushing which, however, only adds to the water-tightness, but apparently does not affect the structure. In the case of hardwoods, it is necessary to know the moisture content of the materials at the time of fixing, and to allow for the effects of swelling to saturation without buckling, since hardwoods do not crush, by making use of shrinkage factor corrections.

Wickett: This is a complicated question, since there are so many types of boats and methods of storage, etc. I made on spot check on the moisture content of below-water line planking of jarrah which had been in the water all the season and on the slip for one day. I obtained a moisture content of 15 per cent. for below-water planking. This boat had been properly painted with an anti-fouling preparation. As a general observation, dry timber should always be used in amateur built boats because the time taken in building ensures that even green timber would be dry by the time of launching. The use of dry timber will therefore usually result in less distortion in the finished craft.

Page: When the Standards Association Committee T.M.9 was re-writing Specification No.069 "Timber for Marine Craft", a small sub-committee was formed to investigate this question. Measurements were actually taken on small craft in Sydney Harbour. Recommendations are embodied in this publication.

ITEM 7. UTILIZATION

Item 7(a). Review of Research Activities (D.F.P.)*

Enquiries on a wide range of utilization topics continue to be dealt with at the rate of about 1,200 p.a. Arrangements have been made for some types of local enquiries to be answered by the Forests Commission, Victoria. Laboratory investigations on sawing, cutting and jointing have been intensified.

Properties and Uses

Regarding properties and uses, new information is being recorded as it becomes available from other Sections of the Division and from the publications received. The data provide the up-to-date background for advisory work. Notes printed from time to time become aids to dealing rapidly with questions. A sawmillers' association has been assisted in preparing a manual on timbers sawn in Victoria.

Sawmilling

Previous mill studies provide data for continuation of help to the sawmilling industry on sawing methods, operational characteristics of particular machines, merits of different layouts, and factors influenced by saws, personnel and power. Recent studies have related to sawmilling of small girth logs and are discussed under item 7(d)(ii).

An inaugural course for sawmill managers from Western Australia was conducted late in 1963 at the Division and in industry. Knowledge accumulated over many years was imparted in that course and is being used again in expanded form in lessons on sawmilling referred to under item 9(c).

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*Prepared by R. F. Turnbull.

Saw Studies

One of the results of the Section's studies of efficiency of sawing in sawmills was a demonstration of the close relationship between sawing efficiency and the ability of the saw teeth adequately to withstand the cutting forces developed during sawing. Investigations have continued on the dependence of saw tooth stiffness and stress on tooth profile. We, as well as Thunell, have endeavoured to clarify this problem mathematically but have unavoidably introduced assumptions and simplifications which throw serious doubt upon the dependability of the results. For this reason, an experimental approach has aimed at determining the stress and deflection characteristics of various shapes and these data have been used as a basis for the design of profiles with improved characteristics. Stress analysis employing both brittle lacquer and photoelastic methods has led to development of the design criteria necessary for high stiffness and low stress. Specifically, a profile which is about 25 per cent. stiffer and carries about 25 per cent. less stress under lateral load than the traditional profile is now being generally promoted for all types of ripsaws.

The important factors affecting the performance of small diameter circular saw blades used in portable electric saws were summarized at the last Conference. Optimum saw blade designs have, since then, been developed. The success of these designs depends very largely upon strictly maintaining precision during manufacture and subsequent servicing, and it is accordingly clear that there is little value in specifying design parameters and tolerance limits if manufacturers are not prepared or equipped to work within these tolerances. Thus, it has become necessary to develop not only suitable saw blade designs, but also instruments for the rapid measurement of critical parameters and additionally quality control programmes around this equipment. For example, instruments for the rapid measurement of saw blade flatness and of tooth set have been designed and are to be used for quality control in both the contracting factory and the receiving warehouse. To the best of our knowledge this is the first time, at least in Australia, that manufacturing methods coupled with quality control programmes based on design requirements rather than on traditional practice have been employed in the manufacture of saw blades.

In co-operation with the Industrial Research Section of the University of Melbourne, research on the reasons for faulty welds on wide bandsaws has been completed. The principal faults were fissures originating from penetration of the solid bead into the parent metal during forging, unsatisfactory post-welding heat treatment of the weld area and heat affected zone, and decarburization of the melt. Welding procedures that remedy these defects have been developed and published.

Cutting Research

Inclined cutting. - A rotating disc sharpened at the edge and inclined to the direction of cutting was used for studying the cutting forces in three cutter-to-grain situations. The influences on these forces, and on chip form and on surface, of edge inclination, peripheral speed, edge bluntness, wood density and moisture content were studied. The parts of the work carried out with Professor N. C. Franz up to 1963 were published in the Forest Products Journal, January 1965. Inclination reduced cutting forces and produced a high quality end-grain surface on workpieces of any species when the inclination was sufficiently great. This is largely because inclination reduces the effects of bluntness. Experiments permitted the effects of bluntness to be deduced.

Inclined cutting in the longitudinal plane has also been studied with edge parallel with the grain (as in veneer cutting) and perpendicular to the grain (as in planing) in order to assess the potential values in these directions. The results, in course of being analysed, indicate that the advantages are greater in the latter situation than in the former.

Bluntness. - The inclination work showed that an edge radius of only 5 microns bluntness tripled the energy consumed in cutting a chip of 0.005 in., and added 50 per cent. in cutting a chip of 0.040 in. thickness. (In practice a blunt edge may be of 80 microns radius.)

Further analysis since publication has provided support for the following conclusions:

> for ideal sharpness, the cutting force is proportional to chip thickness;
>
> below a certain ratio of edge radius to chip thickness, the added force due to bluntness is roughly constant, so that the ratio of this force to that for ideal sharpness is inversely proportional to chip thickness;
>
> this ratio is largely independent of wood properties or rake angle;
>
> the added force due to bluntness is proportional to the square root of the edge radius.

The mechanics of cutting with an ideally sharp edge is the subject of current interest.

Finger Jointing

The application of finger jointing to reclaiming waste and to overcoming several production difficulties has been encouraged. An experimental electrical heating unit for use in the gluing of green finger joints has been built and used successfully. Limited tests on joints made in green Group C hardwoods have shown an average modulus of rupture of 8,200 lb/sq.in. and minimum values well in excess of the minimum required for the working stress of standard grade Group C timbers to be applicable.

Work aimed at producing joints suitable for structural applications is continuing. The effect of densifying the adherend surface has been studied and a new type of cutter, capable of producing joints with tip thickness of 0.030 in. in dense hardwoods has been developed.

The influence of timber properties on the relationship of scarf angle to joint strength is at present being studied.

Standards

Collaboration with the Standards Association of Australia has continued. Chairmen and members have been provided for several committees and assistance given in advancing preparation of specifications for sleepers, sawn hardwoods of south-eastern Australia, timber for small watercraft, flush doors, bulk bins for fruit and other products. Considerable time was devoted to the revisions of terms and definitions, and of nomenclature.

Discussion

Bryant: Our Utilization group is, at the present time, in somewhat of a state of flux, as one of our officers is leaving the Department. We have just completed an intensive study of floor finishes in two schools, with the Defence Standards Laboratories. Unfortunately, we cannot publish this work in detail, but have sent a brief comprehensive report to D.F.P. and to D.S.L. We found that one of the cheapest materials - Taubman's Solpah - was the most satisfactory.

We have been looking again at the utilization of brush box, including its use as veneer. This use is favoured by the low availability of good peeling species from overseas.

We are also trying to promote the use of box as a cladding material, rough sawn, and treated with a Madison finish to compete with western red cedar and other high-priced imports. Our problem here is that we can only do so much developmental work; the rest is up to the industry, which is backward and leaves most of the promotional work to the importers. T.D.C.A. could assist in persuading millers to take advantage of this work and we have had discussion with them to this end.

We are working on chemical stains which impart to rough sawn timber an appearance such that the industry can offer to architects a range of materials which do not require painting, but which may be painted. We wish to find out whether there are any changes in appearance on exposure. Quite cheap staining materials can give a range of colours and this may help to reduce the cost of cladding.

We are recommencing work on the effect of acids and alkalis on some of our species.

We propose to do some paint testing as we do not feel that other people are going in the right direction.

We are particularly interested in the sawing of fast-grown blackbutt. Some sawing studies were conducted without much success using twin edgers but we now believe from the experience of a sawmiller that by storing the fast grown material for a period, sawing by conventional means will give satisfactory results. This has proved the case with fast-grown blue gum.

McConochie: In relation to the use of brush box, I can advise that Hancock Bros. of Ipswich are using brush box 4 x 1, 5 x 1, and 6 x 1 for laminating beams using resorcinol glue and R.F. heating. Regarding the small diameter blackbutt, we have found that the main problem has been spring. Logs that have been stored for a while develop checking, but seem to saw with less spring. A cutting sequence suggested by one of the sawmillers was found quite satisfactory, but detailed results are not yet available.

Whiteside: In New Zealand we are involved in several Standards Committees. The Standard of most general interest is 169, covering the grading of exotics. One of the problems is the number of conifers coming on the market and the fact that group marketing might be necessary. Some of the species are superior to radiata pine and the grading rules are satisfactory, but trouble arises with species of lower density, particularly some of the southern pines.

Visual grading rules for structural grades of radiata pine and Douglas fir have been formulated.

Work is being done on the use of radiata pine for exterior joinery utilizing short clear lengths from grades at present marketed.

Work has also been carried out on the relation of silvicultural practices to the quality of sawn timber produced, particularly with radiata pine. Bandsaw studies have been carried out on hard beech. Work has been done on the formulation of standards for structural plywood and glulam.

Uprichard: At F.R.I. work has been performed on the problem of "wavy-edge" frame-sawn timber. This timber possesses waves along the width of the board every 1 to 3 ft, varying in depth from 0 to $\frac{3}{8}$ in.

Experiments have shown that one of the major causes of this defect is insufficient tension exerted on the saw blade through the saw buckles. Loads of 14,000 to 17,000 lb must be maintained on the saw blades of the log frame in order to produce accurately sawn timber. As there is a tendency for the load to decrease under operating conditions, it is recommended that some form of elastic element be incorporated with the saw buckles in order to absorb any change in the stress conditions of the saw blade.

Attempts are also being made to reduce the amount of slivers on the bottom edges of frame sawn timber, particularly that associated with the sawing of Douglas fir. In particular, closer tooth spacing and lower hook angles than those normally used on New Zealand frame saws are being investigated.

Smith: Our recently issued Pamphlet No.5 entitled "Queensland Building Timbers and Specifications for their Use" is particularly useful for advisory work. Some of our local authorities will not approve finger-jointed material, and I would like to suggest that an authoritative publication, such as the Newsletter, should publish figures on the strength of finger-jointed material and its application to structural components. This would aid utilization, particularly in relation to finger-jointed studs.

Turnbull: There is a Standard in advanced stage of preparation on finger-jointed studs, plates and nogging pieces, and this might be a starting point. Whilst we can make statements about finger-jointed material, we cannot ensure that all manufacturers comply with the Standard.

Boyd: Quality control is incorporated in the Standard and should overcome this problem.

Booth: One of the keys to finger-jointed studs is that of adhesive durability. We believe, on account of our own and overseas results, that urea cannot give adequate structural strength for the life of a building, and there seems to be a tendency for the industry to get started with urea resins. We cannot support this until they are prepared to use glues of known durability and we hesitate to recommend finger-jointing for items of long term structural use. The present standard, as drafted, does not lay sufficient emphasis on this point.

Page: The standard stipulates that the glue used shall be waterproof and we have been asked to define what waterproof is. We have indicated that resorcinol is the preferred adhesive. The items which are covered in this specification are studs, nogging pieces, and top and bottom plates. None of these is highly loaded.

Colwell: Are there any plants in Australia finger-jointing wide boards? I have gained the impression that the finger-jointing of Araucaria species in the Territory is not justified costwise.

Page: As far as I know, in Australia the market for wide boards in pine is being lost to particle board.

McConochie: A Queensland firm has manufactured a finger-jointing machine for export to New Zealand. It is operated by one man and has a throughput equal to some imported machines. Some of the material finger-jointed in Queensland from pine thinnings is finding its way into the moulding market.

Galvin: Has anybody investigated the relative economics of finger-jointing compared with pruning in Pinus radiata?

Whiteside: Our Economics Branch has no doubt that pruning is cheaper than the finger-jointing operation.

Thomas: Our tentative conclusions are the reverse.

Turnbull: We abide by the idea that finger-jointed material should not be singled out by itself; in other words, finger-jointed flooring should be judged by the requirements of flooring in general, and other products should also be comparable with full length material.

Boyd: The overall question of defining a satisfactory product cannot be resolved simply in terms of a short duration test performance only, such as may be made to test the strength and stiffness of flooring; the question of durability is involved. The point at issue is whether guidance should be given by a Standard. This applies not only to finger-jointed material, but also to laminations in glued-up assemblies. I believe some appropriate suggestions might usefully be made to the Standards Association.

Turnbull: The Standards Association has not had the problem of assemblies of finger-jointed material put before it. When considering construction standardization they could provide standards for construction, and include finger-jointing.

Booth: This is an important aspect. Whether this would be dealt with at a standards level I do not know. I gain the impression from the manufacturing side that they have tended to gloss over the durability aspect. We should emphasize this as it reflects on the reputation of the product and the Standards Association should bear this requirement in mind. Regarding finger-jointing adhesives in construction, there has been a steady use of finger-jointed flooring and mouldings in New South Wales. P.V.A.'s appear to be satisfactory in flooring and internal mouldings, but there has been trouble with them in exterior mouldings and weatherboards. Some production using urea has taken place and interior performance is likely to be satisfactory with this, but we should be cautious, as overseas experiments indicate trouble with structural joints using urea. We are doubtful about the success of anything but resorcinol or similar adhesives.

Page: We do not recommend P.V.A. at all now: we recommend urea, as jointed material intended for interior use may become wet in transit or in a merchant's yard and deteriorate before installation.

Boyd: Would leaders of delegations indicate whether they feel this Conference should bring to the attention of the Timber Industry Committee the suggestion that gluing recommendations, in terms of standards or guidance, should be laid down for timber for construction, including the various aspects of use? Note: There was general agreement that this should be done, and it was suggested that the advice should be passed on through the Conference Secretary.

Colwell: What is the position regarding standard trade common names?

Turnbull: Australian and exotic timbers grown in Australia have been covered in the new Standard just issued. An interim Standard of nomenclature of imported timbers is to be revised. A Committee of the Standards Association on Wood Technology deals with this and they would like suggestions for timbers to be included.

Ryley: The Ampol refinery recently built in Brisbane was erected by an American company and there were a considerable number of piles required for the foundations. The American company originally intended using concrete. They finally tested six timber piles against eight equivalent concrete piles, and were surprised to find that the timber was superior. In particular, spotted gum was, in this case, superior to ironbark. We hope to get some publicity from these results.

Boyd: We would be interested in obtaining information on this when available.

McConochie: The particular results published by the engineers provided one of the most comprehensive publications of this type. It is a very fair report on timber and concrete for this purpose.

Item 7(b). Trends in Sawmill Design and Equipment*

Recently in North Queensland there have been several major takeovers of sawmilling concerns and endeavours are being made by two firms to establish better mills.

Considerable work in setting out log yards and seasoning yards has been carried out. The placing in service large American log trucks and loaders is improving log handling. Apart from maintenance to sawmill plant this firm is concentrating on yard handling because of the high seasoning loss both to sawn timber and logs.

The other firm is building a complete new mill, the buildings to be all timber construction. The sections are laminated in panels in South Queensland and railed to North Queensland. The roof will be plywood also.

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*Prepared by N. C. McConochie.

Several remodelling programs are at present being carried out in North Queensland. Three mills have installed sizing carriages with fast resaw benches.

Two new mills have been built in Central Queensland, one for brushwoods and the other for hardwoods. Both mills are using sizing carriages, the brushwoods mill using a band head saw and the hardwood mill a twin circular.

A new hardwood mill has been built near Brisbane to replace two older mills in the same area. This mill uses sizing carriage and resaw bench, both circular.

There has been very little improvement in cypress or plantation thinning mills recently.

Interest is being shown in the use of high speed gang saws for cutting small sized logs. At present one is being installed for dimension cutting of spotted gum. Another has been working for some years in a mill near Brisbane, again for dimension cutting of hardwoods.

The Department's experimental mill is now complete and several studies have been carried out to examine the effects of silvicultural practices. The species studied were: plantation maple and kauri, ex North Queensland; plantation E. grandis, ex Yarraman and Murgon; plantation hoop pine (pruned stems), ex Imbil; plantation slash pine (pruned stems), ex Beerwah; plantation and natural regeneration E. grandis, ex Gympie.

The results from these studies are still under consideration.

No Discussion

Item 7(c). Hard Metals for Increasing Sawmill Production*

Tungsten Chromium Cobalt Alloys

Investigations into the problems of machining hardwood such as brush box (*Tristania conferta*) have been carried out.

It was felt that there was a need for research into the development of cutter blades that would compare favourably with existing cutters for price and working life, and which the bush sawmiller could produce in his own workshop.

The experience gained in tipping saw teeth prompted the trial of the tungsten chromium cobalt alloy known as Cobalide 3 which is suitable for welding to steel as a hardfacing material.

Efforts were confined in the first instance to the 4 in. cutters in the leading heads or 4 and 5 header moulding machines. These heads are used primarily for taking what is known in the trade as the "rough" cut.

The techniques involved in the process are simple and require only a slight knowledge of welding.

Test runs were conducted in the moulding sheds of two large sawmills on the north coast of New South Wales running brush box flooring.

In both cases the results were approximately the same; the Cobalide tipped blades gave a working life of 5 to 6 times that of high speed steel knives and three-quarters of the life of tungsten carbide cutters.

The pair of hardfaced cutters were produced for £5 per pair, approximately the same cost as the purchase price of the high speed steel pair. This price, however, was for a custom made job which, no doubt, could be reduced if made up in quantity.

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*Prepared by New South Wales.

The price of the cobalide cutters (£5 per pair) compares more than favourably with that of the tungsten carbide type (£22 per pair) when considered on a cost/output basis.

Hard Chroming of Saws

By adopting the technique of hard chrome plating large saws we have achieved spectacular results which avoid the problem of hard tipping and yet increase saw life three to four times.

The chrome is applied as a band about 4 in. wide on the periphery of the saw. About 0.0005 in. of chrome is sufficient.

Sharpening of these saws is carried out by conventional means except that filing is uneconomic. Small hand-held grinders have proved most effective for hogging the teeth and hand abrasive sticks are also successful.

Cutting all types of coastal hardwood including ironbark and brush box at power feeds ranging from 300 to 400 ft/min, saw lives between sharpenings of 9 hr have been achieved. The same saws without plating run 2 to 3 hr. The performance of these saws raises interesting questions on the way in which saws become blunt and these are now being examined.

Discussion

Booth: D.W.T. has been interested in hard facing, particularly for the cutters on planing machines and circular saws, for some years. Progress has been difficult because of the metallurgical properties of saw steels and application of hard "cobalide" type alloys to saw teeth is in abeyance. We are now trying the application of these hard metals to mild steel blanks for the cutters of planing and moulding machines and the results are extremely good. There are no metallurgical problems and there is sufficient strength in the cutter to support the hardened face. The process is simple for anyone versed in welding technique. Results are spectacular and cost is low. For example, with some of the harder New South Wales and Queensland timbers being processed into flooring, 1,500 ft were run with hard steel cutters, while 7,000 or 8,000 ft may be run with hard alloy cutters. Honing is not required in this time and quality of finish is improved. Hard faced cutters have the advantage over tungsten carbide in that they are low in cost and work better in older moulding machines which are in common use. They are robust and self-sharpening, but do not chip - a fault with tungsten carbide. We are continuing work in this field and have applied the material to veneer knives, but not with complete success as yet.

We have applied hard chrome plating on large diameter saws, as a 4 in. peripheral strip on, say, a 42 in. blade, in three large sawmills with a great increase in productivity. Under optimum conditions life may be increased four times, but under poorer conditions as regards saw maintenance life is doubled. This process is extremely important from an economic viewpoint. Saws are best plated when new, but used saws can be plated.

McConochie: Brandons have used this process on the fifth head of a 5 head machine to give a fine degree of finish with no chipping, on runs of up to 13,000 ft. Hard chroming is being used in Queensland by a country sawmill with reasonable success. We have used a hard chrome plated saw with a chisel tooth in our own mill, with very satisfactory results. This was a 42 in. saw, 5 in. chrome band and cost £4 for plating.

Jones: Has D.F.T. tried hard tipping saws with cast bits in the form of rod brazed with a bronze based alloy? These have three distinct advantages over weld deposited tips: heat damage absent if well brazed; low porosity; easier to apply by unskilled men.

Concerning chromium plating, we felt it was possible to get better results at a comparable cost by hard metal tipping.

Booth: We have used hard faced knives in veneer jointing operations and they seemed successful and gave a longer life in radiata pine and soft brushwoods. We have had a 42 in. chrome saw running for 2 months on a power-feed bench. Whereas average saw life was $2\frac{1}{2}$ hr this has been increased to 9 hr. Grinding is carried out on the back and the front. We feel that differences in performance in different mills are due to the saw doctoring. Points to bear in mind are: apply plenty of tension to the saw because of high feed speeds and long running periods; remove saw as soon as it wobbles regardless of bluntness; it is essential to set the saw correctly as running period is long. Only the very tip should be turned over (for setting) with these saws.

We have not tried hard alloy tips. We feel that cost of brazing hard alloy is high and tungsten carbide saw tips in Sydney are cheap - 2/0d. each; therefore, we might as well use tungsten carbide. Hard tips do tend to fracture easily and we feel hard chroming offers greater possibilities.

Galvin: The Forestry and Timber Bureau has tried chain saws with a 4 thou. thickness of chrome. These gave 8 hr cutting. Have you tried a thicker layer of chrome plate?

Booth: No; we have not experimented in thickness. Commercial plating ranges $\frac{1}{2}$ to 1 thou. We plated our own to 1 thou. thick.

McKenzie: I think that a thick plating on the edge would give a blunt edge as a result of self-sharpening. Thus the thinner the plating the keener the edge.

Item 7(d). Problems of Utilization of Logs from Low Grade or Immature Stands

Item 7(d)(i) - Harvesting low grade eucalypt forests

Booth: There could be many advantages in machine grading hardwoods from our large areas of poorer grade logs which are immature, pipey, or otherwise defective, but of high quality species. Such material is difficult to market as scantlings. Grading is impossible visually, but may be practicable mechanically. Species include spotted gum and black blue gum (E. saligna) which has turned black due to fungal stain. This timber is very unreliable in strength - it may look all right but is weak, and vice versa. Selective cutting is impossible because of faults and it can only be cut at random into, say, 4 x 2. This, followed by machine grading, results in reasonable recovery and also results in a high sawing rate. Marketing of such material is not yet complete. The aim is to supply precut framing material for the Housing Commission. If this operation is successful, it will gradually increase the potential supply of timber to the coastal hardwood industry.

Another operational study concerns mobile sawmilling and partial sawmilling in the bush. The presence of the pipe affects markedly transport costs based on log volume, not wood volume. The aim is to transport junked logs on the cheaper flat-topped trucks resulting in a lower cost at the sawmill. This would also prevent a lot of otherwise wasted material being left in the bush. The project is being developed with a sawmiller on the coast and indications so far are promising. We have another project farther north where the same ideas are applied and mobile sawmills are producing sawn timber in the bush. Productivity rates per man hour are comparable with good mills situated in the town. Here the object is to improve the breaking-down process which is carried out with swing saws - a dangerous and slow operation. In spite of this, production per man hour is high. We aim to produce a machine which is safe and has twice the capacity. This will enable the mobile sawmiller and, more importantly, the large miller, to be in a better operating position to harvest this low grade material. The idea is to cut up the logs in the bush, thus removing the pipe and main faults - and bring them into the town mill. We are using linear programing techniques to optimise various factors. We hope by developing an operational research type of approach to these problems we will be able to produce results of economic significance.

McConochie: In one of our plantation areas we faced a problem concerning Eucalyptus grandis which had been damaged by insects. Most of the timber derived from this area was common grade or lower and we have been able to use it in our own projects. We think we could put such material on the market especially for the building trade where it is to be covered up.

Page: In regard to the mobile mills in New South Wales, what range of log sizes can they handle and what is the capacity of these mills? How long does it take to move a mill?

Booth: Log sizes 6 ft to 18 in. diameter. Capacity 1,000,000 ft p.a. Pick up and set down time 2 days, from work stopping to restarting.

Page: What man day production figures are you attaining? What sized products?

Booth: 590 super ft per man day in scantling. Sizes including a small amount of palings.

Page: We have had experience in Tasmania with a firm which was obtaining an overall recovery of 33 per cent. on Hoppus volume. It had decided that, with those low recovery logs, it would be economic to operate three bush flitching mills to supply flitches to the sawmill. In practice, however, it was found that in a significant number of cases the flitching mills merely converted the whole log into three flitches and sent the lot to the sawmill. The firm, therefore, decided to close the flitching mills and are now building a central sawmill. They now face the necessity of transporting the whole logs some 25 miles to the central sawmill for conversion.

Booth: Our situation is different as most of our logs are badly affected by pipe. We are carrying air and the flitching approach is therefore worth-while.

Elsey: Flitching in the bush has been tried in Victoria and the economics of the operation have not been a success. Millers claim that when the logs are flitched in the bush and brought to the mill, the breakingdown crew is idle and the resaw benches oversupplied. The cost on mill skids of producing flitches in the forest is greater than that of flitches obtained by breaking down the log in the mill.

Whiteside: The idea of using machine stress grading for low grade material may have application under New Zealand conditions. What stress levels were considered suitable for this eucalypt material for scantling?

Booth: We are only interested in obtaining two grades, the lower being 1,500 lb/sq.in.: the eucalypt is pretty strong and most is above this. That which falls below is rejected. The overall level of recovery on this basis was quite normal.

Turnbull: We are concerned with design of portable mills and the potential success is tied up with the design of the machine and the degree of mobility in relation to a reasonable cost. Is the mobile sawmill to which Mr. Booth refers a wheeled unit or is it something which is transported? Could he describe its characteristics?

Booth: The results of our operational studies indicate that the organizational factors of a mobile sawmill are decisive. We feel the success of a mobile sawmill is 80-90 per cent. organizational and only 10 to 20 per cent. bound up with machinery. This is why many people have been too concerned with design in the past and failure has been because too little attention was paid to the over-riding importance of the organizational aspect. The mobile sawmills in question are based on the combination of a docker and a bench on the one chassis, which is built up on large hardwood members about 14 in. x 6 in. with road wheels attached. This is only transported on forest roads and road transport regulations are not applicable. The swing saw breaking-down system is completely separate. There is no problem of space for waste disposal in the bush, therefore it is not necessary to design a compact type of mill unless it can be done cheaply and efficiently.

Turnbull: Have you been approached by the Productivity Committee in Tasmania for information on this? They are searching for a suitable portable unit.

Booth: No, but we would be interested and ready to make available information.

Item 7(d)(ii) - Logs from Immature Stands*

Problems associated with the utilization of immature ash eucalypts in two States are being investigated: in each case this work was commenced at the request of the Forest Authority.

An area of interest in southern Tasmania has 130,205 acres of regrowth forest, comprises 79,355 acres designated the "pulpwood" area and 50,850 acres the "reserve" area. The species composition is approximately 80 per cent. *Eucalyptus obliqua*, 13 per cent. *E. regnans*, 4 per cent. *E. globulus* and 3 per cent. other species, while the mean annual growth over the next 80 years is expected to exceed 84 million super ft gross volume.

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*Prepared by M. W. Page.

Forestry and Timber Bureau
Library

At present, logs for milling are being obtained from stands averaging 60-80 years of age and which contain trees averaging about 6 ft girth at breast height.

The Tasmanian Forests Commission wishes to achieve integrated use of this resource by rationalizing the selection of logs for pulping, case milling and general-purpose sawmilling. The details aims of the study are to:

define the minimum size and quality log required for
general sawmilling,
case sawmilling;

assess the reliability of visible surface log characteristics as indicators of wood quality and the practicability of using these features to select logs suitable for various end uses;

decide if the mechanical and physical properties of these regrowth timbers differ markedly from those of the old growth.

Currently a sawmill study is being conducted in Tasmania in which logs of E. obliqua, of certain girths and containing certain defects varying in size and location, are being converted while sawing time, grade yield and the size and distribution of defects in the sawn products are being observed. Analysis of these results is progressing.

In Victoria, regrowth, mainly E. regnans, occurs on an area of approximately 315,800 acres and of this area some 287,000 acres carry regrowth following the devastating 1939 fires. In these 25-year-old stands, three distinct site qualities are distinguishable, the best being heavily stocked with trees averaging 28 in. girth at breast height.

In first thinning operations the intention is to remove 40 per cent. of the basal area: 30 per cent. as trees with girths below 32 in. at breast height and 10 per cent. as trees which are considered desirable to remove, either because of form or position in the forest.

The volume of thinnings will be in excess of that required for pulp and consequently suitable outlets for the remainder are desired.

The work now planned is to be carried out in the Division's sawmill. Its aims are:

to study the behaviour of logs during sawing;

determine the incidence of various defects;

assess the reliability of visible surface log characteristics as an indicator of wood quality and the practicability of using these features of selecting logs suitable for various end uses: at the present time (mid-May) sample logs are being collected.

Discussion

Page: This item is included to indicate our activities in this field, although no results can as yet be presented. In southern Tasmania we have just concluded a sawmill study involving a sample of 200 logs ranging in girth and containing defects varying in location and number in the log. Grading was carried out upon conversion and results are now being analysed. In Victoria, we are about to convert logs of E. regnans in our sawmill to study its behaviour during sawing and to study the incidence of defects. In both these studies we will endeavour to correlate the surface characteristics of the log with the quality of sawn timber.

Item 7(d)(iii) - Flooded Gum and Messmate Stringybark*

Flooded Gum

Plantation grown N.S.W. flooded gum frequently contains pockets of decay associated with branch stubs. Three unidentified brown rots and one white rot were widespread in the material examined. All the decayed areas were associated with mechanical damage. Wood moth attack and faulty branch shed were the most important initiating factors. Decays spread rapidly in both the sapwood and heartwood. Stains due to Ascocybe, Paecilomyces and Penicillum spp. were common.

Six flooded gum transmission poles were treated with creosote at Grafton. Although retentions of the order of 9.5 lb/cu.ft were obtained in the sapwood very little or no treatment was apparent in the areas around the branch stubs. Because of the non-durable nature of the heartwood it was considered that the species was unsuitable for the production of treated poles.

Messmate Stringybark

The defects in Eucalyptus obliqua known as pencilling and brown stain are common in overmature messmate stringybark from the Oberon area of New South Wales.

Pencilling in this timber appeared to be associated with insect attack and did not appear to be an indicator of degrade due to incipient decay. This is a different situation to the "pencilling" defect of jarrah which Tamblyn has demonstrated to be associated with the decay Fistulina hepatica.

Brown stain in the Oberon E. obliqua was invariably associated with one of three types of decay. These decays have not yet produced sporophores but one type is believed to be Polyporus portentosus. At present it is difficult to selectively log so as to eliminate these

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*Prepared by D. Edwards and R. Koirle.

decay containing trees and this has caused a serious utilization problem since the decays render the timber unsuitable for mining timbers. This latter usage is at present the main outlet for timber from this forest.

Mechanical tests on the affected timber did not reveal significant loss of strength compared to clear timber and the wood is regarded as quite suitable for scantling.

We would welcome comment on the utilization potential of these two timbers and on members' experiences regarding pencil streak in other eucalypts.

Discussion

Edwards: I would like to discuss something which comes from the work described, i.e. the extreme importance in utilization work of close liaison between foresters and wood technologists. The work on flooded gum resulted from a mill study by research foresters in our Division of Economics and Marketing. In this study they established there was a significant relationship between instances of wood decay and both faulty branch shedding and insect attack. The question arose as to whether in this plantation-grown species biological control could be used to combat this fungal/insect combination. Our Forest Entomologist surveyed the insects present to see if a silvicultural approach could be made and a parallel study was made of the wood-rotting organisms. If only one insect and one fungus had been involved, biological control might have been possible. Unfortunately, this was not the case.

McConochie: We have found some plantation flooded gum badly attacked by insect and fungal agents. We then decided to compare timber from plantations, in its natural habitat and also natural regeneration. It appears that although some material had decay in dead branches the species in this area does appear to be overcoming and outgrowing it. This indicates, as far as we are concerned, that it may be a site problem rather than a species problem.

Item 7(d)(iv) - Log Grading in Papua-New Guinea

Colwell: It became apparent about 3 years ago that as our log export was increasing, more control would have to be exercised. It could be that we had overlooked the use of grading rules established throughout the world, e.g. by Malaya, Philippines, F.A.O., and these may have been applicable to local material. However, a trial on the basis of those established grading rules showed that in most cases the logs produced by us would have been rejected, so we have had to try to develop our own rules. We decided to have four grades and to make these cover 80 per cent. of the bush, and applicable to all species. The problem is made very difficult by the fact that we do not have many mills producing veneer or sawn timber where we can carry out an assessment on which to base rules. We have produced a set of interim rules for trial but it is unlikely that these will be accepted immediately. In the next 12 months we hope to grade some 12,000,000 ft of logs and to carry out some actual recovery studies in Japan. I would like to enquire whether anybody has had experience with log grading rules. Also, I wonder whether we should endeavour to provide grading rules covering all tropical species. For developing countries the rules must be simple. Also, I wonder whether it is realistic to cover 80 per cent. of the bush with four grades.

Turnbull: I can offer no particular advice, but Mr. Colwell certainly has a problem. I was involved with the preparation of the F.A.O. rules in the Pacific South West region and they were developed from the Borneo export log grading rules. I would be interested to hear whether, in fact, these were used and if they have proved satisfactory.

Colwell: I understand Borneo is at present endeavouring to devise more applicable grading rules because they were not satisfactory.

Turnbull: When Borneo rules were operating, would you conclude that they were picking the eyes out of the forest?

Colwell: Not necessarily. The market is changing; also rules up to now in the Territory have been established with some mythical idea of what is a marketable species and what is a marketable log. Furthermore, some of the important marketable species have been completely left out. This shows how the demand has changed.

Elsey: Grading logs is difficult. We have attempted log grading in a minor way without much success. We are overcoming the problem by making allowances for defects. Current pressure is upon us to make more defect allowances in pine.

Muir: We are attempting to grade logs, but have the greatest difficulty in grading even a single species, let alone several combined together.

Colwell: I have no doubt that what I am trying to achieve is possible, provided sufficient logs are available to get the necessary data. The difficult thing to determine is where to draw the line, say, between the first grade and a second grade veneer log.

Smith: Some of the latest literature from North America indicates worth-while development in the application of grading rules to logs, particularly where they must be applied by people with little training. One particular publication illustrates defects with photographs and provides quantitative data on how the yield from a log is affected by the defect.

Turnbull: A lot of work has been done by IUFRO, who have recently set up a committee to look at factors affecting wood quality. One committee is studying the outside characteristics of logs and relating these to internal quality. I can show you a bibliography applying to this topic.

Page: The work we are doing in Tasmania is aimed at helping the Forestry Commission to determine log grades.

ITEM 8. VENEER, PLYWOOD, GLUING

Item 8(a). Review of Research Activities

I. DIVISION OF FOREST PRODUCTS*

Peeling

Peeling trials of twenty species were carried out in co-operative work with various Forestry Departments. Species included some important timbers from Fiji, Bougainville Is. and the British Solomon Islands Protectorate and were from the following genera: *Acicalyptus*, *Alphitonia*, *Atherosperma*, *Calophyllum*, *Campnosperma*, *Canarium*, *Dacrydium*, *Dysoxylum*, *Endospermum*, *Gonystylus*, *Intsia*, *Kermadecia*, *Myristica*, *Palaquium*, *Podocarpus*, *Planchonella*, *Terminalia* and *Trichospermum*. A comprehensive survey of Fijian species with air-dry density of below approximately 40 lb/cu.ft is near completion. Several species show promise and it appears that most could be used more or less successfully for veneer manufacture.

Some attention was given to the problem of controlling veneer surface woolliness associated with tension wood in *Campnosperma brevipetiolata* and pink poplar (*Euroschinus falcatus*). The effects of most lathe variables on surface woolliness were investigated and it was found that substantial improvement in cutting smoothness could be obtained only by maintaining the veneer knife in a very sharp condition. It was established that woolly cutting in tension wood was due mainly to loss of effective knife sharpness caused by a matting of fibres over the knife edge.

A microscopic study of veneer formation recently undertaken has revealed the mechanism of formation of surface roughness and has

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*Prepared by J. W. Gottstein.

shown that both roughness and severity of peeler checks are distinct functions of wood ray and fibre axis orientation at the knife edge.

In an extension of work on thickness control in peeling, the importance of stiffness of veneer knife profile as a variable affecting the stability of the knife edge in cutting was examined. A mathematical expression for stiffness of knife profile under various support conditions was derived and confirmed experimentally. An analysis of the results of this work has provided the specification of a knife and knife supporting system giving maximum practicable stiffness for the laboratory lathe. Experimental evaluation of this knife system is in progress.

Methods for predetermining figure quality in logs were studied. A rapid and accurate assessment of the quality of quarter cut figure was obtained by taking a 3 in. end section from a log, splitting it radially, and then inspecting the fracture for grain angle, deviation characteristic of ribbon and variations of ribbon figure. Spacing of ribbon bands, lustre, colour and colour variations are also apparent.

Dogging and flitching techniques for semi-rotary peeling were developed in laboratory and field experiments.

An evaluation of qualities of veneer knife steels in terms of their performance in veneer cutting and their mechanical properties and micro-structure has been commenced. Six knife steels tested showed wide variation in performance and properties. Results of work carried out so far have provided a better understanding of the steel requirements for veneer cutting.

Coachwood veneers produced with severe variations in tightness along the grain failed to develop drying splits in our laboratory drier.

Further work was carried out to evolve simple methods to make peeler checks more clearly visible.

The effect of nosebar pressure on radial direction collapse which occurs in thick (1/10 in. and over) ash eucalypt veneers was examined. High nosebar pressures tend to make this shrinkage more uniform, but there was practically no difference in the total drying shrinkages between low and high nosebar pressures. This total shrinkage amounts to more than 18 per cent. with veneer dried to 12 per cent.

Gluing

Tannin formaldehyde adhesives. - Adhesive properties of *Phyllanthus emblica* bark extract were examined.

The relationship between solids concentration of mangrove tannin solutions and viscosity and the gelation rates of a 35 per cent. solution with 8 per cent. formaldehyde over a pH range of 1.5 to 7.3 were examined. Adhesive properties of unfortified mangrove tannin on hoop pine were studied.

The effect of pH on viscosity of a 35 per cent. wattle tannin solution was investigated using sodium hydroxide to adjust pH over the range 4.5 to 11.7.

Species gluing tests were carried out using unfortified and 10 per cent. fortified mimosa tannin adhesives on radiata pine, negrohead beech and mountain ash.

The effect of pH on the pot life of a mimosa tannin adhesive was studied using mixes containing 8 per cent. formaldehyde and 8 per cent. paraformaldehyde over a pH range of about 6.0 to 10.5 and at 25°C.

Gluing properties of *Terminalia brassii* with an unfortified tannin was examined.

The laboratory-developed resistance control methods have been used successfully throughout the tannin bond work.

<u>General adhesive studies.</u> - A change has been made in our gluing work in the past 2 years in that endeavours are now being made to study certain aspects of adhesive synthesis in relation to bond control and bond quality. However, much specific work has been continued.

M.R. control methods for laboratory experiments have been referred to briefly in the previous report. The technique has since been used successfully in the laboratory.

General work has included studies of the bonds obtained using PF resins on coachwood veneers treated with a copper-chrome-arsenical preservative and good results were obtained.

Bonds obtained with PF and UF resins after diffusion treatments of green veneers with ammonium phosphate-sulphate salts showed serious losses in strength.

Catalysed PVA co-polymer resins appear to give stronger and more boil resistant bonds than uncatalysed types. The effects of additive insecticides and fungicides to PF glues showed that at 5 per cent. addition some additives were deleterious, while others appeared to have little effect.

Studies on low temperature bonding of ash eucalypt and tulip oak veneers using a commercial phenolic resin gave difficulties with both dry bond quality and boil resistance.

The effect of different flour extensions on cold bond quality was studied on negrohead beech using a commercial UF resin.

Filled and unfilled PVA bonds were studied in end to side and side to side grain glue joints. Resin with filler gave an inferior result on side to side joints but appeared to be more satisfactory on end to side joints.

Bonding of aluminium and lead to wood was studied with a laboratory casein-rubber latex formulation and PVA, the commercial

PVA gave reasonably satisfactory results, although the casein-latex formulation appeared slightly more satisfactory.

Bonding of galvanized iron to jarrah was studied with a commercial epoxy resin using a phosphoric-acid detergent wash pretreatment. Results were satisfactory, the bond between iron and galvanizing being weaker than that between galvanizing and wood.

The effect of an ellagitannin (myrabolans) on gelation of a commercial phenolic resin was studied <u>in vitro</u>. The general superficial effect on gelation was remarkably similar to that of using lactic acid in a quantity which gave a similar reduction in pH. The overall effect was a slight reduction in gelation time. The effect of various insecticides on pot life and gelation time was also studied on UF resins.

In connection with the high density bonding of solid timber, water absorption rates of wood blocks of a number of species was studied over a range of moisture content from 0 to 15 per cent. Pines appeared to be able to absorb moisture up to 10 times more rapidly, but there are also considerable variations in hardwood species. This work was followed by grooving of high density wood surfaces using Whitworth thread form and at a controlled moisture content to give fairly rapid water absorption.

An approximate doubling of bond strength was obtained using commercial RF resins. In addition there was a much greater uniformity of bond quality. Mechanical grooving apparatus is being developed to extend laboratory work.

Factorial experiments have been carried out on the interactions of glue spread, moisture content, assembly time, pressure and species on area of transfer in pre-pressing of veneers. This has also been related to mass transfer from the spread to the unspread veneer.

Preliminary work has been carried out in relation to this on the development and loss of grip with time and moisture content, glue spread and other factors.

The effect of veneer species, moisture content, assembly time and adhesive on the pH of phenolic glue films was studied. It was shown to be critically important in many cases and it has been found possible to control some of the deleterious effects of long assembly with liquid phenolics and to obtain good bonds after as long as 96 hr assembly with certain controlled additions.

The effect of solids concentration on gelation time of a number of laboratory PF formulations has been studied. A study of the effect of different PF resin formulations on rheological and chemical properties is being undertaken. A number of special phenolic resins have been formulated for major studies on high density bonding and this is being supported by microscopic and electron microscopic studies in collaboration with our Wood and Fibre Structure Section.

Studies of compression of veneers in thick plywood assemblies, simulating hot-press conditions, have given surprising results with nearly 2½ times as much compression occurring in the outer as compared with the inner veneers over normal pressing times.

The possibility of using veneer distortion to indicate the rate and distribution of water absorption from a liquid glue film is being examined.

The effects of resorcinol concentration on the gelation characteristics of a PRF resin have also been studied in connection with our high density gluing work.

Drying

Tasmanian sassafras logs were converted to core veneer thicknesses for evaluation. Blocks peeled cold produced veneers which cupped severely towards the loose side in drying, making handling difficult. Heated blocks yielded veneers which gave little distortion in drying. The steamed blocks showed 3 per cent. more drying shrinkage than cold peeled material, while logs peeled at 160°F shrank 1½ per cent. more than veneers produced from cold blocks.

A field study showed that rotary veneers of ash type eucalypts when peeled 1/10 in. or more in thickness can develop serious radial drying collapse with consequent deleterious effects on recovery, glue bonds, sanding, and general quality. Similar, but much less serious thickness variations of this type have been observed in several scrub species.

A scout study using H.F. heating showed that at a veneer moisture content of 20 per cent. veneers 12 in. x 6 in. could be reconditioned in 15 min while wrapped in a polythene bag. Recoveries were complete and identical to that obtained by steam reconditioning of matched material for 30 min.

In order to examine possibilities further, ash type logs have been peeled in the laboratory to produce veneers suitable for study. Moisture content limits and reconditioning times in steam reconditioning are being determined. Several reconditioning methods including steaming, heating and H.F. treatment will be evaluated.

A simple method of estimating changes in surface smoothness as a result of reconditioning treatment has been examined.

Longitudinal shrinkage studies of veneer have been continued and shrinkage of gaboon, taun, Calophyllum and semi-rotary veneers of red meranti has now been examined.

Stability

The value of a grooved surface for minimizing sinkage difficulties in glued assembly joints between sawn timber and plywood was confirmed in hot and cold pressing, parallel and cross-grain joints and glue spread variables. Optimum moisture content conditions were also determined.

An investigation of some of the stability problems of large hollow structural or decorative panels using thin plywood skins was commenced. Panels were made as 8 ft x 4 ft assemblies using various internal support spacings. Plywood moisture content at the time of assembly was controlled to 5 or 12 per cent. After fabrication using a jig assembly and cold-setting UF resin, the panels have been subjected to repeated cycling conditions over moisture contents ranging from e.m.c.'s of 5 to 17 per cent.

A panel assembled with plywood moisture contents of 5 per cent. and 12 per cent. on opposite sides distorted considerably even at assembly room conditions after pressing. In general, plywood skins which were at 5 per cent. moisture content at the time of assembly have given rise to far more distortion under cycling conditions.

Fire Resistance of Plywood

Further work on vermiculite films has given disappointing results because of the difficulty of handling and applying the film, and the limited decorative value and mar resistance of the finish. Its anti-flame spread properties are, of course, excellent.

One inch thick plywood panels have now been prepared with and without subsequent pressure treatment with fire retardant compounds. Assessment for fire resistance of these panels will include special joint treatment.

Special Application Work

Stressed skin plywood floor panels of several types were assembled for evaluation by the Timber Mechanics Section.

Mechanical Properties

An exploratory study of the effect of peeling tightness and gluing variables on the stiffness of plywood assemblies was made using 3-1/12 in. veneers of blush tulip oak.

Loose and tight peeling, moisture contents of 5 and 20 per cent., and a hot-press UF and a PF glue film showed that 5 per cent.

veneer moisture content at assembly gave noticeably higher stiffness than 20 per cent. in loading both parallel and transverse to the grain direction. At both moisture content levels stiffness was higher with tight than with loose veneers, while at a moisture content of 5 per cent. stiffness favoured the UF rather than the PF film bond.

Pinus radiata plywood assemblies incorporating various natural defects are now being assembled for mechanical property evaluation.

Wood Finishing

The use of the dichromate dip treatment which was satisfactory on green yellow walnut veneer has not proved of great advantage on other species. Attempts to produce bleaching by the use of ultra-violet rays on yellow walnut was not successful.

Exposure Tests

After nearly 8 years' exposure on the Lecture Room both medium density PF overly (Crezon) and madapollam have proved excellent paint bases, giving superior paint life. An unpainted medium density PF overlay (Crezon) is still in reasonable condition. Painted Kraft paper overlays applied with a PF glue film (Tego), but without PF reinforcement, deteriorated severely after about 7 years' exposure. Clear finishes, of course, gave only a short life on this test.

On our weather exposure site at Highett, and also in the weatherometer, both Hypalon and pigmented Tedlar films have behaved very well.

Silky oak plywood was installed at Highett about 18 months ago. This is being reported separately.

II. NEW SOUTH WALES

Progress in this field has been reduced over the period because of the need to concentrate limited resources on other fields of interest. However, the following points are worthy of mention.

Production of Plywood from Flooded Gum (*E. grandis*)

In order to provide alternative uses for this species, which has proved difficult to utilize as sawn timber, we have made serious efforts to produce plywood from it. These have proved successful but the exact economic factors governing the operation are not yet clear.

The species peels readily cold to produce a high yield of first class veneer, from logs graded as select type. Probably a lower quality log can be used than is acceptable to sawmills.

Drying and gluing present no special problem and the resulting plywood is strong, not too dense and of attractive colour.

Providing sufficient logs are available in a given area there is no doubt that plywood of this species could be marketed and promoted. Where quantities are more limited then the species is fully acceptable for use with rain forest species in general purpose plywood.

The gluing properties of this species with all types of adhesive are good.

Cross Linking Type P.V.A. Glues

These glues which set cold to form a waterproof bond are now available in Australia.

Because they hold such promise as easy-to-use structural adhesives, we have investigated their properties fairly thoroughly.

So far we have had uniformly good results and we believe that their future for such applications as finger jointing and minor gluelam products is very good. They are particularly easy to use compared to resorcinols and their chief disadvantages are: the need to ensure adequate cold cure before exposure to wet conditions; short storage life of the basic adhesive.

Weather test pieces broken after over 18 months have shown at least equal performance to resorcinol controls. They give good bonds on species difficult to bond well with resorcinol type adhesives.

Discussion

Whiteside: Two major studies were being completed on the compatibility of waterborne preservatives in glues. One study was concerned only with sapwood of radiata pine and there is no evidence of any loss of immediate bond strength in gluing treated timber. In the second study on a variety of glues, the preservatives used were polyborate, copper chrome arsenate and copper-zinc-chrome arsenate. All possible combinations of these materials were tested and losses of immediate bond strength exceeding 20 per cent. were found in only nine cases. The findings can be summarized as follows: the curing of urea formaldehyde and phenol resorcinol formaldehyde glues is susceptible to interference from high concentrations of polyborate. This may be associated with the alkalinity of the preservative. In all cases where a serious loss of bond strength occurred, joint fracture was characterized by an almost granular appearance devoid of the usual detritus of wood fibre.

Wickett: Referring to the cross-linking P.V.A. glues, are these glues readily available and what is their approximate price? What is their resistance to high temperature, since the ordinary P.V.A. is thermoplastic? How long should they be cold cured and what temperature do they require for satisfactory setting?

Booth: They are made in Australia, having just become available in quantity. The approximate price is 4/6d. per lb. Once setting is completed, they are no longer thermoplastic, and will pass all the tests that a phenolic glue joint will pass. To achieve complete curing after initial setting, they should be stored for approximately 1 week at 65°F, and will cure faster at elevated temperatures. I do not think satisfactory curing can be achieved at temperatures below 50°F.

Page: We have had finger-jointed samples in the weatherometer for approximately 18 months and the results to date are nearly as good as those obtained with resorcinol glues.

Item 8(b). Development and Evaluation of Structural Plywood

Whiteside: Up to the present time, grading of plywood for structural purposes has been based solely on appearance. Our thoughts on structural specifications are based on radiata pine plywood, and this raises several queries. Apparently some of the radiata plywood manufactured in Adelaide from run of the bush logs is directed to the car case market. Does plywood compete favourably with hardboard for utility uses? Has knotty radiata plywood been used for buildings and how have allowable stresses been arrived at? Also, what is the influence of core gaps on the strength of such plywood and can these gaps be reduced to a satisfactory minimum for structural work?

Gottstein: Some work has been done in the Division on the influence of core gaps on the shear strength of plywood, different numbers of gaps being deliberately introduced into the assembly. The specimens were square with 2 in. sides and were tested in the block shear apparatus used for solid timber. Veneers with gaps oriented parallel to the shearing force naturally carried no load, but gaps only slightly reduced the shearing strength if oriented perpendicular to the shearing force. Gaps can be limited to acceptable amounts during plywood manufacture. Because of its price, plywood probably does not compete very favourably with hardboard for some utility uses in Australia. On the other hand it is used extensively for furniture and in formwork; in the latter case radiata is sometimes used for the core veneers and stronger or harder material for the faces.

Very knotty radiata is usually confined to core veneers and an attempt is made to use reasonably clear material in faces. Small knots do have some degree of acceptance in faces in formwork and diaphragms.

We are working in collaboration with the Timber Mechanics Section in evaluating defects and we are including in the experiment material peeled to simulate the effect of sloping grain as well as knots and other faults.

Item 8(c). Veneer Cutting Studies*

Microscopic Study of Veneer Formation

This microscopic study of veneer formation in hoop pine illustrates the mechanism of formation of a major type of veneer roughness and shows roughness and the form and severity of peeler checks to be functions of the transverse anisotropy of wood.

In this work 1/10 in. veneer was peeled cold without a nosebar. Fibres were maintained parallel with the knife edge, but the billet was dogged away from the pith to produce all possible orientations of rays to the knife edge. In this way all cutting situations between quarter cutting and back cutting were produced. Several distinct types of fracture were observed and each was associated with particular orientations of rays at the knife edge. In practically all cases the line of fracture was either along rays or parallel to the growth rings. When either of these preferred failure lines was aligned at a small angle with the cutting plane, as occurs commonly in peeling and slicing, cutting was characterized by a sequence of splits developing from and ahead of the knife edge along the failure line. Splits forming on the veneer side of the cutting

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*Prepared by B. McCombe.

plane constituted peeler checks on the back of the veneer being cut. When a split occurs on the workpiece side of the cutting plane, lifting of the unsupported section of the workpiece directly ahead of the knife causes a deviation of the cutting path. This leaves a furrow on the workpiece surface with the original split either coinciding with or just below the surface. In many cases peeler checks appear clearly as tension failure following cantilever bending of the veneer about the knife edge.

Both smoothness and tightness varied noticeably with ray orientation at the knife edge, and the smoothest and tightest veneer was obtained when the angle included by the ray axis and the knife back was either approximately 10° or 100°. Under these conditions, veneer was free from roughness furrows and peeler check depth was 25 to 30 per cent. of the veneer thickness. Maximum roughness was observed at ray angles of approximately 70° and 160°. With 70° orientation peeler check depth was 60 per cent. to 70 per cent. of the veneer thickness.

Defects of the type shown occur in commercially peeled veneer but severity will depend on how effectively the nosebar is used.

In the film (shown at the Conference) billet diameter was 8 in. and peripheral speed was approximately 3 in./min. The low cutting speed used may have allowed peeler checks to develop more fully, but trials carried out at normal speeds showed that differences, if any, were of a minor quantitative nature.

In the next phase of this work it is proposed to fit a nosebar and show its effects in a similar manner.

Discussion

Smith: It appeared that there was more crushing and checking away from the bands of apparent late wood. I wonder whether similar observations have been made on *Pinus* species and whether that situation does actually prevail.

Gottstein: Hoop pine has a rather sharp differentiation of properties in different cutting directions. Radiata is rather similar in this respect. I would expect, therefore, that radiata would behave in a similar manner; crushing occurs readily with such thin walled cells. As yet we have not carried out this experiment with any other species, but we hope to do so.

Uprichard: Is it possible to fit a pressure transducer to the knife in order to measure forces thereon?

Gottstein: This is tied up with the study of knife edge stability, which we hope to pursue at a later date. In the normal peeling operation, the knife edge is in equilibrium between forces applied to the knife face by the log and forces applied to the knife back through the veneer from the nosebar. A change of knife angle during peeling does have a marked influence on the stable position assumed by the knife edge. A change as small as a quarter of a degree can result in a knife edge movement of several thousandths of an inch and may result in a severe change of power consumption. It may be doubled quite readily.

Blomquist: In our laboratory we have produced a similar film showing the cutting of southern pine, which demonstrates the different cuts obtained with summer wood and late wood. Our officers will be interested in exchanging films.

McKenzie: I would expect that radiata pine would show worse splitting than hoop pine. Also, you have a greater contrast in density between early wood and late wood, and this should give rise to more damage to the good surface.

Item 8(d). Tannins as Adhesives*

Tannin is being used in increasing quantities for plywood in Australia and there has been considerable overseas' interest in the Division's work in this field. A paper on our mangrove tannin investigations has been published and the results of the wattle tannin work are being prepared for publication.

Experimental work on tannin adhesives has been greatly reduced in the past 2 years and in future will probably be confined to occasional tests on new tannins. Because of the improvements achieved in gluing control since the mangrove tannin work was carried out, we recently repeated some gluing tests with this extract. The results fully confirmed those obtained previously, which had indicated that the extracts available were inferior to commercial wattle tannin in adhesive properties.

Some physical and chemical properties of wattle tannin have been examined, particularly the effect of pH on viscosity and on reaction rate with formaldehyde and paraformaldehyde.

The gluing properties of a number of species with wattle tannin adhesives were investigated. Borneo cedar gave a strong bond both dry and after boiling in all tests with an unfortified glue mixture. Other species, including hoop and radiata pines, sassafras, yellow carabeen, white birch, blush tulip oak, and ramin, required from 5 to 15 per cent. fortifying resin for a consistently strong bond.

A limited study of the bark extract of Phyllanthus emblica (from Thailand) showed it to have a remarkably fast reaction rate with formaldehyde, the gelation time of a 41 per cent. solution at pH 4.5 and 25°C being approximately 9 min. In gluing tests a strong dry bond was obtained with coachwood, but wood failure after a 6 hr boil was low.

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*Prepared by K. F. Plomley.

Discussion

Gottstein: Mimosa tannin is being used in Australia for plywood assemblies and Mr. Plomley has already published some of his work in this field. He has investigated the gluing properties with a wide range of species using up to 15 per cent. of a special fortifying resin which he has developed. It appears that most of the commercial species in Australia could be bonded effectively with tannin based adhesives. The economics of tannin adhesives varies with country and the size of the plywood plant; where phenols are low in price, there is nothing to be gained by using tannins but, in Australia, with the relatively high price of phenolic adhesives, very singificant savings are possible. The saving is such that it justifies the additional work involved in preparing the glues, especially in a large plant.

Bryant: I would like to inform the Conference that as a result of action by the Division of Forest Products, the Forestry Commission of New South Wales, and, I believe, the Particle Board Company of Australia, N.Z. Forest Products Ltd. withdrew its application for a patent covering the use of radiata pine and other extractives for adhesives in Australia, and I would like to thank the Division for its action in opposing this patent. I think that had it not been for the alertness of Mr. Hillis and his colleagues, we would have had a patent in Australia which would have restricted the use of these adhesives.

Item 8(e). Gluing High Density Species - Veneer and Solid*

Veneer with Phenol Formaldehyde Resin

Initial tests have been made using silvertop ash veneers and PF resins prepared in the laboratory. Strong dry bonds have been

*Prepared by K. F. Plomley.

obtained readily with this species, but with laboratory formulations similar to some commercial adhesives the bond quality after boiling was very variable.

Exploratory tests have shown that certain variations in glue formulation appear to favour the development of a strong bond under boil test conditions. The mechanism by which this is effected is now being studied.

The results obtained suggest that the use of special PF formulations in conjunction with glue line moisture control may lead to improvement in the bonding of high density species generally.

Sawn Timber with Resorcinol Formaldehyde Resin

The effects of adhesive formulation, priming, surface grooving and sanding, wood moisture content, assembly time and other variables have been investigated in relation to the bonding of some high density species.

The species studied were karri, spotted gum, blackbutt and grey box. Tests were carried out with sawn timber specimens $4\frac{1}{2}$ in. x 1 in. x $\frac{1}{8}$ in. which were glued after the various treatments to give a 1 in. x 1 in. lap joint, or blocks 2 in. x 2 in. x $\frac{1}{2}$ in. were used.

The tests showed a small improvement in bond strength with use of glue primer and by varying the glue formulation, but very substantial increases in failing load and wood failure were achieved by grooving with 20 or 48 grooves to the inch (Whitworth thread form). Sanding gave only a small increase in failing load over untreated controls. Moisture content control appears to be important.

Results are shown in the Table.

The wood failures of these grooved blocks are not as high as those obtained with lap joint specimens, but the failing loads are particularly high and very close to those of unjointed blocks.

It is concluded that a major improvement in the bonding of high density hardwoods with resorcinol formaldehyde adhesives is possible through the extension of the gluing surfaces.

Glue shear tests of grooved and ungrooved blocks (glued area 2 in. x 2 in.) of blackbutt and spotted gum bonded with a commercial RF adhesive

Treatment	Blackbutt	Spotted gum
Ungrooved	62 - 0*	1670 - 0
Grooved	1900 - 14	2595 - 25

*Failing load (lb/sq.in.) and wood failure (%)
Mean of 6 blocks.

Discussion

Gottstein: This work arises from requests made several years ago. We have had bonding troubles with certain veneer species for a long time, and we have prepared a number of laboratory resins which appear at this stage to be rather promising. Again, in bonding solid timber, we are faced with the desirability of making useful bonds on species such as spotted gum, ironbark and blackbutt, so we have done an appreciable amount of work on these species. Absorption rates from water films appear to be about one-tenth those of the lower density species. Further, at moisture content below 10 per cent., water is absorbed from the glue line much more rapidly than at higher moisture contents. We have also tried a number of laboratory synthesized resorcinol formaldehyde adhesives and resorcinol primers with favourable results.

The most spectacular result, however, has been obtained by a modification of a very old grooving technique. Using Whitworth thread form chasers of 20 to 48 threads/in. to make grooves on the mating surfaces of the specimens, it is possible to double the gluing strength with all the resins we have so far tested. This occurs whether the grooves are matched or mismatched. In addition, there is a greatly increased reliability of the glued joint. This is presumably related to having a greater surface area available with a greater moisture absorption from the glue line, and possibly to a large extent to the rheological behaviour of the resin and wood surface.

Booth: We have done some work on the gluing of brush box which confirms that reported by Mr. Gottstein. We think this is effective because of the stress-raising effect in the transition from the high density material into the glue line. By breaking up the surface by grooving you achieve a gradual transition from the timber through the glue line and back into the timber.

Blomquist: We are approaching this problem in a different way. We have done a lot of work on metal bonding for the aircraft industry and one of the things that was pointed out to us was the advantage of adhesives with a lower modulus of rigidity. We have an extensive program on special experimental formulations with controlled lower degrees of deformability to try to get this problem of transmitting stress from the wood to the glue line and out again. We are treating the glue line as another engineering material. We are interested in the problem of gluing lumber at angles to the grain. In applications as in pallet manufacture, you often strike this problem where two adjacent members overlap each other at right angles and the differential shrinkage at the joint severely stresses the glue line. Grooving is an interesting approach to this problem and we may look into it.

Item 8(f). Effect of Peeling and Assembly Factors on Weathering Properties of Plywood Panels*

At present this project comprises 79 silky oak (Cardwellia sublimis) film phenolic bonded panels - half the exposed face of each painted and half untreated. Sixty-seven of the panels have been

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*Prepared by K. Hirst.

exposed on racks at approximately 45° to the vertical facing north at Highett, Victoria, and 12 at Baradine, New South Wales.

Variables investigated include thickness of face veneer (1/32 in., 1/16 in. and 1/8 in.), veneer quality (commercial, intermediate, optimum and over-tight), moisture content at the time of hot pressing (5, 10, 15 per cent.) and "loose" or "tight" side of veneer exposed. Three different paint systems were used - acrylic paint on an alkyd primer, an elastomeric system of neprene and "Hypalon", and an alkyd primer. The last-named was expected to break down rapidly due to absence of undercoat and finish coat. Photographs of panels received from Baradine have not been sufficient to show weathering effects and therefore the following applies to Highett only.

After 2 years' exposure the unpainted parts of the panels have changed to a dark grey colour and appear rough and checked. Analyses show that check width, pitch and length increase with increasing face veneer thickness. Thicker face veneers also have rougher and more furry surfaces than thinner ones.

Surfaces of panels with the loose side out were generally rougher, more furry and had more and finer checks than those with the tight side out. Effect of moisture content at the time of assembly and of veneer quality is not very pronounced, but there is a tendency towards fewer and finer checks at the higher assembly moisture content.

The optimum condition (thin checks and small pitch of checks) occurs with over-tight veneers when the tight side is outside, while with the loose side out it is found with "optimum" veneer quality.

The experiment has shown that surface roughness apparently starts in many instances with slight curling up of the surface near checks. This is especially evident on the sharp angle of oblique checks. Cracks then appear at the base of the curl causing it to break partly away, which gives the surface a furry appearance. Eventually these small slivers break away completely and the edges of the checks are left rounded.

Of the panels painted with the short life expectancy pink primer, all specimens with 1/32 in. face veneer, 63 per cent. with 1/16 in. veneer and 10 per cent. with 1/8 in. faces show fine checks. All primed panels show chalking. There are no signs of chalking of the acrylic paint, but three of the panels with 1/16 in. faces show slight checking. The Hypalon finish shows signs of dirt collection and slight chalking, but there is no evidence of checking.

Discussion

Gottstein: About 8 years ago we started tests using medium density overlays which have shown favourable results. At the same time we decided to investigate the behaviour of different assemblies. Other work prevented us getting all these out into tests, but 2 years ago we succeeded in exposing silky oak (*Cardwellia sublimis*). We added paint primers to some surfaces to delay the onset of surface crazing and to determine the ultimate effects. We also included Hypalon and acrylic paints on the basis of our weatherometer experience.

New South Wales is collaborating in exposing some of the samples although we have not yet had the opportunity of inspecting these. The Victorian exposure tests have yielded interesting results after 2 years and I feel we should inspect the Baradine site as soon as possible.

Blomquist: I would like to comment that I think the work Mr. Gottstein and his staff are doing is very important, and I hope he is permitted to continue it at the same standard.

Item 8(g). Dimensional Stabilization of Wood Veneer as a Means of Reducing Craze-Susceptibility*

Examination of check dimensions and frequency in treated hoop pine and coachwood veneers of assorted thicknesses up to 1/16 in., after 12 months' "weathering" followed by retention in the 5 per cent. e.m.c. room for an extended period, has given some useful guides to the planning of any future work, viz.:

although coachwood has proved to be the more amenable to treatments such as acetylation and cross-linking with formaldehyde, hoop pine, being more subject to checking and with checks more amenable to measurement, would be preferred for actually assessing the efficiency of such treatments;

for similar reasons, thicker veneers should be preferred: however, for practical reasons affecting the actual treatments, it may be necessary to limit thickness to 1/24 or 1/32 in.;

the most promising treatment for hoop pine was acetylation with zinc chloride (1 per cent.) as catalyst;

for coachwood, best results were obtained by cross-linking with formaldehyde, again with zinc chloride as catalyst.

From a detailed study of acetylation and cross-linking with formaldehyde by application to matched 1/48 in. coachwood veneers, the following observations have been made:

best treatment was acetylation with either zinc chloride or pyridine performing equally well as catalyst; after 12 months' "weathering", the most outstanding veneer was

*Prepared by W. E. Cohen.

that on which zinc chloride had been the catalyst; pyridine was effective as catalyst at low concentrations, i.e. 1 or 2 per cent. of the weight of wood treated;

for cross-linking with formaldehyde, zinc chloride was more effective than alum as catalyst;

pre-impregnation with both alum and formalin, each at 1 per cent. concentration, resulted in some measure of reduction in craze-susceptibility, although not quite as much as with acetylation and with cross-linking with only the catalyst pre-impregnated.

Past experience with acetylation with both reactant and catalyst (pyridine) applied in their liquid phases and with the reaction temperature (120°C) below their boiling points, has shown that uniformity of reaction cannot always be achieved because homogeneous wetting of the veneer is not always ensured. Therefore, attempts have been made to apply them in their vapour phases by admitting them to an evacuated and heated reaction vessel containing the veneer. Judged from the reduction in tangential movement thereby achieved, acetylation under these conditions was reasonably successful when applied to 1/48 in. coachwood veneer. However, when applied to 1/24 in. hoop pine veneer, it had no significant effect on dimensional stability. Concurrent trials on cross-linking with formaldehyde but with formic acid as catalyst, were equally unsuccessful.

Apart from having the various agents in their vapour phases, it had been hoped that the exclusion of air by pre-evacuation of the reaction vessel and veneer, would have facilitated reaction within the wood substance (i.e. in the voids) and thereby avoided the "skin" treatment which would otherwise have resulted.

It is obvious, therefore, that hoop pine is more refractory towards dimensional stabilization treatments than is coachwood.

Discussion

Blomquist: I think we have reoriented our thinking as regards stabilization. Dr. Cohen may be interested in the work of Tarkow on surface stabilization. The object is to improve the surface for paint-holding purposes. Tarkow feels that bulk treatment of the wood is rather uneconomical and he is working on surface stabilization.

Cohen: This can be done with overlays.

Blomquist: This is so, but Tarkow is trying to do it directly on the timber surface to improve the surface for a depth of a few fibres.

Item 8(h). The Wood-Glue Joint*

This investigation has not progressed much beyond the position reported at the last Conference. Whereas it had been possible to remove the wood adherend from an assembly consisting of coachwood veneer bonded to aluminium by means of epoxy resin, attempts to dissolve the aluminium so as to set the adhesive film free have not been successful. With either cupric chloride or sodium hydroxide, in most cases the adhesive film disintegrated as the aluminium dissolved. In the few cases where an intact film was isolated, the samples had been taken from parts of the assembly where the bonding had been suspect.

Because it had been shown that the adhesive film remained intact while the wood adherend was being removed, it was decided to work on assemblies consisting of coachwood bonded to coachwood by means of epoxy resin. With thin veneers, the adhesive too readily penetrated right through to their exposed face. Therefore, 10 per cent. of walnut shell flour was incorporated in the adhesive formulation as a means of

*Prepared by W. E. Cohen.

restricting this penetration. Dr. Harada used part of this assembly for his recent electron microscope study of the glue line. Apart from this no further work can be reported at this stage but it is hoped to proceed with the separation of the adhesive film shortly.

No Discussion

Item 9(a). Report of Committee to Co-ordinate Fire-Retardant Test Program*

The last Conference set up a Committee consisting of Messrs. Beesley (DFP, Convener), Cokley (QFS), Edwards (DWT) and Keough (CEBS, co-opted member), to co-ordinate a program for fire-retardant tests.

This Committee held its first meeting at the CEBS on 23rd April 1964, and was attended by all members, with Mr. T. Ryley acting for Mr. Cokley.

At this meeting, Mr. Keough explained the work of the Building Station and outlined the work leading to the publication of SAA No. A.30 - Fire Tests on Building Materials and Structures. During discussion a statement was made to the effect that Madison had claimed that there was no significant difference between untreated timber and timber impregnated with fire-retardants in the time taken to reach mechanical failure under load in a fire. This led to a question on the probable resistance to fire of the denser Australian hardwood building timbers relative to the impregnated timbers likely to be available on the Australian market. This question was of particular interest to both Queensland and New South Wales, where existing legislation required all such treatments to be approved and registered before sale.

The Committee agreed that there was a need for test data on the fire resistance of Australian timbers, that this need was urgent

*Prepared by J. Beesley.

in view of expressed commercial interest and existing legislative requirements and that the Committee's first endeavours should be directed towards fulfilling this need.

The Committee therefore planned a test, the aim of which was to establish the benefits likely to be conferred by impregnation with fire-retardant chemicals and to compare the performance of impregnated timbers with that of some untreated Australian hardwoods commonly used in building. It was considered that if these tests showed that impregnated timbers (mainly softwoods and permeable, low density hardwoods) were not markedly superior to common building timbers in their resistance to fire, the need for devising special tests for the approval, under the Timber Marketing Acts, of fire-retardant treatments would not arise. The Committee noted that coatings applied to timber <u>in situ</u> were not subject to approval under the legislation and did not include them in the test program.

It was agreed that comparisons should be made on the basis of the Early Fire Hazard Index (SAA A.30)* and that tests would be limited to untreated timbers and timbers impregnated with Hickson's "Pyrolith Plus" or Celcure's fire-retardant "Celcure F". Both companies donated sufficient chemical for the whole test program. All impregnations were carried out at the Division of Forest Products in Melbourne.

The complete program involved the Building Station in over 120 separate exposures. The Committee desires to express its appreciation to the Director of the Station for permitting the work to be performed there and to Mr. Keough for his interest and assistance

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*<u>Early Fire Hazard Index (SAA A.30)</u>. Test based on six conditioned specimens or panels, each 24 in. x 18 in. which are exposed to, and advanced towards a radiant panel at a standardized rate. The Index or Early Fire Hazard = $2\frac{1}{2}$ (Ignitability Index + Spread of Flame Index + Heat Evolved Index). The Index may range from 0 to 100, the degree of hazard increasing as the index increases.

in doing the work and helping to prepare a report which is now available from CEBS as "Survey of ignition and early burning properties of Australian timbers".

Discussion

Blomquist: Is there much pressure on the wood industry against fire in Australia? In the U.S.A. the manufacturers of steel and concrete point out the advantages of these materials in resisting fire when compared with wood. The timber industry is studying the problem of fire resistance without publicizing the fact because the more publicity that is given the poorer the public image.

Bryant: We are going to face this problem in the future but, because we have no well-developed lamination industry and because wood is not used structurally to the extent it is in parts of America, the problem is not yet very serious. We have no data on the process which has been patented in Israel of bromination followed by chlorination but the little work we have done on it indicates that it is effective in part, although it does weaken timber such as P. radiata. At least one group of hardboard manufacturers has looked at the patent and has decided to take no action. However, we have arranged for further test material to carry out some joint work with CEBS.

Edwards: The present attitude of CEBS is that if timber is used structurally it should be given the same order of protection against fire as other structural materials, in other words insulation protection is wanted on the outside of the timber. A lot of work has been done on the effect of fires on roof structures and CEBS has come to the conclusion that the efficiency of the fire resistance of a ceiling is a measure of the fire resistance of the roof structure. One thing that concerns us is the multiplicity of fire regulations from State to State and from council to council. In both New South

Wales and Queensland we are faced with the problem of some standard for acceptance of fire retardant treatments under the timber marketing acts.

Turnbull: There is discrimination against timber buildings by insurance companies and this is a considerable handicap the timber industry has to overcome.

Hirst: For some time we have tried to glue Vermiculite to wood but we have not yet succeeded because we cannot use high temperatures. Results are inconsistent with urea glues. Another material "Asbestolux" (calcium silicate-bonded asbestos) has glued extremely well to timber but we have not been able to test it.

Wickett: In Western Australia we are up against a lot of opposition to the use of timber in public buildings, schools, etc., and any work which can be done to change that attitude based on ignorance and prejudice, would be welcome.

Booth: It is essential to understand what the authorities are trying to do in this matter. There is no prejudice against wood as a material by the research authorities or the more informed municipal authorities. The problem of the authorities is twofold. Firstly, they have to make sure people are not killed; this happens in the early part of a fire mainly due to asphyxiation from smoke. Secondly, they want to reduce losses from the fire by ensuring that it is compartmented within barriers of known fire duration. In regard to these points the position of wood is not too bad. The evolution of smoke from combustible materials is to be avoided in the early stages of the fire so that the escape ways are not filled with smoke and people can get out.

In this regard, it does not matter if the wood is impregnated or not; it is a combustible material capable of evolving smoke and therefore cannot be used in main escape ways.

If separated from the fire, wood can do a very good job. In New South Wales, fire rated plaster ceilings, which are widely used in flats throughout Sydney, have succeeded in keeping wood in roof construction and we now have methods of treating flooring to make fire rated flooring for use in warehouses. All this enables wood to be used as a structural material.

With regard to use of wood as a decorative material, although we cannot use it in escape ways, in a multi-storey building there is plenty of other space where it can be used and in most big buildings veneered partitions are used within tenancy areas. In my own work we have found that impregnation of the outside veneers is of no value in prolonging the fire rating of a door. It is necessary to develop a fire retardant treatment which completely prevents the evolution of smoke in the early stages of the fire.

Gottstein: The standards, which have been produced very carefully, explain the difference between the early fire hazard index and the fire ratings.

Harding: Surface coatings would be extremely important in relation to the spread of fire. I would like to see some work done on the decoration of timber as well as on the fire proofing of timber itself.

Edwards: The purpose of this investigation was to explore two issues, firstly to get fundamental information in relation to the three indices which the building station has developed and, secondly, to answer the question as to whether the commercial fire retardants which are offered have any value whatsoever. The authorities in New South Wales are very anxious to get an answer to the second question and the committee has concentrated on this aspect.

Beesley: The CEBS would like a direction from the Conference as to whether or not you would like the work of the Committee to continue.

Boyd: There is full agreement that this Conference wishes to see the work of the Fire Retardant Committee continued.

Item 9(b). The Need for Co-ordination of Applied Research Activities Between D.F.P., T.P.N.G., B.S.I.P. and Fiji*

The developing countries in the Pacific area, including T.P.N.G., B.S.I.P. and Fiji, are all endeavouring to develop their forest products industry.

In order to achieve this endeavour two types of information sources are required: firstly, mechanical and physical properties have to be determined to enable the optimum end use of species and marketing prices to be determined; and secondly, the necessary applied research must be carried out to enable information to be fed to the industry on such aspects as preservation, seasoning, etc.

The Division of Forest Products is presently carrying out work on behalf of these three countries with the object of obtaining information under the first requirement above. I consider that this is as it should be for the following reasons:

these developing countries did not and still do not have the resources necessary to carry out their own basic investigational work;

even if finance and staff at a sufficiently high level became available it would probably take many years to establish a reputation for honest and accurate work.

However, applied research must be carried out close to the point of application of the results on account of the time factor, and also because of the peculiar circumstances existing in these areas calling in most cases for a high level of local knowledge. The Forest Department is presently having constructed a laboratory at Port Moresby with working accommodation for chemists, preservation, entomological, timber identification and structure workers. I think that the possibility of the laboratory being used as a regional establishment should be

*Prepared by J. S. Colwell.

seriously considered, particularly in regard to regional projects under preservation and seasoning headings. Low cost housing investigations could also be a consideration.

The Seventh Session of the Asia Pacific Forestry Commission, Rotorua, 1964, discussed this question of the possibility of assistance in finance and staffing of regional projects. Finance could be available from EPTA funds, U.N. Special funds and F.A.O. Regular Programme funds, if regional projects were submitted.

This is particularly attractive to us in the situation where we have personal and working accommodation but where we cannot get the necessary staff. I would appreciate Conference opinion and support if general agreement is forthcoming.

Discussion

Colwell: The Territories have many problems making development a slow process, but at last in T.P.N.G. we see signs of the timber industry starting to move ahead. However, we face tremendous difficulties in the almost complete lack of technical information and most people in the industry have had no previous experience; hence the problem is accentuated.

We have asked the Division of Forest Products to step up the basic work they are doing, but it is necessary for us to carry out some of the applied work in New Guinea. Up to the present the States have been answering many of the queries concerning our timbers, but we are not at all happy about this as on-the-spot factors cannot be taken into consideration.

We want to establish Port Moresby as the regional centre for this applied work covering mainly the fields of seasoning, preservation and low-cost housing with, if possible, financial and staff assistance from F.A.O. and kindred bodies.

In the past we have made no serious effort to encourage staff to come to the Territory due to the poor availability of housing and the lack of suitable office or laboratory accommodation. However, we now have quite reasonable residential accommodation and by November will have an air-conditioned laboratory building with all facilities. We still need help in getting suitable staff and I am hopeful that members of this Conference will be able to provide some assistance in this regard.

Boyd: The establishment of a regional forest products laboratory in Port Moresby is a development of major significance and great value to the Territory. This move is very desirable, as experience in New South Wales and Queensland has no doubt indicated over the years, and I feel that other States, particularly Western Australia, are also well aware of the value of being able to give proper consideration to the local problems that arise. Because of the contact of this Division with a very wide range of species and special problems of marketing and use, it is considered by many authorities overseas that we are most capable of helping developing countries with their timber utilization problems. Nevertheless, we are not, and can never hope to be, entirely familiar with all local problems. It is highly desirable that there should be a combination of efforts such as those of this Division and those of a regional laboratory to achieve effective promotion of technical development in the area. New Guinea is to be congratulated on putting forward the idea that their laboratory might be developed as a regional laboratory for adjacent Territories with similar problems. I feel sure that this Division will give full encouragement both to the development in New Guinea and also to assistance of other Territories along these lines.

Colwell: This whole matter has been given some prominence by the recent World Bank investigation of the Territory's resources.

The World Bank recommendations are that Australia should be responsible for the staffing of this type of development in the Territory, but I feel there are many problems in the way of this as the Federal Government could not instruct people to go to the Territories.

Turnbull: It has been my experience that many of these F.A.O. specialist assignments leave the local people wondering whether the money spent has been really worth-while. A specialist makes a recommendation on the topic in question, but this is completely wasted unless action is taken to follow up his recommendations. This deficiency has been noted in the past in the forest products field. It would appear necessary for the New Guinea Forest Department first to build up its staff on the forest products side and then, if felt necessary, to seek assistance from specialists in certain fields. We should also be prepared to assist in the training of specialist staff in this Division.

Higgins: I feel that it will be necessary for New Guinea largely to help themselves by developing their own staff for this activity, as have other countries which have recently developed laboratories in this field. We have recently assisted Malaya in the establishment of a pulping laboratory and I am quite sure that we would be prepared to assist in New Guinea in the same way. If it is impossible to obtain trained staff, perhaps local people can be trained, even with the help of this Division, in the appropriate techniques. The work that we are doing for New Guinea at the moment on pulping I feel could be carried out by relatively low-grade technicians, provided that they had suitable training in the techniques involved.

Bryant: I agree with Dr. Higgins that there must be a considerable number of indigenous people who can be trained here in Australia to tackle the problems at the level at which they are most pressing in the Territory.

Colwell: For information, I might mention that we have a technical staff of three in our Utilization Division, but much of the time of these people is taken up in marketing which is also the responsibility of this Division. The Territory is eligible for F.A.O. assistance, but I quite agree that finally we must do our own work. We have our own forestry school in the Territory and we are constantly running specialist schools to improve selected people. However, we still do require assistance and it has been laid down that Australia has an obligation to the Territory. Whether this extends beyond financial obligation I do not know, but I would think so.

Tamblyn: Some years ago the New Guinea Department of Forests had a preservation problem and I was invited to go up there to look into it with them. We did quite a lot of work in the Division and in collaboration with the Department a satisfactory solution to the problem was found.

Arising from that visit some seventy or eighty species, five trees of each, were sent to the Division and we have done durability, Lyctus susceptibility and permeability tests. Also scout tests for mechanical properties have been carried out and certain physical properties determined.

This result derived from a specific request and I suggest that it would be more helpful both to their own requirements and this Division's if their needs could again be defined and specialist help, if required, should be sought accordingly from this Division. It is not sufficient merely to ask for more work to be done. The particular requirements must be defined and the best method of attack worked out. I do not think anyone else has been invited to collaborate on a particular problem since I was in the Territory and it is up to New Guinea to tell us what they need.

Boyd: I agree with Mr. Tamblyn that it would be helpful for the requirements to be outlined, but I appreciate that Mr. Colwell has some fairly big problems. I feel sure that this Division will always be most willing to give him whatever assistance is possible.

Item 9(c). Training in Industry*

The Division became involved some years ago in examining various proposals re training in industry, and is currently associated with action that is proceeding on one of the proposals sponsored by AUS.T.I.S. The council of AUS.T.I.S., after receiving suggestions over some years, convened early in 1962 a Committee on Training which agreed that a course for supervisors and managers of sawmills was overdue, indicated the scope favoured for such a course, and submitted recommendations for the content of preferred subjects to the AUS.T.I.S. Conference in September 1962. The recommendations were subsequently implemented in one State: the Tasmanian Timber Association arranging for the Tasmanian Education Department to conduct a sawmill management course by correspondence starting in first term 1964; the scope comprising 25 per cent. on "Wood, the Material", 50 per cent. on "Production", and 25 per cent. equally divided between "Management", "Accounting" and "Marketing"; the study load approximating 4 hr weekly for 42 weeks annually; and continuing 3 years for a Certificate and another 2 years for a Diploma. The Division accepted responsibility for preparing the whole of the "Wood, the Material" subject and for "Sawmilling" which represented about three-fourths of the "Production" subject. About 42 students enrolled, out of these 10 sat for the 1964 exam in "Wood, the Material Stage I" (8 passed and 2 failed) and 8 sat and passed "Sawmilling Stage I". Other students made different amounts of progress during 1964 without fulfilling the Department's requirements for admission to examinations. Successful examinees are progressing with Stage II of their courses. The Division prepared its lesson texts in form suitable for mailing to students, marked the answers to questions attached to each lesson, and carried out examiners' duties. Preparations for the 1965 program are in hand.

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*Prepared by R. F. Turnbull.

The Hoo-Hoo Club of Melbourne completed arrangements with the Royal Melbourne Institute of Technology for a course in Wood Technology to be started early in 1965. Attendance requirements approximate 52 hr p.a. The responsibility for suggesting the syllabus and providing the lecturer fell to this Division.

In May 1965 the Timber Development Council of Australia conducted the first of its schools for top management in the timber industry. The Division was requested to conduct one day in the fortnight's program; this involving the preparation and delivering of the leading paper on the theme "Timber Movement and Handling", briefing the collaborators, chairing panel discussions, suggesting a case for study and commenting on the resultant proposals from three study syndicates. The T.D.C.A. Committee on Training has drafted an extensive program. At present little of the program has been definitely assigned to instructors and it is not clear what load is likely to fall on the Division or other forest products research laboratories.

While the abovementioned instruction has been developed since the last Forest Products Research Conference, the Division has continued its seasoning correspondence courses. Also the Division has provided papers and speakers at the All-Australia Timber Congress, at the AUS.T.I.S. Conferences, and met requests for numerous addresses at gatherings of timbermen. Additionally it has received groups from T.D.A., Technical Schools, Education Departments and other bodies, all groups expecting to be conducted around most Sections of the Division and to be informed on current investigations. The Division has accepted, for periods of training, technical personnel from some trade associations and from some companies and students from overseas selected under Colombo Plan and other technical assistance programs.

For professional students the Division has the following annual commitments:

Melbourne University - about 80 hr in the subject Forest Products for forestry undergraduates.

- 10 hr on timber in the subject Science of Materials for architectural undergraduates.
- 8 hr on timber in tropical archiecture for graduate architects.
- 3 hr of timber lectures plus a design exercise for civil engineering undergraduates.
- 5 hr on Timber Design for graduates proceeding to Masters Degree in Engineering Science.

Australian Forestry School, Canberra. - 1 week's instruction on forest products.

Victorian Forestry School, Creswick. - 1 week's instruction on forest products.

For practising engineers and timbermen a series of twelve 1-hr lectures on Timber Engineering have been prepared and delivered by Divisional staff over a period of 5 years to large audiences assembled for one series respectively in Sydney, Melbourne, Brisbane, Adelaide and Perth.

The interest in training in the timber industry seems to be greater at present than at any time in the past. Sawmillers' Associations seem anxious to arrange for more training for their members and some companies desire training for their staff.

The need for co-ordination of the majority of efforts on training is apparent to those who are involved in preparing subject matter. Few men can be found who are able and willing to undertake the actual preparations for instruction and so their potential service needs to be spread as effectively as possible. The duplication of effort needs to be avoided. Moreover, courses similarly named should provide approximately the same standard of training regardless of the place where they are given or the person involved in delivering them.

Discussion

Boyd: As Mr. Turnbull has indicated, this is becoming a matter of increasing seriousness so far as this Division is concerned. I do not feel that we should step out from our close association with the universities or assistance to industry, either directly or through educational bodies. I do, however, feel certain that it will be necessary for us to relinquish some of the work in which we are at present involved. At the same time, I think it will be necessary for the State Services and the Forestry and Timber Bureau to encourage technical people to take up and continue some of the services that we have been providing. We cannot effectively handle Australia-wide courses from Melbourne even if we had the staff. It is outside our basic function of undertaking research, but we consider it not unreasonable and, in fact, desirable to do a certain amount, particularly where it is encouraging higher education. We will continue to help in the preparation and outlining of courses that might be given and, in some cases, where it cannot be done in any other way, we will provide specialised lecturers. However, even in such cases, once courses are launched, it is desirable that eventually they be taken over by other lecturers appointed to do the job.

Gottstein: In the plywood field we have been encouraging members of the industry to help themselves, and the formation of study groups in both Brisbane and Melbourne has been most successful. We hope that these will be the basis of giving industry some knowledge of how to help itself.

McConochie: Could the lectures, as given in the Melbourne University, be made available?

Boyd: In general, yes, although we would be a little diffident about these being made available without some control, as they depend for their effectiveness on the presentation and we would not agree to their being published in their present form.

Booth: I would like to compliment the Division on the educational work which it has carried out. I realize that this can be a boring and thankless task. The industry, as a whole, is facing a number of severe problems, the cause of a major one being that the last industry that a bright young person leaving school would think of entering is the timber industry. This means that the problem of training the people we do get is even more difficult, as they find it very hard to learn.

The problem of availability of information can be solved to some extent as was done with the production of the Timber Engineering Design Handbook. This is readily available and one can refer design enquiries direct to it and so save a tremendous amount of time. I feel that, whilst it is extremely hard work to prepare a volume such as this, nevertheless once prepared it would be extremely useful. There is a great need for a book such as Boas to be available to the Australian industry as there is a continuing demand for information on Australian timbers from the Australian timber industry and people do not mind paying for a book such as this, which provides a ready reference. We have struck this problem in connection with educating people to use machine graders. We have developed material on the lines of programed learning in an attempt to get these people to assimilate the necessary facts, and in view of the type of material that we have offered, I feel we should rethink the entire approach to education in the trade. Whilst I know that such efforts detract from research, nevertheless they are so important that they cannot be overlooked.

Boyd: With reference to the comment on Boas, we consider that this has virtually been replaced by the Australian Timber Handbook.

Bryant: In my opinion, it has not been completely replaced as I do not consider the Australian Timber Handbook represents the level at which we would like to see Boas rewritten. This does not mean that the Handbook is not a particularly important addition to our literature on the subject, but in any case, there have been many changes since the last edition was produced.

In New South Wales we have a wood technology group. Its organization was taken over largely by industry and it operates once a month. The level of these meetings varies enormously from a fairly high technical level to promotional discussions between various firms as to the excellence of their products. It is difficult to get our people to take any interest in these meetings because of the possibility of their being involved in an argument and, in general, the technical quality of the meetings is so poor that it is unfair to ask them to attend. On the other hand, it is important that there should be somebody with a technical background present in order to bring some degree of sense to the discussions. Unfortunately, in many cases, the leaders of industry regard education and promotion as synonymous, and this is where it is important for the Division of Forest Products to produce literature for the more technically-minded members of the industry. I feel that the Division has to do this job unless we can find some way in which the universities or technical colleges can take over, but since you constitute the main pool of technical knowledge for the industry, how can the job be passed on to anyone else? The Division must get the personnel to do the job and must fight for more money to make sure that this is possible, and whilst industry cannot solve its own educational problems it can find the money, probably from Federal Government sources, to finance such a scheme.

Turnbull: The existing edition of Boas is very much out of date and at the present time there are moves within the industry which would make one wonder whether a book as comprehensive as this is necessary anyway. In Victoria the Sawmillers' Association has appointed a Promotion Officer and he has worked on a Manual of Victorian Timbers. This Manual has been very well prepared and is due for public release shortly. It has been shown to other interested bodies throughout Australia and the reaction has been to favour similar publications in other States. Industry appears to feel that the responsibility is on them to produce this type of publication. It will serve the purpose and in time there will be less demand for a comprehensive book such as Boas.

Wright: The Division is still involved in the preparation of material for these manuals, and I feel what is really needed to overcome this problem is a whole series of specialised handbooks covering all aspects of the industry, such as one on preservation, one on seasoning, one on sawmilling, etc.

Blomquist: We are facing exactly the same problem in Madison as you have here and, for many years, we have been trying to get out from under. We are fortunate that in many of our forestry schools we have very good wood technology sections that are quite capable of preparing this material with a little help from us. We fully appreciate the importance of education in industry and, until now, this has rested largely on our laboratory.

Marshall: I would like to support Mr. Wright's statement to the effect that handbooks covering all aspects of the industry are an urgent necessity in Australia. We have very few publications to which we can refer students or enquiries and this places a very big responsibility on individuals.

Wickett: I would also like to support Mr. Wright's remarks.

Boyd: I understand that one of the aims of the Timber Development Council is to collect together all the courses that are being presented at various centres and to make them available as a "package line" so to speak, to other centres. However, even in this case, lecturers still have to be found, although the course has been prepared. The State Forestry Departments and the Forestry and Timber Bureau can help very much in this field by making available specialists to ensure an authoritative presentation of the subject. It would be undesirable to leave the presentation of such a course to one who was not basically interested in timber. Whilst industry is becoming more aware of the necessity for these courses it still rests with the technical people to ensure proper preparation of material contained in them.

Item 9(d). IUFRO Meeting

The Chairman gave details of the forthcoming IUFRO meeting to be held at the Division in October. He indicated briefly the fields in which discussion would take place and said that some 50 invited papers were expected.

Item 9(e). Next Forest Products Conference

It was generally agreed that the 2 year interval be maintained.

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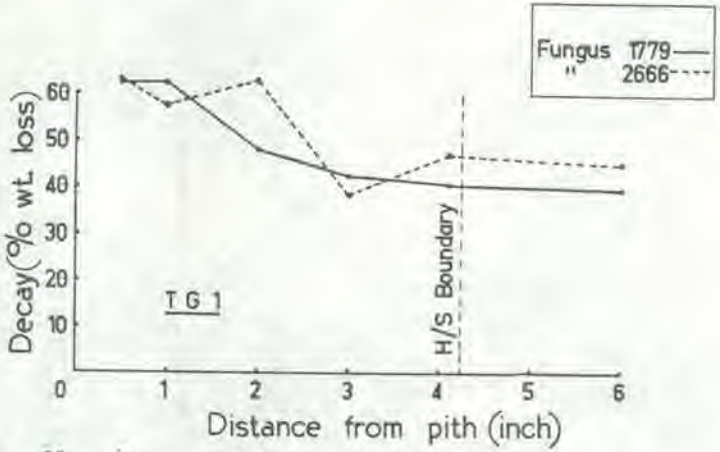
Forestry and Timber Bureau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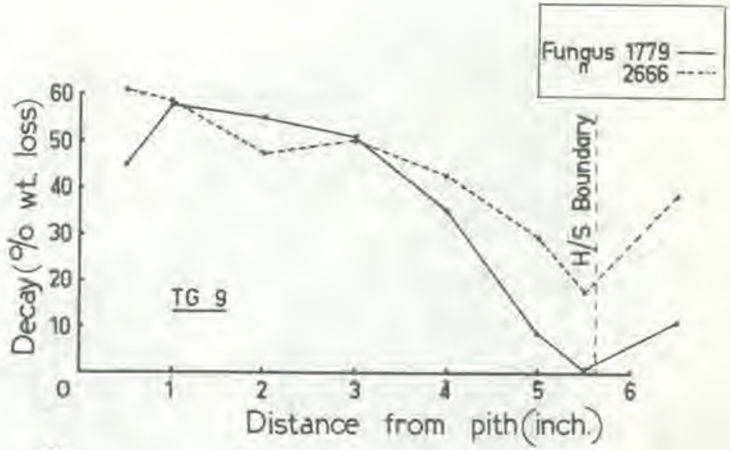
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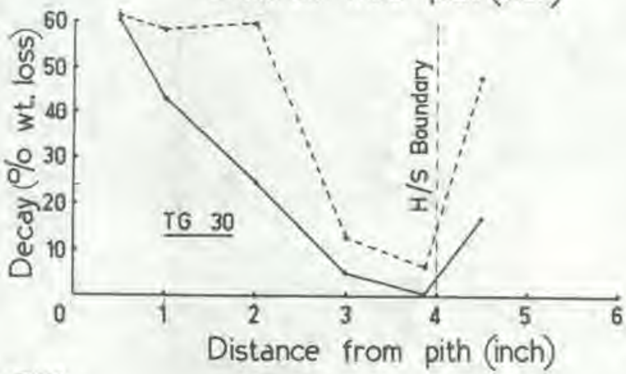
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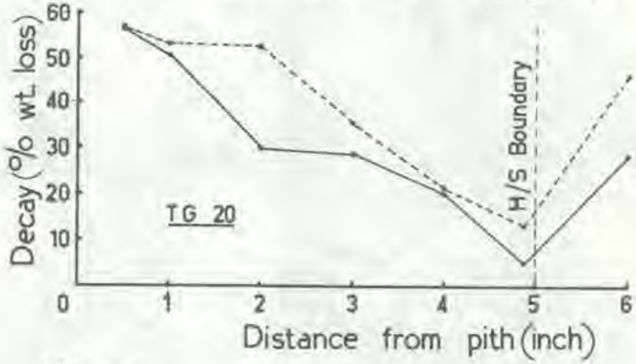
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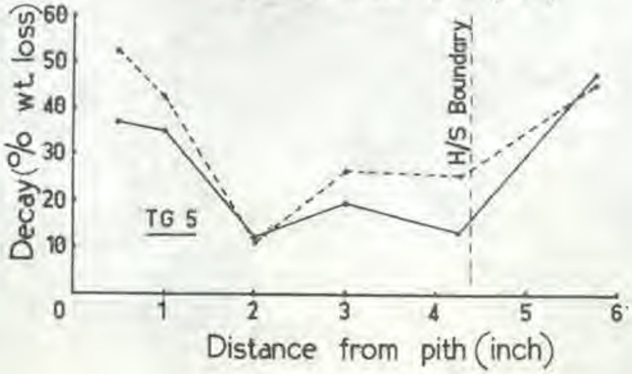
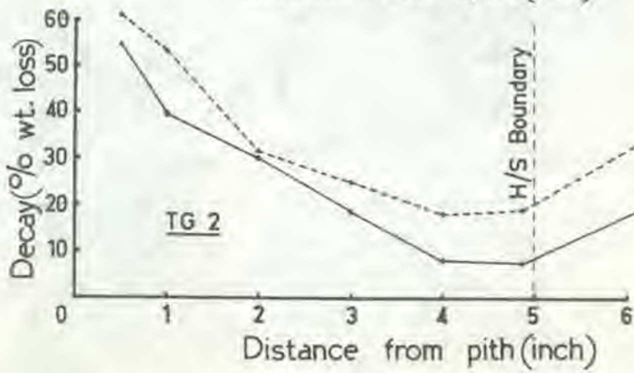
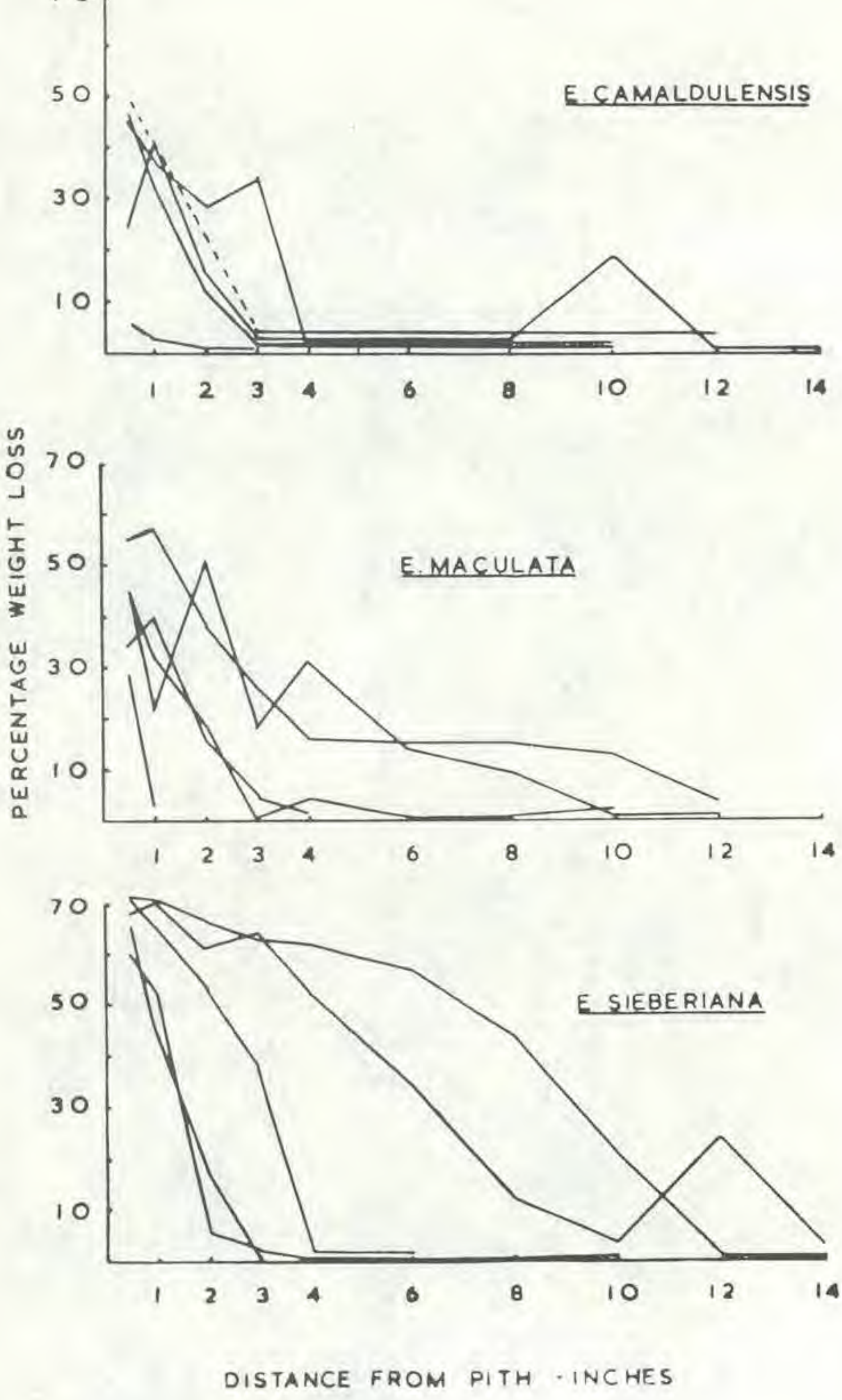
H/S Boundary
Distance from pith (inch)


Decay (% wt. loss)
60
50
40
30
20
10
0
1
2
3
4
5
6
TG 5
H/S Boundary
Distance from pith (inch)


Decay (% wt. loss)
60
50
40
30
20
10
0
1
2
3
4
5
6
TG 2
H/S Boundary
Distance from pith (inch)



E. CAMALDULENSIS
E. MACULATA
E. SIEBERIANA
PERCENTAGE WEIGHT LOSS
70
50
30
10
1
2
3
4
6
8
10
12
14
DISTANCE FROM PITH - INCHES