PROCEEDINGS

ELEVENTH

FOREST PRODUCTS RESEARCH CONFERENCE

HELD AT

THE DIVISION OF FOREST PRODUCTS,

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION,

MELBOURNE

JULY 8 - 12, 1963

REPRESENTATION

Western Australia	-	H. C. Wickett.
South Australia	-	J. Willington, J. H. Harding, J. Thomas.
Victoria	-	C. W. Elsey, A. J. Threader (and others for some items).
Tasmania	-	F. A. Noar.
New South Wales	-	W. D. Muir (Commissioner), L. Bryant, E. B. Huddleston, R. F. Bamber, D. W. Edwards, H. E. Booth.
Queensland	-	T. F. Ryley, K. Cokley, N. McConochie.
Papua - New Guinea	-	Not represented.
New Zealand	-	J. Kininmonth.
Melbourne University School of Forestry	-	A. Leslie.
Forestry and Timber Bureau	-	Dr. N. Cromer, A. G. Hanson.
Division of Forest Products	-	Dr. H. E. Dadswell and officers.
Secretary	-	A. P. Wymond.

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CONTENTS

ITEM 1. WOOD AND FIBRE STRUCTURE

Item 1(a)

Review of Research Activities

I. D.F.P. *

In the Proceedings of the Tenth Forest Products Research Conference a general review of the organization and the aim of the research programme of this Section was given. The work of the Section is divided into six, somewhat arbitrary, lines of investigation and recent work relating to these is reviewed below.

Since the Tenth Conference, Dr. R. C. Foster and Dr. D. S. Skene have joined the staff of the Section. Dr. Foster has commenced work on the cytological changes which accompany cell differentiation with special reference to the origin of crystalline inclusions in cells. Dr. Skene has commenced an investigation into the origin of kino veins in eucalypts. Mr. F. Addo-Ashong of the Ministry of Agriculture of Ghana has undertaken an investigation of the changes of the anatomy and fine structure of wood which accompany its mechanical deformation. Mr. R. Allen of the University of Houston, Texas, who is in Australia on a Junior Fulbright Fellowship has been working in the Section for the past 6 months becoming familiar with techniques used in the study of fine structure of plant cells, and has recently commenced a study of the hygroscopic mechanism governing the movement of scales in pine strobili. In September, Dr. Clinton J. Dawes of the University of California at Los Angeles, will take up studies in fine structure under a Post-Doctoral Fellowship of the National Science Foundation of the United States.

In addition to papers presented to meetings within Australia such as those of A.N.Z.A.A.S., Appita, and the Royal Australian Chemical Institute, contributions have been made to overseas meetings; in particular: the European Tappi (E.U.C.E.P.A.) meeting at Stockholm; the Oxford Symposium on the Formation and Structure of Paper; the Second Cabot Foundation Symposium at Harvard University; the Forest Biology Meeting of Tappi; the Pan-Pacific Conference at Honolulu and the Chicago Meeting of the American Chemical Society.

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*Prepared by Dr. A. B. Wardrop.

(a) Identification of Wood (H. D. Ingle)

During the period under review routine identifications have exceeded 1,100 excluding some 1,000 macroscopic determinations of North Queensland species.

Some work has been done on sectioning and identification of brown coal wood material from the Yallourn and Bacchus Marsh fields. Most of these have proved to be Agathis, though some Phyllocladus and a species resembling Athrotaxis have been recognized.

Examination has been made of thirty-five species of Fijian timbers received by the Division for testing. Full descriptions have been prepared and macroscopic and microscopic cards compiled for these. Duplicate sections from all material have been prepared for the Fiji Forestry Department. In addition, duplicate sections have been prepared for this Department from timbers collected in Fiji by A. C. Smith in 1954 and made available to the Division through the courtesy of the Smithsonian Institute, Washington. These comprise 250 samples covering some 180 species.

(b) Differentiation and Fine Structure
(A. B. Wardrop, R. C. Foster, D. S. Skene, G. W. Davies)

(i) Cell Differentiation

Following earlier investigations of the nature of surface growth in differentiating fibres and tracheids, attention has been directed especially to the surface growth of fibres in species with a conspicuously storied structure such as Papuodendron. The microfibril orientation has been mapped over the outer surface of mature cells and it has been concluded that the region of elongation lies somewhat behind the tip. As in earlier studies, the observations made suggest the operation of the multi-net mechanism in these cells. Previous work on the formation in the secondary wall has been extended to include fibres of tension wood and of phloem. Optical and electron microscopic examination of these cells show that the secondary cell wall is initiated near the centre of the fibres and grows towards the tips. Examination of the cytoplasm has yielded no evidence of the intra-cytoplasmic origin of cellulose.

A study of the cytological changes which accompany formation of crystalline inclusions in cells of a variety of tissues of different species has been commenced. Formation of the

crystals (calcium oxalate) is extremely rapid, and there is little structural change in the cytoplasm of cells before the inclusion is formed. Following the formation of the crystals, however, there is evidence of some disorganization of the cytoplasm often followed by the death of the cell. In many instances the crystals appear to develop around an organic nucleus. The formation of the gelatinous layer of tension wood fibres has been shown to involve the deposition of the microscopically visible band of cellulose with a convoluted form when viewed in cross-section. (Collaboration with G. Scurfield.) After a time this band of cellulose straightens on to the existing cell wall and another band of similar form is deposited. The possibility that these changes are involved in the geotropic recovery of the stem is being investigated.

(ii) Cell Wall Structure

The cell wall organization of tension wood fibres has been further investigated and the types of organization previously recognized in natural material have been observed in experimental material. A number of modifications of cell wall organization which appear to be intermediate between that of normal wood and tension wood have been recognized but require further investigation. Ultra-violet absorbing bands existing within the gelatinous layer have been shown to involve no alteration in the direction of microfibril orientation. Experimentally some degree of lignification of the gelatinous layer can be deduced, and appears to proceed centripetally within the fibres.

An investigation of the wart structure in conifer tracheids has shown that these structures consist of localized thickenings of the inner layer of the secondary wall which have the form of minute papillae protruding into the lumen. In mature cells the thickenings are covered by a membrane of cytoplasmic origin. This membrane arises from the denatured remains of the plasmalemma and tonoplast together with any denatured organelles enclosed between these two membranes. This membrane system covers the entire surface of the lumen and the pit chambers.

The vestures of pits in some angiosperms have been shown to consist of localized elaborations of the middle or inner layers of the secondary cell wall, and in parts of the cell removed from the pits these structures closely resemble the wart structure of tracheids. As with wart structures, the vestures are covered by a membrane of similar cytoplasmic origin. Further studies on the cell wall organization of vessels and xylem parenchyma have been made.

The relation of wood anatomy to the path of penetration of liquids into wood has been further investigated. It has been shown that for heartwood the pathway through the vessels is the ray parenchyma and thence through the pits to the fibres and is the same for both polar and non-polar liquids. Preliminary studies of the movement of the vapour of heavy metal compounds such as osmium tetroxide and chromyl chloride suggests that these follow a similar path.

An investigation of the changes in the anatomy and fine structure which accompany mechanical failure in wood has been made. It has been shown that the application of forces in tension, compression and shear involves rupture of the cell wall between the outer and middle layers of the secondary wall. This is consistent with the known differences in composition, physical texture and microfibril orientation which exists between the middle layer of the secondary wall and the structural complex external to it. It is not considered that the ray parenchyma is of significance in governing the direction of failure in large specimens. An electron microscope study of the nature of slip-planes formed during long-time loading and by compression parallel to the fibre axis has been made.

(c) Lignin and Lignification (D. E. Bland, A. Logan)

(i) Artificial Lignin

Investigations of artificial lignins have been continued. A methoxyl free lignin has been produced on potato parenchyma and shown to resemble moss lignin. Similarly, artificial guaiacyl lignins resemble hardwood lignins. An artificial syringyl lignin has been produced which, as far as is known, has no counterpart in nature. All the artificial lignins may be estimated by the sulphuric acid method except the syringyl lignin which is soluble in the acid. The way in which aromatic nuclei of the artificial lignins are linked is being studied to determine possible methods of linkage in natural lignins.

(ii) Reaction Wood Lignin

Experiments on the formation of reaction wood in seedlings induced by bending stems are being carried out in order to compare the nature of the lignin with that of reaction wood formed under natural conditions. Tristania conferta seedlings when bent formed tension wood which had a low lignin content. The wood opposite

the tension wood had a normal lignin content but the lignin was low in methoxyl. These observations parallel exactly those made on mature forest trees of other hardwood species.

(iii) The Uptake of Copper by Wood

Some of the above fundamental investigations have been utilized in the study of the uptake of copper by wood. It has been shown that for the mechanical lignin the uptake of copper is about 0.4 g/100 g of lignin, compared with about half this amount for methanol lignin, and one-tenth of this amount for cellulose. This is of interest since the toxicity of copper to fungi is known to be much less when incorporated in wood than in the medium of fungal cultures. Many fungi attack the middle layer of the secondary wall where the uptake of copper is much less than in the lignified region external to this layer.

(d) The Study of Cell Contents (W. E. Hillis, K. Isoi)

Earlier work has shown that heartwood extractives are formed at the periphery of the heartwood from stored and translocated carbohydrate. The next stage, namely the elucidation of factors controlling the type of extractives formed, has been greatly assisted by the discovery of mutants of E. sideroxylon containing relatively large amounts of stilbenes in the leaves. With very few exceptions, stilbenes are found only in wood where their occurrence is related to durability in some species, pulping difficulties, and the stability of varnish and paint films. Work has shown that stilbenes are formed in the same general pathway as the more common polyphenols. The evidence indicates that only slight changes are needed to cause a divergence of the pathway to stilbenes.

The kino of E. sieberiana has been studied in detail to obtain data on polymerized leucodelphinidin - labile material which is common in eucalypt woods and is probably responsible for some of the darkening of eucalypt newsprint. The kino of E. hemiphloia has been examined to obtain compounds which occur only in small amounts in eucalypt woods.

The examination of the extractives of New Zealand and Australian Nothofagus species has been continued. The composition of the polyphenols in the leaves of over 130 Eucalyptus species indicates that there is some relationship between the chemistry of the leaves and morphology of the species.

(e) The Influence of Environmental Factors on Growth (G. Scurfield)

A glasshouse has been erected on the property of the Natural Resources League at Springvale. In recent months two growth cabinets providing control of temperature and day length have been installed. Each cabinet has three compartments in which the conditions may be separately varied. Some final parts of the installation are yet to be completed, such as the installation of continuous temperature recorders. Three main lines of work have been initiated. A study of the factors governing the juvenile to adult transition has begun using species of Hakea, Eucalyptus and Acacia as experimental material. It has been shown that the rate of change from the juvenile to the adult form is increased by increased day length and decreased by a decrease in temperature. The associated anatomical changes are being investigated. In addition a study of the influence of environmental factors on the development of lignotubers has commenced and a survey of the reaction of various Australian species to environmental changes is in progress.

(f) Anatomical Assessment of Wood Quality
(H. E. Dadswell, J. W. P. Nicholls)

Work in this project has proceeded under two broad headings, viz. the comparative evaluation of wood quality for selected populations and the investigation of quantitative estimates of inheritance for selected wood characteristics.

In co-operation with officers of the Forests Department, Western Australia, the wood characteristics of material from ten trees from each of four geographic races of Pinus pinaster were examined. Analysis of the results has provided an indication of the extent of variation between these four races. In addition, five trees of Pinus halepensis var. brutia were examined and results compared with those from the P. pinaster trees.

In co-operation with officers of the Forestry and Timber Bureau, Australian Capital Territory, two studies dealing with the heritability of wood characteristics have been completed. Firstly using material from clones and seedlings of Pinus radiata, broad sense heritability estimates were sought. This preliminary work was followed by an investigation on open-pollinated groups of progeny of the same species. Some 495 trees from a 1952 planting were examined to obtain estimates of narrow sense heritability for ring width, late wood content, longitudinal shrinkage, fibre length, basic density and spiral grain.

II. New Zealand

Kininmonth: An investigation has been made of Ladell's method for measurement of tracheid length, in which a tangential section is projected to fall across two parallel lines 0.5 mm projected distance apart. Statistical analysis of results indicate that the method is capable of producing mean values with confidence limits (95 per cent.) of $\pm$ 0.15 mm about a mean value of 3.5 mm. There are some advantages to using lines with a projected distance between them of approximately one-third mean tracheid length. Ideally the distance should be greater, but variability in length is such that the distance is limited by the consideration that it must not be greater than the length of the shortest tracheid.

An investigation of observer bias between six observers each measuring six slides on two separate occasions showed:

(i) Reasonable consistency by individual observers.

(ii) Gross discrepancies between observers, even though periodic checks had been made, and all were operating under the same conditions with the same instructions.

Currently we use two observers to measure each slide independently. If results agree they are combined. Where differences are in excess of one standard deviation the slide is re-measured. Statistically this is a little too strict, but it gives the observers more confidence, and the standard of measurement has improved, because over-caution can sometimes lead to as many errors of observation as a too-casual approach.

III. New South Wales

Bamber: The principal work of our small laboratory is identification. Over the last 2 years we have identified approximately 1,600 samples of timber, a good number of which originated from trade sources, the remainder coming from other sections of the Division. We feel that greater importance is now being placed on identification of species, particularly where there are problems concerning the timber. There has been greater interest in the identification of softwood species due to the changed attitude of the lending authorities. Great reliance is being placed on the D.F.P. card-sorting keys, particularly for the New Guinea and Island timbers which now form a considerable part of the

market. The biggest problems in identification are the eucalypts and long experience is required before one can be positive of the identification; we are interested in the possibility of some form of chemical analysis to assist in positive identification. We are also developing a card-sorting key for the identification of pines based on their needles. This has been worked on by Miss Lanyon and there are now some fifty species represented in the key. It is hoped to increase this to at least sixty to seventy representatives of the genus.

We have also undertaken a minor study on the vessel size and distribution in hardwoods which we class as resistant to Lyctus. The interest in starch content is being continued and at the present time we have an investigation under way on the variation in starch content of Eucalyptus grandis. Investigations have also been undertaken into the presence of silica where excessive dulling of saws has occurred. In connection with the identification of larch and its separation from spruce, we feel that a possible means of identification is the relative ray volume of these two genera, larch having a greater proportion of ray tissue than spruce. The interest in bark has been mained, and also the determination of the properties of Pinus radiata with a view to assessing our plus trees. I feel that our laboratory should be doing more research into wood properties in view of the great practical problems that exist in forest industries. This is emphasized by our recent investigations into the properties of E. grandis where apparently perfectly sound logs from ideal silviculturally planned forests, when sawn up have shown a surprising amount of defect. I feel that lines of research which should be followed here are: the effects of environment, physiology of trees, genetics and within-tree and between-tree variations on density, the formation of gum veins, fibre length, tension wood and susceptibility to various fungi.

IV. Queensland

Ryley: Work in Queensland has consisted mainly of assessing the wood quality of the plus stems used in the seed orchards, one being established at Imbil and one at Beerwah on Pinus elliottii. We are checking on the basic densities of P. caribaea, the oldest of which is 13 years and ranges from Beerwah in the south to plots on the Atherton Tableland. The analyses of this work have not yet been completed, but the basic densities to date range from 21.9 to 31.4; this has not yet been related to the areas in which the trees were grown. We have also checked, for the local building board mill, the basic densities of

six samples of 6-year old Eucalyptus pilularis and E. grandis, the former being 29.5 and the latter 27.8. We have also investigated the occurrence of heart shakes and pitch streaks in P. elliottii. We are doing quite a lot of identification work on New Guinea and Island timbers.

Discussion

Kininmonth: Does Queensland know the seed sources of their P. caribaea?

Ryley: Yes, we can find this out fairly accurately.

Ingle: In view of the large number of Island and other imported timbers coming into Australia, it looks as though there is a definite requirement for a card key to cover these timbers. We are getting a lot of requests, particularly from Technical Colleges and Woodworking Schools in New South Wales, for such a key and I feel that a key covering these timbers would be of more use to them than the Australian key. Another problem at the moment is that we are getting such a large number of these requests, particularly from New South Wales, that we just have not the time or the staff to prepare the required number and we would ask that New South Wales does not recommend it so strongly, particularly to schools.

Bamber: Requests for the key come in quite unsolicited and the Wood Technology Course at the Sydney Technical College is being handled by a man who may not know the problems of producing a card-sorting key. I suggest that he be advised of the difficulties.

Turnbull: What were the defects found in E. grandis logs which appeared ideally grown?

Bamber: There were two types of defect - a large pocket of gum, possibly stimulated by a bark boring insect attack, and another type due to a large wood borer producing a hole of approximately ¾ in. diameter around which rot develops.

Bryant: There is also trouble from included branch stubs which decay and the rot travels into the centre of the tree. The trees in question came from an 80-acre plantation, established by the Commission but used by the Forestry School, and were all selected for vigor and excellence of form. We are very concerned at the amount of defect.

Ryley: We now have an experimental mill and will shortly undertake the sawing of 100 plantation-grown E. grandis logs.

Huddleston: We are very interested in this, and are at present looking at E. grandis critically as we will soon have a substantial quantity of it for sale. We will appreciate any help that can come from the Queensland sawing tests and would like to send an observer.

Wright: Does the fatty layer on the inside of the lumen occur in both softwoods and hardwoods, and does seasoning tend to spread or to crack it?

Wardrop: There is an analogous form of membrane on the inside of all fibres - this is extremely thin and is resistant to chemical attack. It appears to be continuous over the lumen and pit chambers.

Harding: This sort of problem has occurred with some P. radiata posts from the Adelaide hills. Is the explanation tied up with the fatty layer?

Wardrop: We have found no other explanation. It could be the fatty layer.

Harding: Some posts were exposed to blue mould fungi and this helped penetration, as did roughening the outside of the posts.

Item 1(b)

Within-Tree and Between-Tree Variation of Fibre Length, Basic Density and Polyphenolic Materials in Eucalyptus grandis*

Investigations into the wood properties of plantation grown Eucalyptus grandis have been extended to 20-year old trees. This supplements an initial study of 5-year old trees. It has been felt that such a study into wood grown at maximum rate under an ideal silvicultural system should be made as a matter of urgency.

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*Prepared by K. Bamber.

A range of wood properties have been extensively measured some of which will be reported under Item 5(i). Mention will be made here only of fibre length and basic density. The work on polyphenols is not yet complete. Fibre length was selected because of its relationship to paper strength and because of the known shortness of fibre in eucalypts. Basic density was selected because of its relationship to strength and general working properties and polyphenols because of the relationship with colour and probable relationship with decay resistance.

The principal material in this study was 10-, 20-year old trees, representative of the various size classes in the forest and which were sampled at 25 ft levels starting from 1 ft above the ground.

This work has confirmed some provisional results previously reported for 5-year old trees.

(i) No significant relationship between rate of growth and basic density.

(ii) Basic density increases with age of cambium, that is with distance from pith (Duff and Nolan Sequence 2) at all levels sampled.

(iii) In wood of same cambial age but of increasing height (Duff and Nolan Sequence 3) there does not appear to be any highly significant change in density.

(iv) Fibre length shows no effect of rate of growth.

(v) Fibre length increases with increasing age of cambium (Duff and Nolan 2).

(vi) In wood of same chronological age but of increasing height (Duff and Nolan 1) there is no suggestion of a decrease in fibre length and it may, in fact, show a slight increase (to be analysed).

A population study of basic density has been made on 200 trees, 20 years old, from the same site, all trees being sampled in the outer zone in all codiminant trees. These reveal a most surprising range of densities suggesting that the significant influence on density is a genetic one. A comparison of a histogram of these densities with one of 5-year old wood shows dramatically the effect of age.

These results are important for two reasons. Firstly they indicate that fast growth has no significant effect on basic density and fibre length, therefore where these criteria are concerned then the trees can be grown at their optimum rate. Secondly, where these two criteria are considered, due to the fact that they show no appreciable variation due to height, then upper parts of the tree should be fully utilized where diameter is of little importance.

Discussion

Turnbull: Had the 5-year old material attained a commercially suitable fibre length?

Bamber: Mean fibre length in 5-year old trees going from the centre out was 0.62 to 0.81 mm in the inner 1/5 (next to pith). In the outer 1/5 (next to bark) the range was from 0.92 to 1.13. The corrected mean could be in the vicinity of 0.9 mm.

Item 1(c)

Anatomy of Barks of Australian Lauraceae*

Sufficient evidence has been accumulated in recent years to justify the systematic study of bark anatomy to assist in the identification and classification of woody plants. Work along these lines in Australia, despite a promising beginning by R. T. Baker on the Australian coniferae, has been fragmentary to say the least. Two small works on the anatomy of Acacia sp., on oil bearing Eucalyptus sp. by M. B. Welch, and some minor comments by Francis, are the only studies which I have been able to find between 1917 and the important contributions made by Margarat Chattaway in the 1950's. Chattaway's work on the eucalypts, as far as I am concerned, represents the first significant study of angiosperm barks in Australia and serves as a yardstick for future studies both in Australia and other countries. Her second study on the genus Eugenia sens. lat. demonstrates the importance of bark anatomy in plant classification.

While interest in barks has long been maintained at the Division of Wood Technology in respect to various aspects of utilization, it has only been in the last few years that attention has

*Prepared by K. Bamber.

been redirected to anatomical studies. From this attention two studies have been forthcoming, one on the Callitris barks in which the relationship between structure and resistance to jewel beetle attack was suggested, and another study on the Myrtaceae tribe Leptospermoideae in which an attempt was made to compare the anatomy of a number of genera and species. In both these studies keys were devised for the identification of genera and in some cases species.

Consideration is now being given to the important rain forest family Lauraceae and, althought not yet complete, the study reveals to date interesting information. The family appears to be characterized by oil or mucilage cells and by simple sieve plates. The simple sieve plates are considered by various authors on bark to be indicative of a high degree of specialization. Within the family two distinct lines of development have been observed. One, which is characterized by the presence of true phloem fibres, having a rounded appearance in cross-section and with needle like crystals in the phloem parenchyma members of the tribe of Persoideae, and the other in which true fibres are rare or absent, sclereids are common, and crystals are rhomboidal, members of the tribe Lauroideae.

There still remains in our knowledge of bark, large holes which, one is tempted to feel, should be filled if any sort of balance is to be kept in our studies into the Australian plants. It is only when enough of the holes are filled that one can begin to see a pattern unfold, and in respect to bark it is my contention that knowledge of such patterns will be of benefit not only for identification and classification, but also in effective utilization of barks and physiology of trees. The significance of bark in respect to the growth of trees has been given scant attention and is suggested here because of the obvious role played by bark in the protection of the tree from the environment, the storage of starch and the translocation of sugars.

No Discussion

Item 1(d)

Wood Properties of Plus Trees of *Pinus radiata* in New South Wales*

Working with 11 mm increment cores the investigation into the wood properties of plus trees of *P. radiata* has continued. As has been previously reported this work is patterned on the experiments made by the Division of Forest Products and the range of properties examined are spiral grain, fibre length, basic density, per cent. late wood and ring width.

During the year a number of refinements in the techniques of measurement have been made or have been planned. The measurement of spiral grain in 11 mm cores is a difficult task due to the lack of accuracy in establishing a data line from which to base the measurements. It has been decided that in future the angle of the grain on the outside of the tree will be measured and this used as a correction factor for the deflections obtained within the core.

Following a suggestion made by J. W. P. Nicholls (D.F.P.) the technique of marking and measuring late wood and ring width has been improved by the use of transmitted light. As the 11 mm cores do not lend themselves to the cutting of a fine shaving across the rings as is possible with larger cores, a light box which focusses a high intensity light source on a slit, in which the core can be held, has been designed. The late wood only transmits the light thus allowing the ring widths and the extent of the late wood to be either measured direct or marked.

It has been felt that the technique of fibre measurement could be improved by means of a tally counter in association with a fibre measuring device, for where large counts are made the operator must either remember the number or else stop counting so as to record the number. An instrument which successfully measures both the number of fibres and the lengths of fibres has been developed. This instrument utilizes miniature micro-switches which are coupled to electro-mechanical counters. The total cost of materials without labour is less than £25. Use of dark-ground field illumination has made the determination of whole fibres at the 80x to 100x magnification range much easier.

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*Prepared by K. Bamber.

A study has been commenced into the effect of site on wood properties in P. radiata. Six trees from ten differing sites have been received for examination. Concern is felt that if a site variation exists then this should be taken into account where plus trees are being examined.

Discussion

Kininmonth: We have indications, from a study of the specific gravities of all the plus trees in Kaingaroa forest, and a limited study of tracheid length, that the plus trees have similar mean wood properties and a similar range of properties to normal dominant trees on the same site, i.e., within one compartment specific gravity of outer wood is 50 per cent. higher in a "dense" tree than in a "low density" tree. Average specific gravity of outer wood varies from 0.40 to 0.51, according to site.

As the greatest improvement in wood properties can be achieved by improvement of tree form (straightness of stem, branch size, angle, etc.), the only selection for wood properties will be the elimination of trees with very low specific gravity (for the site) or very low tracheid length, and only then if these poor properties can be shown to be present in the progeny.

An exception may be made in the selection of trees for short rotation pulpwood only, if this proves silviculturally desirable. Priority would then be given to vigour, wood density and tracheid length, judged at 15 years of age. Stem form would be of secondary importance.

Tamblyn: We have been impressed with the need to look at the permeability of radiata heartwood as the species will have to be largely treated in the future. If foresters are selecting elite trees, they should give some consideration to whether or not permeability of the heartwood can be bred into trees of the future; it would simplify the preservation of this timber.

Kininmonth: We would like to breed radiata trees without heartwood at all, but we have not tackled this problem.

Chairman: We should breed trees that form heartwood late in life and harvest them early.

Kininmonth: There has been a lot of work done on environmental factors affecting formation of heartwood in radiata.

Bamber: There are now a number of laboratories where properties of radiata wood are being examined, but there seems to be no uniformity of opinion of what we are really looking for, except perhaps longer fibre and greater density. Is there any prospect of standardizing techniques of measurement in the various laboratories?

Chairman: This could be done by greater co-operative effort and more visits by research people between laboratories.

Item 1(e)

The Chemical Constituents of Eucalypt Leaves

Hillis: Currently we are studying some of the factors controlling the formation of heartwood polyphenols by using E. sideroxylon leaves. Leaves, of course, are much easier to use than heartwood for the collection of certain data. E. sideroxylon was chosen from a number of species because it contained the particular compounds in which we are interested. Leaves of other species will be needed for the study of other compounds and the search for the best species has been coupled with another aspect, namely, the application of these data to the taxonomy of the Eucalyptus genus. Professor Pryor and I have examined the data from leaves of 144 species and it appears that the nature of the polyphenols will be a valuable additional criterion in the classification of the genus and the detection of hybridization. To test certain conclusions and to examine a few selected groups of species we will need samples of fresh leaves from a number of species, some of which may not be readily obtainable.

I have taken this opportunity to explain the background behind the work and to ask for your co-operation when shortly I request the collection of certain samples.

Discussion

The States agreed to co-operate in providing material.

ITEM 2. WOOD CHEMISTRY

Item 2(a)

Review of Research Activities

I. D.F.P. *

During the last 2 years the Section has been represented overseas at the 18th International Congress of Pure and Applied Chemistry in Montreal in August 1961, at a Symposium on the Formation and Structure of Paper at Oxford in September 1961, at which two invited papers were presented, and at a Conference of the Australian and New Zealand Pulp and Paper Industry Technical Association (Appita) in New Zealand in May 1962, at which two papers were also presented. In addition papers have been read by proxy to the 10 Pacific Science Congress in 1961 and the United Nations Conference in 1962 on the Application of Science for the Benefit of the Less Developed Areas. Within Australia papers have been presented at the 1962 Appita Conference in Tasmania, A.N.Z.A.A.S. Congresses, and a Conference on Hydraulics and Fluid Mechanics in Perth in 1962. The 18th Pulp and Paper Research Conference was organized and held in the Division in October, 1961.

A senior officer of the Section, Mr. A. J. Watson, was elected President of Appita for 1962/63. One of our Experimental Officers, Mr. K. J. Harrington, is working overseas for a year at the Oxford Paper Co. in Maine, under conditions equivalent to a C.S.I.R.O. studentship. Officers of the Section have been admitted to senior doctorates in the University of Melbourne, and to Fellowships of the Royal Melbourne Institute of Technology and the Institute of Physics. Visitors from overseas have spent various periods working in the Section.

Co-operation with the universities has developed during this period. In particular, a joint project in collaboration with the Engineering School of Melbourne University has now reached an active stage, and the first report has appeared. In addition, seminars have been conducted within the Faculty of Applied Science, Melbourne University, and lectures have been given to forestry students at that University and from the Australian Forestry School. Contact has been maintained with various other University departments on specific research projects.

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*Prepared by H. G. Higgins.

A considerable amount of time has been spent on building up our facilities and equipment. Some twenty rooms or laboratories have been rebuilt or renovated according to our requirements. We have also been concerned with bringing our staff up to its full strength, and Dr. Michell, Mr. Balodis and Mr. Poppleton have been appointed to professional positions in the Section during this period.

The work of the Section is divided into four main groups, and details of their fields of interest are shown below.

Wood Chemistry, Pulp and Paper

Organic Chemistry of Carbohydrates

Constituents of the cambium
Biogenesis and constitution of cell wall polysaccharides
Plant gums

Physical Chemistry

Hydrogen bonding in sugars and polysaccharides
Conformation of pyranoid compounds
Spectroscopy of wood
Retention of pulp strength after drying

Fibre and Paper Physics

Flow of fibre suspensions
Mechanism of beating
Mechanical behaviour of fibres
Fibre flocculation and paper formation
Drainage through fibre pads
Deformation, strength and fracture of paper

Pulp and Paper Technology

Fibre separation
Fibre morphology and paper properties
Fibre chemistry and paper properties
Holocellulose pulps
Pulping potentiatilities of various species
Mechanism of action of beater additives

These activities range over a fairly wide spectra of scientific disciplines and also attempt to bridge, at a few points, the gap between science and technological application. The central interest of the Section is the carbohydrate fraction of wood and its industrial utilization, particularly in the field of pulp and paper. Some specific items have been placed on the Agenda of this Conference, relating to the constituents of the cambium, plant gums, and the pulping potentialities of various species, because we think they may be of special interest to some of the delegates here; these will be dealt with by other officers and I shall not refer to them further.

If you glance down the list of projects you will see that some of them represent an analysis of segments of industrial processes, but we attempt to look at these processes in terms of basic principles wherever that is possible. Other investigations are of a fundamental character, without direct application, and the rest are of a technological nature. I shall attempt to review very briefly, in the order that the projects are listed above, the work that is proceeding in the Section.

(a) Organic Chemistry of Carbohydrates

Cell Wall Polysaccharides. - The aim of this work is to determine the chemical structure of the non-cellulosic polysaccharides of Eucalyptus regnans. This is necessary in order to understand the reactions during the pulping process. Recently we have been making extensive preparations for these studies by the purchase of equipment and the building of laboratories for chromatography and other purposes, and as these preparations are nearly finished, we are looking forward to considerable activity in this field during the coming period.

(b) Physical Chemistry

Hydrogen Bonding. - The covalent structure of cellulose has been known for more than 30 years, but little precise information is available about the pattern of hydrogen bonding which maintains the chains in their specific relationship to each other. One can obtain information on this topic by a direct examination of oriented cellulose films in infra-red radiation, and in particular by studying the dichroism of particular absorption bands, or one can approach the problem by the study of smaller molecules analogous with cellulose. Both of these approaches are being followed. In the study of hydrogen bonding in materials such as glucose, xylose,

cellobiose and other derivatives, the fine structure of the hydroxyl stretching band, examined under high resolution, provides information on the strength and position of specific hydrogen bonds. Such studies have been carried out on the material both in the form of crystals, in which inter-molecular bonds predominate, and in dilute solution, where only intra-molecular bonds can persist. This work has been facilitated by the recent availability of X-ray determinations of the crystal structure of some of the more important compounds. It is intended to extend the infra-red work to an examination of the dichroism of single crystals and the attachment of a micro-illuminator to the infra-red spectrometer has shown that this approach may be feasible.

Conformation of Pyranoid Compounds. - In association with the work just described, proton magnetic resonance spectra of some of the pyranose sugars and their derivatives are being studied. In particular, the chemical shift of the nuclear magnetic resonance signal due to the anomeric proton, and its coupling with the proton on carbon atom 2, have been examined for various sugars. In an attempt to resolve certain anomalies, the chemical shifts have been compared with those predicted from a consideration of the effects of the magnetic anisotropy of all bonds in which ring atoms are involved. Certain features in the spectra are closely related to the conformation which the pyranose ring can assume.

Spectroscopy of Wood and Paper. - A technique which originated overseas for embedding thin wood sections in pressed potassium chloride pellets for infra-red examination has been perfected, and sections of Pinus radiata and Eucalyptus regnans have been treated with hydrochloric acid and sodium hydroxide, and with sodium borohydride, at various concentrations and in various sequences. It is hoped to interpret the observed effects in terms of the lignin-carbohydrate relationship, which is of course one of the basic problems in wood chemistry. Recently an attenuated total reflectance attachment has been obtained for the infra-red spectrometer, and a survey of its applicability to the identification of paper coatings is in progress.

Retention of Pulp Strength After Drying. - Consideration of certain basic concepts leads to the conclusion that under some conditions encountered by the pulp and paper manufacturer, some of the inter-fibre hydrogen bonds formed will be irreversible. An example of the particular significance of this phenomenon is the loss of potential strength of pulps subjected to an intermediate drying stage for purposes of transport or storage. A study of

means of overcoming this strength loss has been undertaken, and promising results have been obtained under laboratory conditions. This work has formed the subject of a patent application, and the more economically attractive treatments are under industrial test.

(c) Fibre and Paper Physics

Flow of Fibre Suspensions. - Initial work was carried out with laboratory viscometers on the effect of fibre properties on the flow of suspensions, but it became apparent that, in order to translate the results into engineering terms, experiments on a larger scale would have to be conducted. Arrangements were therefore made with the University Hydraulics Laboratory to set up equipment for studying the flow of pulp suspensions through pipes, and a senior lecturer and a Ph. D. student are now engaged on this work, in collaboration with us. The aims are to obtain accurate data on the friction losses of hardwood pulps over a wide range of concentrations, and to elucidate the way in which the intrinsic fibre properties influence friction losses and the flow mechanism.

Mechanism of Beating. - In a contribution to the Oxford Symposium in 1961, primary beating effects, including internal and external fibrillation, the production of fines and fibre shortening, were defined and a discussion, illustrated by experimental data, was presented of their relationship to fibre properties, properties of fibre-water systems and paper properties. A study has also been made of the behaviour of radiata pine pulp in the P. F. I. mill. The optimum beating conditions have been defined in terms of stock concentration, beating pressure and the relative speed and the clearance between the roll and the housing.

Mechanical Behaviour of Fibres. - Apparatus has been constructed for measuring the stress-strain characteristics of individual wood fibres. The stress generator consists of a permanent magnet in which a stabilized current produces a proportional force, and in this way forces of from a few mg to about 100 g may be applied. The strain detector is a modified transducer consisting of an inductive displacement pickup in conjunction with a direct measuring bridge. An X - Y recorder has been fitted to the apparatus. Another aspect of the mechanical behaviour of fibres in which we are interested is their flexibility, and we have acquired an instrument developed by the Pulp and Paper Research Institute of Canada in which flexibility may be measured by observing the shape of orbits taken up by individual fibres in a shear field.

Fibre Flocculation and Paper Formation. - This project is a new one and, as yet, attention has been directed mainly to theoretical aspects. A method of measuring paper heterogeneity by means of beta rays is being explored.

Drainage Through Fibre Pads. - Consideration has been given to various theories of flow through porous media, and in particular we have considered the relative merits for pulp of capillary and drag models. Experiments have been carried out with beds of glass spheres, representing a rigid material, with foamed plastic (elastic) and with pulp (viscoelastic). The glass spheres give good agreement with the Kozeny-Carman equation. The foamed plastic gives a high Kozeny constant but agreement with the Emmersleben drag equation is satisfactory, as it is for pulp.

Deformation, Strength and Fracture of Paper. - Rheological work on paper has been proceeding for several years but lately there has been a greater concentration on strength and failure phenomena. Two aspects have received attention. The question of the relative importance in inter-fibre bonding of lateral conformability of the fibre and of the degree of external fibrillation has been resolved by means of an experiment in which conformability could be varied while external fibrillation was kept constant, and vice versa. This showed that the conformability of the wet cellulose fibre is in fact the dominant molecular factor in inter-fibre bonding and its associated strength properties, but that external fibrillation may contribute to tearing strength, which is not primarily dependent on bonding. A study of methods of determining fracture has shown that a fracture theory for paper, based on stress-strain constants and fibre dimensions, might be developed in terms of the Griffith crack theory. A theoretical study has indicated that various apparently independent methods of evaluating fracture energy are in fact the result of solving Griffith's equation under different restrictive conditions.

(d) Pulp and Paper Technology

Fibre Morphology and Paper Properties. - Various morphological factors influencing paper properties have been examined, including fibre length, cell wall thickness, length: diameter ratio and micellar spiral angle. Of these, cell wall thickness has been found to be of prime importance, as might be expected on the basis of its effect on fibre conformability. Fibre length is of particular importance in relation to tearing strength, and micellar spiral angle mainly influences the stretch or extensibility

of the paper. The length:diameter ratios appear to be largely irrelevant to paper properties except insofar as the individual effects of length and diameter are concerned.

Fibre Chemistry and Paper Properties. - A considerable amount of work has been carried out on the influence of the non-cellulosic polysaccharides on pulp and paper properties. Chlorite holocellulose has been extracted with various solvents with the aim of isolating the effects of physical changes which may be brought about by the extracting medium, e.g. alkali, from the chemical effects brought about by the removal of the hemicelluloses. These studies are of economic significance in respect to the possibility of obtaining pulps of higher yield and better strength than the normal chemical pulps. Experiments have also been carried out with chemical pulps, the properties of which have been modified by treatment with alkalies, electrolytes and dyes. The effects have been evaluated and interpreted in some detail.

Holocellulose Pulps. - An investigation of the properties of holocellulose pulps has been carried out with the aim of exploring their possible economic utilization and of determining the effect of fibre composition on beating response, water retention and inter-fibre bonding. It has been found that fibre separation is strongly influenced by pH and temperature. A maximum was observed in the pH versus ease of fibre separation curve at about 6.7.

Beater Additives. - A study of beater additives has been commenced, with emphasis on the mechanism whereby they influence paper properties. Initial work has been concerned principally with starch and a study has been made of the dependence of paper properties on degree of starch dispersion, starch retention and beating. It was found that bonding could be improved up to the point of maximum size of starch granule. An examination of the system starch-fibre-alum has been commenced and attention is being paid to adsorption and flocculation processes.

II. New Zealand*

(a) Alpha-Cellulose by the Chlorite Procedure

The chlorite procedure of Wise and co-workers has been modified so that it can be used for the routine determination of "cellulose" in samples of Pinus radiata D. Don, or other timbers.

*Prepared by J. M. Uprichard.

Earlier work had shown that when five-ring group samples of a disc of P. radiata were delignified by the method of Wise, and the holocelluloses so obtained were then extracted with 17.5 per cent. sodium hydroxide to yield alpha-cellulose preparations, an increase in alpha-cellulose content was observed over the first ten to fifteen growth rings from the pith: in subsequent growth rings there was little change in alpha-cellulose content with ring-group from the pith. Since these results were similar to the results obtained by Dadswell, Watson and Nicholls, who used the semi-micro Cross and Bevan procedure to investigate the variation in cellulose (resistant carbohydrate) within trees of P. radiata it was decided to further investigate the chlorite procedure.

In the Wise method a delignification temperature of 70 - 80°C is recommended. It was soon found temperature markedly affected yields of holocellulose and alpha-cellulose. Thus a delignification temperature of 80°C gave an alpha-cellulose yield of 46.5 per cent. based on oven-dry wood, the corresponding yield at a temperature of 72°C was 51.4 per cent. Since the type of analysis envisaged was comparative rather than absolute, a temperature of 76°C was used in all determinations. The number of chlorite treatments required was also briefly investigated; in the example given above the samples were given five treatments with sodium chlorite-acetic acid at intervals of an hour between treatments. The results which showed that any increase in the number of treatments over those required to yield a chlorite holocellulose with a Klason lignin content of some 2 per cent. (five to six treatments) merely effected further loss in carbohydrate, are in agreement with the reports of other workers who have examined holocellulose preparation (Erickson). Since, moreover, residual lignin present in holocellulose was subsequently removed in the alpha-cellulose isolation a five treatment schedule therefore became standard procedure. Further improvements in the method resulted from the addition of sodium chlorite as a 27.75 per cent. solution rather than in the solid form; in all experiments acetic acid was added as a 25 per cent. solution. At this stage the quantitative determination of holocellulose was discontinued, and the isolation of alpha-cellulose from air-dry holocellulose (in situ on a sintered glass crucible) became standard procedure. Finally, since the addition of both reagents to an aqueous suspension of wood-wool proved tedious, an aqueous sodium acetate-acetic acid buffer (pH 4.7 - 4.8) was employed as reaction medium rather than water, and sodium chlorite only was added at each hourly treatment.

TABLE 1

Ring-group from pith	1-5	6-10	11-15	16-20	21-25	26-32
Per cent. alpha-cellulose	45.3 45.3	50.3 50.4	53.9 53.1	54.7 54.5	55.3 55.7	55.2 55.2

(Single tree - breast height disc)

Results obtained on a standard sample of radiata pine sapwood over a period of a year were as follows: 51.8, 52.0, 51.8, 52.3, 52.3, 51.8, 52.3, 52.2, 52.8, 52.3.

(b) Wood Properties of P. radiata

In pulpwood assessment studies, five 35-year-old trees of P. radiata from the same site in Kaingaroa Forest were examined for their within-tree variation in cellulose content. Tree sampling was by means of discs taken at every fifth internode (from the stump); within-disc variation was examined using five-ring group samples. In this investigation the extractive and lignin content of samples were determined; the samples were further characterized by measurements of wood density and tracheid length. For three trees pentosan distribution across the fifth internode disc was determined as a measure of between-tree variation; variation in pentosan content at all levels in one tree was also studied.

As found by other authors, cellulose content increased rapidly over the first ten to fifteen growth rings from the pith (Table 1); there was, however, little variation in chemical composition between-trees, when whole tree average values were compared (Table 2).

TABLE 2

Tree No.	Diameter O.B. (in.)	Tree Average Value		
		Alpha-Cellulose	Lignin	Density
1	18.2	50.6	27.1	0.404
2	14.0	49.9	27.1	0.417
3	24.9	50.1	27.8	0.387
4	21.4	49.9	26.8	0.414
5	22.3	49.7	28.0	-

Despite the considerable variation in cellulose content at a given level in the tree, on this site at least there is little between-tree variation. As far as pulpwood is concerned it seems certain that tracheid length and cell-wall thickness (related to density) are the most important variables, chemical composition being of secondary importance.

It was found that the pentosan content of the five growth layers near the pith is higher than that of the outerwood at the same level. It is of interest that there is an increase in pentosan content with height in the tree; there was little difference in pentosan content on a between-tree basis (three trees).

(c) Larix decidua and L. leptolepis

Two trees of L. decidua and L. leptolepis (40 - 50-year-old) were examined for their extractive content in connection with wood density studies of these species. It was found that methanol was a suitable solvent for the removal of polyphenols (taxifolin and aromadendrin, etc.), but that further aqueous extraction of the wood (to remove arabogalactans) was required in order to remove all these extractives, which are present in larch heartwood in the lower position of the tree, and which make an appreciable contribution to the apparent wood density.

The optical density of methanol extracts of larch heartwood, at appropriate dilution, proved a convenient measure of polyphenol content, and was therefore used to study the distribution of polyphenols within a disc of larch heartwood using single ring group samples. Polyphenol content of heartwood showed a steady increase with ring group from the pith as far as the heartwood-sapwood boundary.

III. New South Wales

Huddleston: In the Division of Wood Technology, we have two chemists assisted by three laboratory assistants and they are kept very busy by industry. The staff of five has to carry out all chemical work for the Division, including work on analytical methods of preservatives. The Chemistry Section also has to assist the field staff of the Commission in many other activities such as formulation of rabbit repellents and soil analyses.

No Discussion

Item 2(b)

Pulping Properties of New Guinea and Western Australian Species, and of Plantation Grown Pines*

(a) New Guinea Species

Chemical, semi-chemical and mechanical pulps have been prepared from Anthrocephalus cadamba. Yields were satisfactory and the chemical pulp (made by the sulphate process) was almost equal to commercial eucalypt pulps in its papermaking properties. The semi-chemical and mechanical pulps were less satisfactory.

(b) Western Australian Species

Pulping and papermaking studies to supplement earlier work have continued on jarrah, karri and marri. Sulphate and neutral sulphite pulps have been made from sawmill offcuts of both jarrah and karri. The pulps obtained were slightly inferior in papermaking properties to those made earlier from thinnings of these two species. It is considered that the inclusion of slabs from near the centre of the tree could have been responsible for the poorer pulp quality.

Pulps were also prepared from mature logs of marri. The results indicated that the results obtained earlier on a rather limited sample were typical for this species. The pulp was similar in papermaking properties to that obtained from jarrah and karri sawmill waste.

(c) Plantation Grown Pines

P. radiata. - Pulps have been prepared from slow, medium and fast-grown thinnings. In all cases good yields of pulp with good papermaking properties were obtained when cooking by the sulphate process. As would be expected from young wood, the pulps had good strength properties in the unbeaten state and showed a relatively small response to beating.

Mechanical pulps were also prepared by treating chips in the laboratory Bauer defibrator. In all cases good quality pulps, comparable with the best commercial groundwood from mature trees of this species, were obtained. However it was found that

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*Prepared by A. J. Watson.

the different types of thinnings gave the best results when the Bauer treatment was modified to suit each type of wood.

P. pinaster. - Seven trees of P. pinaster have been pulped by the sulphate process. The yields were slightly lower (1 to 2 per cent.) than those obtained from P. radiata. Work to date on the papermaking properties of these pulps have shown that the tearing strength is somewhat higher than for similar pulps made from P. radiata but that the other strength properties are slightly inferior. Mechanical pulps made in the Bauer defibrator also had slightly poorer papermaking characteristics when compared with P. radiata.

Discussion

Bamber: Was the sulphate pulp from very fast-grown radiata inferior to that from slower grown?

Watson: On this batch, yes, both in yield and strength, but this could have been due to more fibre damage during beating.

Turnbull: There is a machine which produces chips from the circumference of a billet rather than from the ends. Would this method enhance the prospects of producing pulp from the material you have investigated?

Watson: We have not done any work on this aspect. Damage caused during chipping can seriously degrade pulp, particularly sulphite pulp. We use sawn chips to avoid the problem of fibre damage, which is largely uncontrollable. There has been considerable interest in chipping methods over the last 10 years, the problem is usually not to produce a better chip, but to improve power consumption and recovery. It is also directed towards speeding up the pulping process by having chips that are easily impregnated and from which extractives are easily removed.

Item 2(c)

Chemistry of Plant Gums and of the Cambial Zone*

Our main interest is with the cambium and its derived products:

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*Prepared by C. M. Stewart.

(i) Cambial and neighbouring zones, particularly the inner phloem and the developing sapwood.

(ii) Carbohydrates of the cell wall, particularly the non-cellulosic polysaccharides.

(iii) Carbohydrates of abnormal origin, i.e. the plant gums which are exuded when the cambial area is either wounded (mechanical damage or insect attack) or is subjected to abnormal conditions consequent upon drought, etc.

The following are, in brief, some aspects of items (i) and (iii).

The chief nutrients of the cambial region are those excess photosynthates which are exported by the photosynthesizing cells of the leaves and then transported via the sieve tubes of the inner phloem to the cambial zone where they are utilized during the formation of the cell walls on the one hand and the exudates on the other hand (and, of course, for the formation of extraneous materials).

Cambial Chemistry. - In the case of Eucalyptus regnans we have examined, in a preliminary manner, the ethanol-soluble components of the cambial zone (young differentiating xylem).

Materials soluble in 80 per cent. ethanol	≡	50 per cent. of dry weight of cambial zone
Basic portion	≡	8 - 9 per cent. of solubles (Retained on Amberlite IR120)
Acidic portion	≡	c. 30 per cent. of solubles (Retained on Duolite A4)
Neutral portion	≡	c. 60 per cent. of solubles (Passes both IR120 and A4)

The Neutral Fraction

Sucrose	32 per cent.)	
D-Glucose	29 per cent.)	> 93 per cent.
D-Fructose	24 per cent.)	
myo-Inositol	>8 per cent.)	

The Acidic Fraction

Tartaric acid)	
Citric acid)	Krebs cycle acids
Malic acid)	
Glucuronic acid	
Gallic acid)	
Ellagic acid)	Extraneous materials
Ellagitannins)	

The Basic Fraction

Inorganic cations as chlorides

It is thought that sucrose is the chief translocated carbohydrate of the inner phloem; the relatively large amounts of D-glucose and D-fructose are formed, no doubt, by the hydrolysis of sucrose in the cambial zone. It has been suggested that myo-inositol may function as a phytohormone or as a precursor for uronic acids and/or aromatic compounds.

The ethanol-extracted residue was extracted with water at 50° to yield an ethanol-insoluble polymer (4 per cent. of residue); the material soluble in ethanol contained no carbohydrates. The polymer, during hydrolysis with dilute mineral acid, yielded galacturonic acid and the following neutral sugars:-

L-Rhamnose	-	)
D-Galactose	49 per cent.	)
L-Arabinose	33 per cent.	) >91 per cent. of neutral fraction
D-Xylose	9 per cent.	)
Oligosaccharide	-	)

The presence of galacturonic acid, together with relatively large amounts of galactose and arabinose, suggest that the polymer may serve as a precursory substance for the formation of the initial components of the primary cell wall.

In the future we hope to obtain more information concerning the components of the cambial and inner phloem zones and to isolate and determine the functions of the enzymes present in the cambial zone.

Gum Exudates. - We have relied mainly on the good offices of the various State forestry services for the collection of our gum samples. We have received the following numbers of samples:-

New South Wales	... ...	11
Tasmania	... ...	8
Western Australia	... ...	1
Fiji	... ...	2
New Guinea	... ...	1

An attempt has been made to develop methods for the identification of individual gums. Initial differentiation into four groups may be made on the basis of the behaviour of the gums during and after treatment with water.

In Group 1 the gums are completely soluble in water and do not form gels on the addition of thorium nitrate; in Group 2 the gums are soluble in water and do form gels or gelatinous precipitates upon the addition of thorium nitrate; in Group 3 the gums swell considerably to yield a stable, uniform, viscous suspension and the thorium nitrate tests are negative; in Group 4 the gums are only partly soluble in water. Further differentiation within each group may be made by observing the behaviour of aqueous 1 per cent. solutions of the gums with reagents such as cetyltrimethylammonium bromide, alkali, lead acetate, ferric chloride, aluminium chloride, etc.

Further aids to identification include physical properties such as molecular weight, equivalent weight, viscosity, specific rotation, infra-red spectra, etc.

Hydrolysis of gums of Acacia species yield a mixture of monosaccharides:-

D-Galactose	.....	24 - 65 per cent.) Resistant
D-Glucuronic acid	.....	5 - 25 per cent.) basic chain
L-Arabinose	.....	7 - 46 per cent.) Easily hydrolysed
L-Rhamnose	.....	0 - 18 per cent.) with dilute acids

The Wiley-milled heartwood, sapwood and bark of Acacia penninervis have been extracted for 24 hr with water at room temperature (wood : liquor = 1 : 10). The aqueous filtrates and washings, plus 4 volumes of 98 per cent. ethanol, yielded precipitates which were washed and dried by solvent exchange. The yields (o.w.b.) were, respectively, 4.7, 0.3 and 0.4 per cent. The infra-red spectra

of the materials from the wood zones were similar to those of heartwood exudates and of penninervic acid. Microscopic examination of transverse microtome sections of fresh heartwood showed the presence of deposits in the vessels; the deposits were composed, presumably, of penninervic acid because it was shown that they could be stained strongly with ruthenium red and were soluble in water.

The species which we are examining include the following:-

Acacia pycnantha	(Victoria)
Acacia harpophylla	(New South Wales)
Acacia microbotrya	(Western Australia)
Acacia mearnsii	(Victoria and Tasmania)
Acacia deanei	(New South Wales)
Acacia penninervis	(New South Wales)
Acacia cyanophylla	(New South Wales)
Acacia dealbata	(Tasmania)
Flindersia maculosa	(New South Wales)
Owenia acidula	(New South Wales)
Brachychiton populneum	(New South Wales)
Anisoptera polyandra	(New Guinea) - a resin
Canarium vitiense	(Fiji) - a resin

In addition to exudates, seed from a few species have been examined for yield of endosperm mucilage:-

Cassia sophora	(New South Wales)	- reasonable yield
Acacia sophorae	(Tasmania)	- low yield
Acacia dealbata	(Tasmania)	- low yield
Entada scandens	(Fiji)	- little or no endosperm gum.

Discussion

Stewart: The reason for our interest in these substances is that thousands of tons of gums are used annually by industry, and they form a most valuable by-product of wood. The difficulty is in economic extraction, but if we can select the most suitable species, it may be possible to grow them as a plantation, and to stimulate the gum flow as is done in the Sudan.

Cokley: Gummy exudates from some of our brushwood species cause trouble both in sawing and in preservative treatment. Is this covered in your investigation?

Stewart: No, this is largely an extractive problem; I am concerned only with true gums from the legumes.

ITEM 3. TIMBER PHYSICS

Item 3(a)

Review of Research Activities

I. D.F.P. *

Since the Tenth Conference, the work of Timber Physics Section has continued in the same fields as previously.

In wood physics, the study of sorption and rheological characteristics has continued. On the technological side, the determination of moisture meter corrections, and shrinkage and density data have been extended to include Fijian species and many additional New Guinea species.

The Measurement Engineering Group has continued to provide advice on methods of measurement and, where necessary, has developed and constructed new measuring and control equipment for various Sections of the Division.

(a) Sorption Characteristics

Here, the work has been mainly concerned with basic studies of the interaction of wood and moisture. In particular, we have been studying the rate at which water is taken up by individual wood cell walls from both the liquid and vapour phases. Extremely interesting results, some of them quite unexpected, have been obtained.

It had already been established that the rate of sorption of water vapour by thin wood sections was not determined by the rate of diffusion of moisture into the cell walls, as the rate was independent of wall thickness and decreased very markedly as the initial moisture content of the wood was raised or if smaller increases of moisture content were involved. It was thought that the rate-determining mechanism was a slow molecular rearrangement or possibly relaxation of swelling stresses.

More recent measurements have shown that the rate of swelling in liquid water is several orders of magnitude faster than that in vapour when starting from the dry state but that when starting from higher initial moisture content the rate in liquid falls

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*Presented by R. S. T. Kingston.

off very markedly (by 4 or 5 orders of magnitude). These facts have necessitated a complete re-examination of the proposed mechanism of sorption and swelling.

Other investigations have shown that, over a period of time, water adsorbed by wood may undergo changes such that, on subsequent drying by evacuation at room temperature, an amount of water corresponding to as much as 1 per cent. moisture content cannot be removed. However, if the wood is immersed in water immediately prior to drying and then dried rapidly by evacuation, the original dry weight is readily and reproducibly obtained. The quantity of water involved in these changes appears to increase most rapidly when the wood is held at a relative humidity of from 50 to 70 per cent.

Other basic sorption investigations include sorption studies on thin films of cellulose and hemicellulose, the mechanism of the moisture induced deformation of wood under applied stress and the longitudinal shrinkage of wood.

(b) Rheological Characteristics

Static Tests. - The study of the effect of moisture content changes on the deformation of wood under various types of loading has been continued. In most cases, as already mentioned, the experiments have been designed to provide data to assist us in understanding the mechanism of the phenomenon and also its practical application.

It is obvious that knowledge of these phenomena will have wide application in the prevention and removal of distortions in wood during seasoning where large changes in moisture content occur and also in the utilization of wood where small fluctuations in moisture content often cause unwanted distortions in decorative features and structural members.

Tests of several years duration on beams of large size under both indoor and outdoor conditions of exposure have shown that the increases in deformation due to moisture content changes arising from climatic variations, may be greater than those due to creep under constant environmental conditions and could account for many instances where excessive deformations have occurred in structural members under load.

One of the difficulties in the testing of wood is the fact that perfect matching cannot be obtained, thus necessitating the testing of a number of specimens under any given condition. This makes most studies of wood physics a major effort but, in investigating the rheological properties, this becomes even more serious because of the long duration of a single test where time itself is an experimental variable. If one specimen could be tested successively under various conditions, this problem would be much less serious.

To study this possibility, creep tests were carried out on air-dried mountain ash in bending under intermittent loading at a high stress to see whether sufficient mechanical conditioning occurred after a preliminary cycle or two for the specimen to behave identically in successive tests under the same conditions. This would, of course, only enable elastic after-effects to be studied as it would be the viscous deformation which would change in successive cycles.

There was a large change between the first and second period of loading and smaller changes thereafter. It is not yet certain at what stage the specimen would repeat its behaviour sufficiently closely for practical purposes as the results have not been analysed, but it appears that specimens would need a lengthy conditioning and, except for special purposes, this may not be justified.

Hoop pine has been tested in compression at stresses up to 80 per cent. of ultimate at about 10 per cent. moisture content to assess the incidence of non-linearity of creep with stress. A marked departure from linearity was found at stresses above about 60 per cent. of ultimate. Marked non-linearity had previously been found in bending and this shows that it was there largely due to the high compressive stresses caused by the large difference in strength in compression and tension, as little non-linearity appears to occur in tension.

Tests are also being conducted at 13 per cent. moisture content at stresses of 35 and 70 per cent. of ultimate and temperatures ranging from 20° to 50°C. Non-linearity is in evidence at all temperatures.

We are specially interested in data on the effect of temperature and extensive tests are being carried out as, for some materials, results of rheological studies at a higher temperature can be interpreted in terms of results at a lower temperature carried out over a much longer time. It is of interest to see whether

testing time can be saved by doing this in the case of wood. One difficulty is that the range of temperature available here without changing the properties of the material is rather small.

Although we have now a fair amount of data on creep of wood under constant load, we cannot predict the final deformation of a wooden member after a series of varied loads unless we assume that the deformations due to all individual loads are additive. Some further tests have been conducted to check under what conditions such an assumption is justified. Departures from simple superposition have been found but are not severe, except in compression at high stresses.

It has previously been stated that creep deformation in bending is substantially increased at stresses above about 50 per cent. of the ultimate. This has, as already mentioned, been tracked down to the behaviour on the compression side of beams, and beams shaped so that the compressive stress was kept small, did not show excessive creep, even at very high stresses. Beams of clear wood shaped so that they will be stressed less in compression than in tension are stiffer and stronger than rectangular beams of the same second moment of area but cannot be recommended for general use where any defects such as cross-grain substantially influence the tensile strength.

Dynamic Tests. - The elastic properties and the damping capacity of vibrating wooden beams have been measured over a low audible frequency range at various temperatures and moisture contents for three species. It is planned to extend the frequency range to considerably slower vibrations and to explore the relation between the vibrational and static properties of wood. In the range so far tested, the elastic modulus and damping capacity are only slightly affected by the frequency of vibrations.

(c) Species Correction Data for Electrical Resistance Moisture Meters and Shrinkage Density Determinations

In the past 2 years, the emphasis here has been on Fijian and New Guinea species. The determination of moisture meter correction data is in progress on some thirty Fijian and sixty New Guinea species.

Although sampling of material from at least five trees of each species is considered desirable, provisional data based mostly on fewer than five trees have already been issued for twenty-one

Fijian and sixteen New Guinea timbers. These data will be modified when material from the complete samples has been tested.

Since the last Conference, shrinkage and density determinations have been made on five trees of each of forty species from New Guinea. Thirteen additional species are at present under test and extra material is being tested from ten of the more important species among the forty already mentioned. In addition, five trees from each of five species of Fijian woods have been tested and thirty more species are at present under test, as well as three trees of Antarctic beech and five trees of Eucalyptus globulus. It was decided to test the last as most of the southern blue gum tested previously was E. bicostata. However, owing to bad splitting which has occurred in specimens of this species, a considerable proportion of these tests will undoubtedly be lost.

(d) Measurement Engineering

Moisture Meters. - Assistance has been given to an electrical firm in the development of a capacitance meter of the dielectric constant type. This meter will fill a need as, in addition to having a range of about 0 - 200 per cent., it can be used on treated timber up to about 24 per cent. moisture content, whereas the resistance meter can only be used in such a case up to about 15 per cent.

It has certain disadvantages compared with the resistance type meter, for example it is density sensitive; but its wide range of application on both treated and untreated timber enables it to fill a need not filled by the resistance type meter. Because of the difficulty of obtaining suitable density corrections, the resistance type meter will, wihin its range, give more accurate results for untreated timber and up to 15 per cent. for treated.

A resistance type meter is also being developed using only transistors. This will enable it to be very small for easy portability and to be independent of mains or batteries not in easy supply in country districts.

Some work has also been done on 3-terminal electrodes and meters for measuring in the range of 6 - 10 per cent. moisture content under unfavourable conditions of sawdust or dust combined with high humidity. It has an electrical shield which partly

overcomes difficulties of providing sufficiently high insulation resistance to enable the very high resistances encountered in wood at low moisture content to be measured in the presence of electrode contamination.

Development and Construction. - The Measurement Engineering Group is responsible for advising all Sections of the Division on problems of measurement and control. Where suitable equipment is not commercially available, it is designed, manufactured or, where necessary, developed. The following are examples of work which has been carried out during the last 2 years:

A machine for measuring and recording the sliding friction between wood and steel. The information is required in connection with fundamental sawing studies in the Utilization Section.

Three-dimensional cutting force dynamometer also for the Utilization Section.

Tension links and load cells and associated equipment for measuring the loads applied to built-up wooden structures and gauges for measuring the slip in nailed joints under sustained loads for the Timber Mechanics Section.

Small wind tunnel and variable speed fan and controller for calibrating small hot-wire anemometers used in the studies of air movements around and through timber drying stacks by the Seasoning Section.

II. New Zealand*

(a) Physical Properties of New Zealand Grown Larch

Thirty-three trees were felled and examined in detail, and 135 trees were examined by borings from breast height. These represented several site classes in Whaka and Waiotapu forests, also material from Conical Hill and Hanmer.

Basic specific gravity is very variable between trees (0.41 to 0.54 average to 6 in. top), more so, in fact, than between sites, or between L. decidua and L. leptolepis.

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*Prepared by J. M. Harris.

The core is small, being resitricted to the first ten rings from the pith. Outside that, specific gravity is constant if allowance is made for high extractives content of heartwood.

(b) Effect of Grading Douglas Fir for Rate of Growth

Sawn timber, 3 x 2 in. and 4 x 2 in., from Waipa and Conical Hill sawmills was examined for specific gravity and rings per inch. A punched card system was used to assess effect of growth rate on specific gravity, irrespective of age of wood. The object was to see if, by placing some lower limit on rings per inch, low density wood could be excluded, without rejecting high density wood, thereby increasing mean wood density and decreasing variability. Results show that while some improvement would be possible by excluding timber with less than 6 rings per inch, it would be wasteful of good timber and cannot be regarded as a practical way to grade the young thinnings (less than 40 years of age) now coming to the mill.

(c) Effect of Surface Coatings in Reducing "Movement" of Timber

Samples of six species, 3 in. x ¾ in. x ⅜ in., treated with ten surface coatings were brought to equilibrium at 65 per cent. R.H. and introduced to 95 per cent. R.H. Species differences showed up mainly under treatments such as linseed oil to which rimu and red beech are impermeable. Water repellent + 3 coats paint proved to be the most successful coating, and latex type paint the least successful.

(d) Longitudinal Shrinkage in Corewood of Radiata Pine

This investigation aims at examining three contributory causes of longitudinal shrinkage, viz. spiral grain, compression wood and high microfibrillar angle in "normal" wood.

Observations of the extent to which spiral grain translates a proportion of tangential shrinkage into the longitudinal direction agree quite closely with the theoretical model.

Observations will continue of the scattered arcs of compression wood characteristic of the core of many trees, and of microfibrillar angle. An exploratory study of young trees has revealed marked differences in longitudinal shrinkage between trees. This was closely correlated with microfibrillar angle but not with tracheid length. As detailed studies of longitudinal shrinkage in 38-year-old stems reveal considerable differences between the butt

log and top logs it appears unlikely that the relationships between shrinkage, microfibrillar angle and tracheid length remain constant within the stem, but investigations are incomplete.

It is proposed to continue the study using 11-year-old clonal material to examine gross heritability, "proneness" to form compression wood and related phenomena.

(e) Effect of Top-Dressing Phosphate Deficient Sites at Riverhead

Four trees from treated areas and three from controls were examined in detail. Increment borings from a further twenty treated trees and ten controls were used to examine wood density only.

Effects of treatment were negligible on shrinkage, spiral grain, tracheid length and microfibrillar angle, despite some quite remarkable increases in growth rate.

Basic specific gravity was reduced from 0.56 to 0.51, these figures being in keeping with other observations of deficient and "normal" sites in these areas. Reduced density is associated with a lower percentage of late wood and thinner cell walls. Some slight but statistically significant decrease in cellulose also occurred.

Treatment is essential for tree growth in these areas. The problem of contrasted growth rates only arises for the established stands - in future, stands can be treated before deficiency symptoms become apparent.

(f) Effect of Thinning on Wood Density

The programme, in its original form, has been discontinued as more extensive sampling is required. It is hoped that the beta ray densitometer may be used to examine 11 mm increment cores from a fixed internode; in this way many stems can be examined in detail, covering such items as effect on late wood percentage, growth rate, late wood and early wood density and duration of any effects observed.

III. New South Wales

Booth: Physical work in New South Wales is confined mainly to measurements of shrinkage and density concerned with projects in connection with Pinus radiata and E. grandis. Our

work on gamma ray detection of defects in timber has found practical realization and an instrument based on this work is now being marketed in America. We are very interested in the Division of Forest Product's work on the effect of changing moisture content on creep, and would like to see the work applied to wood drying under load with a metal fastening. The question of the flow of timber around the plate under stress during drying could be significant.

I think the development of a moisture meter of the Laucks Sentry type would be of great benefit to the industry. Such a meter would raise the technical efficiency of many small producers who cannot afford the expensive American instrument.

No Discussion

ITEM 4. WOOD PRESERVATION

Item 4(a)

Review of Research Activities

I. D.F.P. *

Many aspects of our work will be discussed under other agenda items. In this review these aspects will be mentioned only briefly to record and to set them in perspective.

It is convenient to review our work since the last Conference under separate headings as follows.

(a) Pole Treatments

With probably 100,000 poles now being treated annually in Australia, we are becoming alarmed at some indications that the standard of treatment may not be uniformly satisfactory. Recent cases of termite entry into creosoted poles in the Mildura area has

*Prepared by N. Tamblyn.

prompted analysis of borings from attacked poles. Our results have shown retentions varying from 1.3 to about 10 lb/cu.ft. of creosote in the sapwood. At one Victorian plant, periodical weighings of individual poles before and after treatment has shown a scatter of retentions ranging from about 6 - 24 lb/cu.ft. in eucalypt sapwood. In some changes of radiata pine, weighings have revealed a scatter from about 2 - 10 lb/cu.ft. to obtain an average charge loading of about 7½ lb/cu.ft.

These results indicate that a number of poles already in service may be seriously undertreated and that all concerned may have to face considerable criticism in the future. At present we are still investigating the position and to obtain more evidence have developed a rapid method for determining creosote retentions from plug samples taken from individual poles. As soon as the facts are clear we will take this matter up with the suppliers and purchasers.

(b) Australian Creosotes

To assist the proposed revision of standard specification K.55, we have undertaken a laboratory evaluation of Australian creosotes. The ASTM method is being used in which small treated blocks are given a prescribed "weathering" and then tested for decay resistance. This enables a threshold loading to be calculated which for good creosotes is about 3 - 5 lb/cu.ft. Results obtained are disturbing as the threshold for one of our main creosotes used for pole treatments appears to be dangerously high. This result, together with the indication that plant practices may be unsatisfactory, is causing us serious concern, and we would appreciate your counsel in these problems.

Other work on evaluation of creosotes has involved a study of tar oils obtained from the Lurgi gasification of Victorian brown coal. The first creosote tested had satisfactory toxicity and permanence but, because of admixture with tar, proved objectionable when bleeding occurred in hot weather. Work on distillate fractions containing no tar is proceeding and it is hoped that a satisfactory product will soon be available.

(c) Rail Sleeper Tests

Our tests are continuing to show good results for various eucalypt sleepers treated at high pressure with preservative oils. Favourable results in Tasmania have led to our recommendation

that a high pressure sleeper plant be installed as soon as possible. Results in Western Australia indicate that karri treated at high pressure with a PCP-oil preservative may be superior to untreated jarrah. A further large scale test of 3,000 karri sleepers should be installed early next year, and we hope that this test will soon provide confirmatory evidence and possibly result in the beginning of an export trade. The main technical problem is to dry karri sleepers in reasonable time and at present it appears that air drying over one summer is insufficient.

(d) Crossarms

Approximately 150,000 crossarms are being treated this year - about 70 per cent. at the Victorian high pressure plant and the remainder at Pemberton. We have spent much time investigating the treatment of karri arms and the reduction of degrade and have shown that cleanliness can be greatly improved by adding a small amount of demulsifying agent to the Kwinana oil preservative. In co-operation with Seasoning Section, it has been shown that kiln drying from the green at fairly severe schedules raises the average level and uniformity of retention, probably because of fine internal radial checks. Also, kiln drying reduces diamonding during drying and treating, probably because of tension set in the case.

The Victorian plant has not had to meet any serious difficulties other than the problem of cleanliness of treated arms. Recently this became a semi-political issue and a changeover to creosote was made with satisfactory results. So far, it has not been necessary to implement other solutions to this problem on which we have done a considerable amount of work.

(e) Small Specimen Test

Treatment of more than 6,000 specimens (representing over 200 combinations of preservative, timber and retention) has been completed and it is hoped to install the test soon in New Guinea, Queensland, New South Wales and Victoria. Two sub-sites in each area are proposed giving in all eight test localities. This is a large and ambitious test which should yield very valuable information. Its success is dependent on the continued help and co-operation of the Forest Services.

(f) Marine Borer Tests

Tests installed in 1959-60 in four posts are showing the copper-chrome and copper-chrome-arsenic salts at loadings of

1.7 lb/cu.ft. are as resistant to teredine attack as creosote and a creosote-tar mixture at loadings up to 20 lb/cu.ft. The zinc-copper-chrome-arsenic salt (Boliden S.25) is also performing satisfactorily. These waterborne preservatives have shown higher resistance to Limnoria than creosote. Our present recommendations for piling are creosote at loadings of not less than 15 lb/cu.ft. or copper-chrome-arsenic at not less than 2 lb/cu.ft. In these tests we are most grateful for the help received from the State Forest Services and from the New South Wales Maritime Services Board.

(g) Treatability of Timbers

A considerable amount of work has been done on the pressure treatability of various timbers including radiata pine heartwood, Canadian western hemlock, eleven timbers from North Queensland potentially available for sugar tram sleepers, a Brachystegia sp. from Tanganyika, and round brigalow fence posts from Queensland. Also, the treatability of spotted gum sapwood with a copper-chrome-arsenic salt at conventional pressure schedules has been investigated and attention drawn to the relatively impermeable transition zone of pale wood between the sapwood and heartwood. Further work on the permeability and durability of this transition zone is in progress.

Tests have also been made with several timbers to determine the penetration obtained from surface coatings of a proprietary emulsion cream preservative. Work on the permeability of New Guinea timbers in pressure and diffusion treatments is continuing. Tests have also been made on pressure-diffusion treatments of green radiata pine given some preliminary drying by steam-vacuum cycles. In this work we were ably assisted by an officer from the Division of Wood Technology, New South Wales.

(h) Preservative Retentions

Our schedule of retentions for waterborne preservatives, which was referred to a committee at the last Conference should be ready for issue shortly and is already functioning as an official standard. Various amendments will be made including cognizance of the effect of timber density on loadings expressed on a weight/volume basis (i.e. as lb/cu.ft.). We have made some tests to determine this effect and, as expected, expression of loadings as percentage on a weight/weight basis has proved approximately correct.

Recently we have given consideration to minimum loadings and penetration depths for K. 55 creosote in various uses and have circulated our tentative proposals to those most concerned.

(i) Termite Tests

In co-operation with Mr. Gay a laboratory test has been completed to determine the toxic thresholds for eight preservatives against three termite species, before and after exposure of specimens to moderate leaching. This test has shown that for the metal-chrome-arsenic preservatives the termite threshold is determined by the arsenic content and that the other components have little termiticidal effect.

(j) The European House Borer

The presence of Hylotrupes bajulus in prefabricated houses imported to Victoria from Europe about 10 years ago is causing us grave concern. Emergences are known to have occurred in twenty-four houses and there are undoubtedly other cases which have not been discovered. We have given our help whenever required in the training of inspecting crews and in verifying suspected cases of attack. We have repeatedly and strongly expressed our opinion that there is urgent need for drastic action involving fumigation of whole areas. So far this advice has not been heeded and it is our belief that there is now some danger that this borer may become established beyond the possibility of control. We also believe that the assurance from other States that they have no similar problem requires confirmation.

(k) Decay in Radiata Pine Weatherboards

Following discovery of serious decay in radiata pine weatherboards in New South Wales, we have made a survey of the position in several Victorian areas. We have inspected about forty-three buildings and though some decay was found in almost 60 per cent. of these, it was judged to be serious in only five houses. This is not completely satisfactory service and we have not contested the decision of Victorian loan institutions to require pressure treatments of radiata pine weatherboards in all financed houses.

Isolations from decayed pine weatherboards have been made and a wide range of wood destroying fungi obtained, the most common being unexpected - Lopharia vinosa, Corticium patricium and an unidentified fungus. We hope to use many of these fungi to check whether preservative loadings recommended for pine weatherboards are adequate.

(l) Causes of Decay Resistance

Since the last Conference we have studied within and between tree variations in jarrah and cypress pine with particular reference to the effect of growth rate on durability. In jarrah there is a marked radial variation in decay resistance, the outer heartwood being typically the only highly durable material present. This pattern is believed to be caused by aging of extractives and we are now examining five other eucalypts to determine whether this applies in other species. We consider that this aging is caused by polymerization resulting in reduced toxicity of the polyphenolic extractives responsible for decay resistance in eucalypts. In jarrah the effect of growth rate appears to be of minor importance compared to the aging effect.

In cypress pine no marked evidence of aging has been found, the outer and middle heartwoods being both typically highly durable. Rate of growth has no direct effect on decay resistance except that wide growth rings result in a larger core of less durable wood. At present we are examining the composition of cypress pine extractive by gas chromatography.

(m) Tolerance of Fungi to Preservatives

Tests indicate that most Poria spp. causing brown rots are copper-tolerant and that, in addition to Poria vaillantii, several other fungi are tolerant of both arsenic and copper. Some of these fungi are not controlled by commercial loadings of copper-chrome-arsenic salts.

In screening of fungi for creosote tolerance, no species has been found with the same high tolerance as Lentinus lepideus. Its use in creosote evaluations therefore provides a reasonable safety factor. Tests with organo-tin and organo-lead compounds have shown that some white rot fungi are relatively tolerant, suggesting that the very high toxicities claimed for these compounds should be accepted with reserve when applied to treated wood.

(n) Fungal Physiology

We have discovered that a common effect of some toxic chemicals on wood destroying fungi is to cause the normal diploid mycelium to revert to the haploid condition. We are investigating the significance of this in wood preservation and in the development of preservative tolerance, and also from fundamental aspects.

Studies are continuing on the physiology of soft rot fungi with particular reference to the effect of nutrients on their ability to attack wood.

(o) Miscellaneous

Several problems involving heartrots and sap stains have been investigated including heartrots in young pines in Western Australia, brown stain in Eucalyptus regnans sapwood, and death of Pinus radiata in Victoria.

Exposure tests of untreated timbers in cooling towers have continued to produce useful information. A new test of various preservative treatments is now being prepared for installation in selected towers. Tests on the effectiveness of in situ diffusion treatments for cooling towers have been set up.

Testing of New Guinea timbers for Lyctus susceptibility, decay resistance and treating characteristics is in progress. Some tests are also being made on Fijian timbers.

II. New Zealand*

(a) Treatment of Wood by Non-Pressure Processes

Factors Affecting Diffusion of Boron into Radiata Pine. - We have investigated along-the-board variation and effect of sawing angle. A test on the comparative diffusibility of flat sawn and quartersawn, with and without heartwood on one face showed that flat sawn all sap was more easily diffused than flat sawn with heartwood on the face and this in turn was more readily diffused than quartersawn all sap. The unexpected result, however, was that quartersawn with heart on one edge diffused the most easily of all types in the test.

Non-Pressure Treatment of Posts. - Some tests have been carried out on the suction sap replacement method of treatment. Tests using copper-chrome-arsenate solution show reasonably good preservative distribution in pine posts but in poles the distribution becomes more erratic - copper tends to be more concentrated in the butt end and the ratio copper: chrome: arsenic becomes provessively lower up the pole. Tests on rimu showed this effect to be maghified.

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*Prepared by A. J. McQuire.

A test on the treatment of eucalypt posts by non-pressure methods was completed and the treated posts have been installed in a service test fence line. Some species, particularly E. macarthuri, E. viminalis and E. pilularis treated well by cold soaking in creosote but a soaking time of 1 week was required to achieve this. The sapwood of all species in the test pressure treated well with Tanalith, and with E. ovata, heartwood was also penetrated. The other treatments used were sap replacement (non-suction) with high pH chrome arsenate, and diffusion with fluor-chrome-arsenate-phenol. The diffusion treatment was the only one that gave any penetration into the heartwood of split posts. Some of the sap-replacement and diffusion treated posts were surface dried and dipped in creosote afterwards to see if this retarded the leaching rate of the toxic chemicals and to try to delay the onset of soft rot attack.

(b) Treatment of Wood by Pressure Processes

Oscillating Pressure Method. - Work on O.P.M. during this period has shown that radiata and Corsican pine (both sawn and natural round) can be treated satisfactorily provided the percentage saturation is reduced to below 80 per cent. before treatment. This is best achieved by presteaming at elevated temperatures. In fact, the results with presteamed timber showed such an improvement over unsteamed that it is probable that other factors (such as an effect on the resins in the sapwood) were involved. The optimum steam pressures used were 20 lb/sq.in. for radiata and 15 lb/sq.in. for Corsican pine. The steaming times necessary were calculated from McLeans graphs for heat transfer in wood (taking the time necessary to raise the innermost portion desired to be penetrated to about 220°F) and the O.P.M. schedules were generally about 1 hr per inch thickness or diameter. Some other softwoods (Douglas fir, Cupressus lusitanica and rimu) and one hardwood (New Zealand black beech) were tried without much success. With beech there were indications that the solution balance (copper : chrome : arsenic) may have been upset. A series of tests on modified O.P.M. schedules (with Corsican and radiata pine) showed that the vacuum phase could be completely omitted and the overall process greatly simplified without significantly impairing the results.

Vacuum/Pressure Treatment of Douglas Fir. - Preliminary work, still in progress, has indicated that with Douglas fir, by far the greatest amount of penetration obtained by vacuum/pressure treatment is longitudinal. The variation in treatability between

posts of this species appears to be due to variations in the number of pits and the percentage of these that are unaspirated but it has not been possible to establish this relationship exactly. Possible methods of overcoming this variation such as altered treating schedules (longer initial vacuum and/or pressure period) and pretreatment conditionings such as steaming, fast drying, slow drying, mercuric chloride treatment and water soaking are currently being investigated.

(c) Routine Examination of Wood Preservatives

Accelerated Exposure Tests. - The ¾ in. x ¾ in. treated stakes have now been installed in Whaka and Hanmer graveyards for 12 years. Untreated controls failed in 1½ - 2½ years and various formulations have been failing regularly since that time. The treatments still effective include copper-chrome-arsenate, copper-zinc-chrome-arsenate, ammoniacal copper arsenite, creosote and pentachlorophenol. A new series of stakes is to be installed this year and these will be 1¼ x 1¼ in. in section, treated with all the currently approved (T.P.A.) multisalts at retentions equal to, and 33 per cent. above and below, T.P.A. specifications. The reason for the change from ¾ in. to 1¼ in. square is to give greater strength (a considerable number of the smaller stakes were accidently broken) and to have a stake which will not dry out so easily during dry spells.

Corrosion of Metals in Treated Timber. - An accelerated corrosion test has been completed using five metal strips clamped between pieces of treated timber and determining corrosion by changes in electrical resistance. The method was suitable for copper and mild steel and for these two none of the preservatives used was significantly more corrosive than untreated wood. One of the copper-chrome-arsenate formulations appeared to be more corrosive to zinc but the results were obscured by "pitting".

Aluminium was unsatisfactory because of the difficulty in achieving a good bond between the probe and the tapping wires and also because where corrosion occurred it was in the nature of a very localized pit. There was some visual evidence that corrosion of aluminium was associated with resinous pockets in the untreated wood.

Threshold Values for Waterborne Preservatives. - One series of tests using Tanalith C, Tanalith U, Boliden K.33 and Boliden S.25 was completed. This test showed that Tanalith U

was insufficiently well fixed to be satisfactory for ground contact use; the other three formulations were all effective except against Poria sericeo-mollis. The series is to be repeated this year to include Tanalith CA, Celcure "A" and Bolit.

Threshold Values for Creosote and Creosote Mixtures. - Tests are at present in progress to determine the threshold values for creosote and creosote/oil mixtures used in the treatment of radiata pine railway sleepers. One hundred sleepers treated with pure creosote and one hundred treated with a 50 : 50 creosote/ furnace oil mixture were weighed individually before and after treatment and were later put under service test. It is hoped that these tests will provide data useful for correlating laboratory and service tests.

(d) Durability of Untreated Wood

The graveyard stake tests of 2 x 2 in. stakes are being maintained and increased. An additional series was installed at Whaka graveyard using ¾ in. stakes. No laboratory tests have been instituted.

(e) Stains and Rots in Forest Products

Further fungi have been isolated from treated timber that has decayed in service and these are being checked for wood rotting ability and tolerance to preservatives. Two such fingi were found to be as tolerant as Lentinus lepideus (the international standard test fungus) to creosote, and are being used in our current threshold values tests. Cultural characteristics of all the unknown decay fungi held have been put on punched cards.

(f) Resistance of Timber to Marine Borer Attack

An accelerated marine exposure test was completed and a report is awaiting publication. In this test copper-chrome-arsenate formulations showed the greatest promise and the minimum concentration required was calculated as that which would give a retention of copper as CuO of 0,5 per cent. of the oven-dried wood weight.

A survey of marine borers in all the major ports in New Zealand is almost complete and shows wide variation in the severity of attack in different areas. The teredinidae species identified were Banki australis and B. brevis, Lysodus medilobata and L. pedicellata, and Psiloteredo edax. Simnosia quadripunctata was found at nearly all the ports and L. tripunctata at Auckland.

(g) Wood Preservation Chemistry*

Chromium Determination. - Rapid "operator method" for hexavalent chromium determination in multi-salt solutions - aimed particularly at solutions where wood extractive level renders hydrometers inaccurate, e.g. O.P.M., sap displacement, and steam-cold quench treatments with salts of the "Bolit" type.

Spot Tests. - Use of rubeanic acid (dithio-oxamide) for copper - has the advantage of permanence over P.C.V.; pieces so treated can be kept for record purposes if required.

Use of eriochromecyanine R and lead acetate/acetic acid as a test for trivalent (fixed) chromium. Useful on salts of the Bolit and Osmosar type, although the colour has been poor on some eucalypts. Colour permanence is good.

Analytical Work. - No new chemical methods; recently we have been using the X-ray spectrograph to examine samples. Although the apparatus has not long been in use, it has already proved its worth for the identification of classes of preservatives.

Tests on the accuracy and reproducibility of results from it show that both are of the order of ± 2 per cent. at the levels of toxic components in which we are particularly interested, small quantities, especially of the elements of higher atomic number, can be detected and measured with reasonable accuracy. Zinc was analysed at a concentration of 60 p.p.m. in ground pine needle material.

A study has been carried out on the variation in distribution of boron compounds in diffusion treated radiata. A general trend for an increased concentration in the neighbourhood of structural changes was found, but so far it has not been possible to define a precise relationship between structure and concentration, other than to say that there will be little variation in clear, straight grained sections.

Future Work. - Development of spot-tests, particularly for arsenic; development of analytical methods for fluorides, both in solutions and in wood; X-ray spectrograph methods for small samples.

Plans for projects using the above instrument include an intensive programme of work on the O.P.M. process, involving

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*Prepared by M. Cummins.

both indigenous and exotic species, a large scale study of the leaching rate of multi-salt preservatives from various timber species, and an investigation of the distribution of the components of multi-salt preservatives in indigenous timbers.

(h) Service Tests*

Transmission Poles. - Service tests on the creosote treatment by the hot and cold bath process of the species rimu (Dacrydium cupressinum) and European larch (Larix decidua) have shown that an average service life of 30 to 35 years may be attained. However this treatment has also resulted in some instances of high failure rate on larch and Douglas fir (Pseudotsuga taxifolia) caused by improper seasoning practice and sub-standard treatment.

Tests on the two latter species using the same process but with the preservatives PCP/oil and copper naphthenate/oil show at present about 2 per cent. failures after 12 years' service.

Sufficient time has not yet elapsed to draw conclusions from tests on the pressure (Rueping) treatment of these species but no failures from decay have yet been recorded (after 5 years). Similar remarks apply to the pressure treatment of radiata, Corsican, lodgepole pine and larch poles, with the modern multi-salt waterborne preservatives.

Fencing Material. - Early service tests on natural round posts (principally pine and larch) show that an economic service life of 20 - 25 years was attained when treated with creosote by the hot and cold bath process.

Until recently, further tests were confined to "graveyard" installations covering a fairly wide range of exotic species and treatments using either oil-based or waterborne multi-salt preservatives. Lack of age precludes conclusions on the treatments with the more modern preservatives.

Tests have lately been established on farms covering a fair range of soil and climatic conditions in the North Island. The more readily available species of natural round, sawn and split posts and battens are under test and opportunity has been taken for comparison on natural durability, commercial treatment and the more simple forms of "home" treatment (e.g. soaking, diffusion and sap displacement).

*Prepared by J. Denyer.

Railway Sleepers. - Extensive service tests dating back from 8 to 12 years cover both non-pressure and pressure treatments of radiata and Corsican pine and embrace creosote, oil-based and multi-salt preservatives. With the exception of Tanalith U the percentage of failure by decay remains low at present.

The New Zealand Government Railways are now using increasing quantities of square sawn P. radiata sleepers pressure treated with a 50/50 mixture of creosote/fuel oil. Economic protection can be given against decay, and recent tests cover more the aspects of spike holding and checking.

Bridge Timbers. - Main road bridge deck timbers formed from nailed laminated P. radiata and pressure treated with waterborne multi-salt preservatives are under service test, as well as the same species glued laminated and Rueping treated with PCP/oil. P. radiata stringers, glued laminated and similarly treated of 33 ft x 22 in. x 9 in. dimension, have also been placed in service.

III. New South Wales*

Since the last Conference we have investigated steam/cold quench and low pressure boron treatments for Monterey pine, and low pressure CCA (60 lb/sq.in.) treatments for this species, for meranti and for hemlock. Field and laboratory investigations have been made into the biology of bostrychids attacking poles in seasoning stacks in northern New South Wales and field exposure tests of CCA treated Monterey pine laid down at Pennant Hills and Narrandera. These samples were treated by the Division of Forest Products and matched samples installed by them in Victoria.

A considerable portion of the Section's time is taken up with ad hoc investigations for the timber industry. Typical items investigated were pentachlorophenol scald in apple cases during cold storage, the nature of yellow stains (quercitin compounds) on boron treated timber, evaluations of a copper pentachlorophenate treated plywood stake test, excessive boron overtreatment in Amberoi, the holding power of staples in treated wood, and the leaching of boron from pine weatherboards.

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*Prepared by D. W. Edwards.

New Lyctus testing facilities are in operation and a second constant temperature/humidity room for insect investigations is nearing completion. Railway sleeper durability tests are in progress at Junee and Dungog where inspections are currently under way. Three fence line tests are now in service - a CCA pressure treated natural round fence at Wallaroo S. F., a creosote treated natural round fence at Wallarawang, and a CCA sap replacement treated natural round fence at Pennant Hills. Cooling tower inspections at Electricity Commission power stations has been completed and re-inspection of a number of larger industrial towers is in progress.

This section is heavily committed to advisory services such as homeowners' enquiries re termites, borers and decay, as well as general preservation enquiries. A full-time Information Officer is now employed. In addition we supervize Hylotrupes inspections, identify all timber insect intercepts for Quarantine in New South Wales, maintain inspection services for and supervize the administration of the Timber Marketing Act. Since the last Conference the number of approvals for preservative treatments under this Act has increased from 70 to 148.

Discussion

Tamblyn: What is the commercial future of the oscillating pressure method in New Zealand?

Kininmonth: Two commercial plants have been given approval to use the method on an experimental basis but neither has yet received final approval as the results have not been entirely satisfactory. The State mill at Waipa has been treating 4 x 2 for scantling and the results have been very close to being completely acceptable. The plant in the South Island treating mainly round timber has not yet achieved satisfactory results.

Hanson: Does the green colour of copper-chrome-arsenic treated timber persist?

Tamblyn: So far as we know it should and examples in Melbourne of up to 4 years old are still showing the green colour.

Hanson: I understand that in New Zealand the boron diffusion process is accepted for radiata weatherboards.

Tamblyn: We have given this a great deal of consideration, particularly as New South Wales had approved this type of treatment for a short time, but we agree now that our building practice is sufficiently different for the New Zealand results to be inapplicable. In addition, New Zealand claim that they are treating only against Anobium, whereas our hazard is also from decay and termites. Considering the whole problem, particularly the fact that New South Wales has shown that there is considerable leaching from boron-treated weatherboards, we felt that the use of this process was too risky in that it would not give the required life. Work on this is still proceeding and we are prepared to change our opinion should evidence warrant it.

Bryant: I am not convinced of the superiority of New Zealand building practices over Australian, and many of the precautions which are supposed to be taken are, in fact, only taken in the northern part of the North Island where the decay hazard is higher. Concerning the O.P.M. method, the figures given to me at Waipa indicate a very considerable reduction in costs and if the problem of variability is solved the process will be very widely used.

Kininmonth: The O.P.M. method will be of particular advantage in treatment of large sections and large rounds where seasoning is a problem. The method will certainly be cheaper than pressure treatment but not cheaper than the diffusion method.

Item 4(b)

Starch Levels Necessary for Lyctus Attack and Seasonal Variations

Edwards: An experiment to determine the starch threshold levels necessary for Lyctus attack in Eucalyptus maculata (spotted gum) has been commenced at the Division.

A number of spotted gum blocks were turned to the same diameter on a lathe and cut to the same length. Starch levels were determined for each block using grindings from both ends. The variation in starch content was 0.16 per cent. to 1.02 per cent.

Each block has been exposed to attack singly in a glass jar using six pairs of beetles in each jar. The beetles, obtained from several different starch cultures were randomized to minimize differences. The experimental blocks are being kept in an incubator at a constant temperature of 26°C and a relative humidity varying between 65 per cent. and 75 per cent.

Discs cut from each end of each block have been kept. Further starch determinations on more restricted areas, as well as starch maps of each end of the blocks may be made should the pattern of attack appear to warrant it.

No beetles have emerged up to the time of writing.

Discussion

Huddleston: This work is a result of work previously reported concerning detection of starch levels in timber. Using the techniques developed it is now possible to produce spotted gum with the desired starch levels simply by defoliating a tree.

Tamblyn: We have always been of the opinion that starch may not be the only carbohydrate on which a Lyctus can subsist, and I feel that unless some really extensive analyses are done on these samples you will not be able to say that Lyctus can or cannot exist at a certain starch level.

Edwards: We felt there had to be some starting point. If the answer is not simple we will have to assess the value of future work.

Cokley: We are very interested in this work as we are also legally committed to the starch level, i.e., the minimum at which the starch content will be detrimental.

Item 4(c)

Sampling, Analysis and Distribution of Preservatives in Round Timber*

The effect of position on sampling may be important as the two following examples show.

TABLE 1

DISTRIBUTION OF COMPONENTS OF TANALITH C IN A 25 FT POLE TREATED BY PRESSURE BOUCHERIE METHOD

Height from Butt	% Copper Cu	% Chromium Cr	% Arsenic As_2O_5
6 in.	0.09	0.35	0.415
12 in.	0.10	0.35	0.356
3 ft	0.07	0.21	0.225
6 ft	0.08	0.15	0.176
10 ft	0.07	0.10	0.135
20 ft	0.04	0.054	0.076
25 ft 6 in.	0.07	0.051	0.129

TABLE 2

DISTRIBUTION OF SALTS IN THE SAPWOOD OF A TREATED EUCALYPTUS DIVES POST IN MG/G OF OVEN-DRY TIMBER

Height of Sample from Butt	Inner Sapwood Shell			Middle Sapwood Shell			Outer Sapwood Shell		
	Zn Salt*	Cr Salt*	Cu Salt*	Zn Salt	Cr Salt	Cu Salt	Zn Salt	Cr Salt	Cu Salt
2 in.	21.5	9.1	3.5	24.0	18.0	1.4	23.0	11.0	2.1
1 ft	13.5	1.2	0.3	19.0	2.7	1.4	N.S.	4.5	2.1
2 ft	-	trace	trace	16.0	trace	trace	39.0	5.7	0.3
3 ft	12.0	-	-	19.0	-	-	40.5	trace	trace
4 ft	5.0	-	-	19.0	-	-	29.0	-	-
5 ft	8.0	-	-	21.5	-	-	33.5	-	-
5 ft 8 in.	-	-	-	21.0	-	-	48.0	-	-

*The zinc is calculated to equivalent $Zn\,Cl_2\,2H_2O$, the chromium to $Na_2Cr_2O_7 2H_2O$ and the copper to $Cu\,Cl_2\,2H_2O$. 1 lb/cu.ft. is approximately equivalent to 25 mg/g.

*Prepared by D. W. Edwards.

The first table represents a recent test, the second series of analyses being done some years ago.

Discussion

Da Costa: These results are interesting in that no one would have expected the copper not to fall off with the other two elements, but the most important point is the figures showing a much higher concentration in the outer sapwood. We need more information on the distribution radially within the sapwood as high figures for the outer sapwood can give us a false impression as to the distribution.

Huddleston: This work is important in that we will have to set a minimum figure which is going to give a loading far in excess of that which we require if this separation is going to persist.

Cokley: We are finding the same radial separation in our hardwoods, the pattern being a high concentration of chromium on the outside dropping off very sharply within about ⅜ in., a similar pattern for copper but the arsenic fortunately fairly uniform. We get a similar falling off of components from either end of pressure treated poles but as the plant in Brisbane is over-treating at the moment there is no problem.

Rudman: The figures quoted by New South Wales are for a Boucherie treatment and not for a full-length pressure treatment where the preservative solution is completely surrounding the pole and where longitudinal penetration is assisted by checks and cracks along the length of the pole. These expose end grain, so I feel that in pressure treatment, marked longitudinal variations should not occur but one would expect some radial variation.

Bryant: This work was done because we anticipated requests for approval of the Boucherie method.

Sampling, Analysis and Distribution of Preservatives (Creosote) in Round Timbers*

We are very interested in this matter, particularly with reference to poles, but at this stage have not a great deal of information to give. However, we are doing work on it which can be summarized as follows.

*Prepared by N. Tamblyn.

Creosote

Sampling. - For weight/volume estimations, sampling with a drill or an increment borer is relatively unsatisfactory as it is difficult to determine the volume of the sample accurately. A sample taken with a ½ in. drill to a depth of ¾ in. is only about 1/3000 cu.ft. and when errors due to measurement of depth, possible loss of some drill turnings, tearing of grain inside the pole and possible redistribution of creosote due to the pressure exerted in drilling are combined, there is room for considerable error. We have therefore designed a tool for cutting a solid wooden plug about ⅞ in. diameter which can be trimmed accurately to the sapwood depth and which is suitable for accurate volume determination by a displacement method. The equipment for this method has been developed by Mr. Dale and we regard it as an important step towards accurate sampling.

Analysis. - The Dean Stark method for creosote analysis is tedious as only one sample can be analysed at a time. The measurement of water is also not entirely satisfactory unless some time and trouble is spent to ensure an accurate reading. We have therefore spent a lot of time developing a method by which analysis of fifty samples could be made daily by one man. The method is simple and does not require costly equipment, other than an oven, a balance and a large soxhlet. So far we are satisfied that it is accurate. We will be glad to demonstrate the method to anyone interested.

Distribution. - In eucalypt sapwood, preservative oils penetrate along the vessels but do not move into adjacent elements to any extent. Distribution is therefore streaky and we have evidence that it may vary considerably from point to point. This makes it difficult to take a fair sample from a pole or post without cutting an excessive number of holes.

Discussion

Bryant: Presumably the above reason is why termites have attacked creosote treated poles.

Tamblyn: We have not yet enough information on this but we have taken plugs from some of the attacked poles and these have shown retentions as low as 1.3 lb/cu.ft. and others as high as 10. Although it is most likely that the termites entered through checks, there would be nothing to stop them going through the section with only 1.3 lb.

Kininmonth: Why is it that there is no radial penetration in the eucalypt poles?

Rudman: There are no open pits through which radial penetration may be obtained. The only path remaining, therefore, is through the vessels.

Kininmonth: We have found that we get no radial penetration with Douglas fir, presumably for a similar reason.

Rudman: We have been looking at an analytical method for waterborne treated poles using the sampling tool previously discussed, and have measured the ash content of untreated timbers and then the ash content of similar samples of waterborne treated timbers. It appears, at the moment, that this method could be quite suitable for giving an indication of the total copper-chromium-arsenic in a pole without any differentiation between the three elements. This method would necessitate the taking of a sample from the pole both before and after treatment as there is considerable variation between different untreated poles.

Huddleston: The results of this work are most disturbing as it seems to indicate that some of these poles are not properly treated. Is there any action being taken to follow this up to prevent such patchy treatment?

Tamblyn: We are trying to collect enough evidence to assess the magnitude of the problem and how best to approach it. We cannot run the danger of causing any panic in the treatment industry, and we are very conscious that poles are being treated all the time, but to take immediate action would seem to be dangerous.

Item 4(d)

Sub-Floor Ventilation

Edwards: The common practice in domestic buildings in New South Wales for underfloor ventilation is to provide two terra-cotta vents per room in the external walls, or vents at about 6 ft centres.

These vents, overall size 9 in. by 6 in., have an effective opening of approximately 4¾ sq.in. In Sydney, it would appear that for most of the houses on various soils (sandstone, clay, etc.) this amount of ventilation is sufficient to prevent noticeable or objectionable distortion of the floors.

The recommendation by C.S.I.R.O. is for 4½ sq.in. of opening for each lineal ft of wall perimeter. If terra-cotta vents are used, this would mean one vent for each ft of wall lenth, i.e. one vent, 3 in. of brick, and so on.

We would be interested to know the basis of this recommendation.

Da Costa: The figure of 4½ sq.in. was meant to give a guarantee that decay would not occur under any climatic conditions. Sub-floor decay normally arises from water vapour from warm moist soil condensing on a cold floor and it could be more severe in Melbourne than in Sydney, in other words it does not necessarily go with a warm moist climate. Our figure was chosen to provide a safeguard for all houses, as you cannot tell when decay is going to occur. Some change in condition such as the use of impervious floor coverings could cause the onset of decay at any stage of the life of the house. Our figure of 4½ sq.in. was based on a consideration of all standards available in Australia and overseas, but was not based on direct experimental work. We feel that the figure can be achieved without any trouble and certainly under Victorian conditions where terra-cotta vents cannot be relied on to give a satisfactory figure owing to blocking of the holes or misformed holes.

Ryley: In Queensland we have had trouble recently, particularly in air-conditioned buildings, and have endeavoured to convince architects that they should give more thought to adequate sub-floor ventilation. This also applies to buildings where there is a non-air-conditioned space between the ceiling and the floor above.

Wright: The question of cupping and twisting of flooring is far more critical than decay in that it only requires about a 5 per cent. moisture content rise to cause trouble. It would therefore seem that the figure of 4½ sq.in. per lineal ft is desirable to endeavour to prevent even this small moisture content rise.

Huddleston: In most cases in New South Wales the ventilation from the two terra-cotta vents is quite adequate, provided they are not blocked or there are no other unusual circumstances.

Item 4(e)

Review of Work on Bostrychids

Edwards: Preliminary field studies of bostrychids attacking poles during seasoning have now been completed at Grafton. Spotted gum billets were exposed near pole seasoning stacks for periods of from 1 - 6 months throughout the year. A progress report will be issued shortly.

The site chosen was a commercial treatment plant seasoning yard where 75 per cent. of the pole input was considered very susceptible to bostrychid damage. It was not intended to evaluate the results obtained statistically but rather to obtain basic facts about the following:

(i) The species of bostrychids commonly attacking freshly felled timber in norther New South Wales.

(ii) The variation in bostrychid attack on logs felled at monthly intervals throughout the year.

(iii) The period of time over which a piece of timber is susceptible to bostrychid attack.

(iv) The appearance of sapwood damaged by bostrychids.

Laboratory investigations have been commenced to determine the moisture content of spotted gum sapwood after various seasoning intervals and its effect on bostrychid attack.

A pamphlet entitled "The Bostrychid Borers" was published in December, 1962.

No Discussion

Item 4(f)

Creosote Poisoning of Stock*

A report of serious mortality of livestock in the Forbes Pasture Protection District due to creosote poisoning has been investigated and the results are submitted herewith.

A survey of the available information since 1944 reveals the following claims of stock losses due to creosote poisoning. In all cases these were reported to be a result of pole maintenance treatments.

(i) P.M.G. - Conondale - Queensland (1948). Suspected poisoning of cows reported to Division of Forest Products by P.M.G.'s Department.

(ii) Forbes Pastures Protection Board - New South Wales (1963). Report of four cases involving fifty-three sheep and seven cattle. Definitely attributed to creosote by District Veterinary Inspector. Other poisons or poisonous plants were eliminated and diagnosis was said to be made on post mortem examination. This will be discussed in detail later.

(iii) State Electricity Commission of Victoria (1963). Have had six claims since 1938 involving three or four cows, give sheep and two pigs. Only five cases were officially accepted. No stock losses from creosote have been confirmed by Victorian Department of Agriculture.

(iv) District Veterinary Officer - Casino - New South Wales (1961). Suspected poisoning of six cattle along a line of freshly treated poles at Camira Creek. Not confirmed by District Veterinary Officer's post mortems.

(v) Cairns Regional Electricity Board - Queensland (1963). One claim last year - this was not accepted by C.R.E.B.

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*Prepared by D. Edwards.

None of these claims except (ii) were definitely confirmed by qualified veterinarians as being due to creosote poisoning. Investigation of the Forbes reports revealed the following.

Of the fifty-three sheep and seven cattle reported affected by creosote poisoning the following were traced to definite paddocks as shown in the table.

TABLE 1

RELATIONSHIP BETWEEN CREOSOTE POLES PER PADDOCK AND STOCK MORTALITY

FORBES PASTURE PROTECTION BOARD DISTRICT

Property	Number of Treated Poles Per Paddock	Deaths Per Paddock		Sick Cattle Per Paddock
		Sheep	Cattle	
1	6	10	-	-
2	10	-	1	-
	16	-	1	-
	4	-	2	6
3	4	25	-	-
	8	-	1	-
Total		35	5	6

Taking the claims of the Veterinary Officer of the Forbes Pasture Protection Board (Mr. Charles) as a basis, i.e. a power pole hexagonal in shape, each face being 6 in. wide and treated to a height of 4 ft with a 1/64 in. layer of creosote, the following very approximate results are obtained:

Total area treated - 12 sq.ft.
Volume of creosote - 27 cu.in.
Weight of creosote - 16 oz/pole.

Dr. Harrison's figures for the toxic doses of creosote for sheep and calves are as follows.

TABLE 2

TOXIC DOSE RATES OF CREOSOTE FOR LIVESTOCK

Livestock	Body Weight in lb	Dose in oz Causing	
		Acute Toxicity	Chronic Toxicity
Sheep	66	10.6	1.3
Calves	220	48.0	4.4

An adult Hereford cow weighs about 1,100 lb so that the toxic doses for adults are considerably in excess of those for calves.

On the basis of a 1/64 in. thickness of creosote, therefore, the killing potential of the treated poles in the paddocks shown in Table 1 would be roughly as follows.

TABLE 3

PREDICTED MORTALITY FROM CREOSOTE TREATED POLES

Property	No. of Treated Poles	Potential Deaths		Actual Deaths	
		Sheep	Calves	Sheep	Cattle
1	6	9.6	-	10	-
2	10	-	3.3	-	1
	16	-	5.3	-	1
	4	-	1.3	-	2
3	4	6.1	-	25	-
	8	-	2.7	-	1

There appears to be sufficient creosote available to cause some deaths in these paddocks.

There are some unsatisfactory features surrounding this report, however, namely:-

(i) The absence of clinical tests in confirmation of post mortem examinations.

(ii) The absence of scarring of the buccal membrane in many of the bodies examined.

(iii) The possibility of confusing the symptoms with those of bloat.

As against this, Mr. Charles is a qualified veterinary officer, his findings have been supported by an independent veterinarian, and creosote is known to be toxic to livestock.

In further support of Mr. Charles, the creosote supplied to him is likely to be "uncut" creosote with a higher mammalian toxicity than the partly refined product marketed by the principal New South Wales supplier. The thick consistency of the former product had apparently given trouble in the past and had lead to a previous suspension of orders to the firm concerned.

The suggestion that a chlorinated hydrocarbon insecticide had been added by the suppliers was denied by them. Examination of a sample of this creosote forwarded by the Central West County Council did not reveal the presence of such chlorinated hydrocarbons and no symptoms of hyperkeratosis were reported by Mr. Charles.

Creosote poisoning of stock by pole maintenance procedures is very rare. In 1937 the United States Forest Service Forest Products Laboratory reported that it was not aware of any cases of creosote poisoning.

No records in the literature of authentic stock poisoning due to creosote were found to 1936 by the Division of Animal Health, C.S.I.R.O.

A search of current wood preservation literature since that date has revealed very few references to such poisoning.

Dr. M. Hudson (1963), a senior member of the A.W.P.A., could not recall an authentic case, though many suspected cases were brought to his notice.

Similar comments were made by Dr. Berkener (1963) of the Boliden Co., Sweden and Mr. Chambers (1963) of Wolman Co., West Germany.

At the recent (1963) Electricity Supply Association Conference, two speakers reported that their respective Authorities have not experienced trouble in this regard (State Electricity Commission of Western Australia, Townsville Regional Electricity Board), whilst others reported a few suspected cases over the years (State Electricity Commission, Victoria; State Electricity Commission, Queensland; Cairns Regional Electricity Board).

The general impression is of a few doubtful cases of creosote poisoning despite the very wide use of creosote for pole maintenance treatments.

The absence of major stock losses does not serve as a measure of the importance of the problem, nor do the opinions of pole users regarding the absence of authentic reports mean that genuine stock losses due to creosote are not occurring. The psychological effect of a farmers' bulletin, such as that issued by Mr. Charles, has widespread repercussions. It is a good excuse for a certain type of grazier to object to pole maintenance teams entering on to his property and could be a steady source of insurance claims. On the other hand, the opinions of various transmission engineers, forest service officers, etc., that creosote treatment does not endanger stock are unfortunately not supported by field tests which take into account the actual maintenance procedures used.

It is therefore recommended that:-

(i) The matter be referred for further investigation by Division of Animal Health, C.S.I.R.O.

(ii) That for the present, creosote pole maintenance treatments be carried to not more than 6 in. above ground line using a free flowing creosote.

(iii) That 2 in. of untreated soil be placed on top of the creosote puddled soil around the pole.

(iv) That collapsible metal guards be placed around each pole where stock are present. The guards should remain in position until the treated surface feels dry to the touch.

(v) That publicity be given to the very infrequent occurrence of such reports and the means of reducing the hazards to stock.

(vi) That a Conference of interested parties be called to discuss the problem.

Discussion

Dale: Unfortunately, calculations made by New South Wales or by any other authority will not convince a farmer that these preparations are not dangerous. Some further work such as noted in the form of precautions for electricity authorities may be necessary to show the farmers that we are acting in good faith.

Edwards: The recommendations which have been made in the present report should help meet some of the objections.

Tamblyn: On our files we have several records going back to the early 1930's of what appear to be authenticated cases of creosote poisoning of pigs, cattle and sheep. In many cases, the evidence seemed to be quite conclusive that creosote was responsible. These results were confirmed by visual observation and by autopsy.

Kininmonth: We have had no evidence in New Zealand of creosote poisoning of stock. Cases of PCP (in fuel oil) poisoning have been reported but not substantiated. Papers on this subject (all preservatives) appeared in N. Z. Veterinary Journal, August 1959 and October 1959. It is stated there that for calves (the most susceptible animal tested) the probable fatal chronic dose rate would appear to be 0.5 g/kg daily (grammes creosote/kg body weight). Symptoms and post mortem findings suggest that the toxicity of creosote is due mainly to the component hydrocarbons. Wood containing creosote as a preservative presents no hazard to stock.

Huddleston: Quoting from the Professor of Veterinary Science at Sydney University: "it is difficult or impossible to confirm creosote poisoning - there are no microscopic changes, and while the presence of phenolic constituents is easily determined, it would be difficult to show that an adequate quantity of these had been taken - sufficient to kill these animals. The minimum requirements for diagnosis would be the presence in the intestines of the animal of appreciable quantities of phenolic bodies".

Item 4(g)

Review of Work on Low Pressure Treatments*

We have investigated the impregnation of Pinus radiata with boron compounds by steam/cold quench, and low pressure (60 lb/sq.in.) processes. Meranti and hemlock treatments by the latter method have also been studied.

Retentions in excess of 1.0 per cent. boric acid (0.25 lb/cu.ft.) were obtained in the core of 1 in. boards by steaming for 4 hr followed by overnight soaking in 4 per cent. solution of disodium octaborate. For successful treatment the initial moisture content should be less than 50 per cent., initial drying after treatment should be slow to prevent excessive redistribution of preservative and a diffusion period of up to 1 week may in some cases be necessary.

It was also found that 1 in. boards of Pinus radiata (average moisture content 12 per cent.) could be treated without difficulty to a core retention in excess of 1.5 per cent. boric acid (0.40 lb/cu.ft.) by pressure impregnation for 1 hr at 60 lb/sq.in. with a 4 per cent. solution of disodium octaborate. Precautions regarding rediffusion during drying are required as for steam/cold quench treatments. Heartwood was not adequately penetrated.

Retentions in excess of 0.9 per cent. CCA salt (Tanalith C) (0.22 lb/cu.ft.) were obtained by a similar schedule, i.e. 60 lb/sq.in. for ½ hr using a 3 per cent. solution preferably with an initial and final vacuum.

This work was done with 1 in. boards dried to an average moisture content of 12 per cent. Heartwood was not adequately penetrated.

Similar work has been carried out with western hemlock (Tsuga heterophylla Sarg.) and meranti (Shorea sp.). Seasoned hemlock (4 in. x 2 in.) and meranti (4 in. x 1 in.) containing varying amounts of truewood were treated at 60 lb/sq.in. with a 3 per cent. Tanalith C solution using a variety of vacuum-pressure-vacuum cycles. Retentions of 0.23 lb/cu.ft. Tanalith C were obtained in some boards of hemlock but not in others - the variation not being strictly related to sapwood/heartwood differences. Sapwood of meranti was readily treated to retentions of 0.55 - 0.77 lb/cu.ft. but meranti heartwood was quite refractory giving retentions of 0.04 - 0.18 lb/cu.ft.

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*Prepared by D. W. Edwards.

No satisfactory schedule was found for the complete and reliable treatment of hemlock, nor for meranti heartwood.

Discussion

Tamblyn: We have done some tests on western hemlock because of difficulties encountered by a treating firm in getting uniform penetration. We treated some material overnight at 200 lb pressure and obtained complete penetration of all samples. We then asked the firm concerned to select material which appeared to be hard to treat; this material was obtained and only two pieces failed to give complete penetration. We consider that the proper treatment for western hemlock is 200 lb/sq.in. for about 18 hr. The area in the two pieces which was untreated was right in the middle and I think that several hours further treatment would have been sufficient to give complete penetration.

Kininmonth: With the pressure diffusion treatment of green radiata in commercial practice, we found that the difficulty was to get a uniform loading. The only way that uniform treatment could be obtained was to be somewhat wasteful of treating material.

Cokley: Commercial treatments of spotted gum are generally at under 100 lb/sq.in. The curve of absorption versus pressure is very flat at just over 100 lb/sq.in. to 200 lb/sq.in. Our experience has been limited to spotted gum and, in this case, increase in pressure time does not appear to make any difference.

Dale: A note of caution should be sounded with regard to low pressure treatment of Pinus radiata sapwood. We have had some very variable results with this material and would not recommend pressures lower than 200 lb for P. radiata as a general practice particularly for sawn timber. On the other hand, we are quite happy about low pressure treatment for eucalypt fence posts.

Item 4(h)

Fire Retardant Test Programme

Edwards: In recent years, interest in fire retardant treatments for timber has greatly increased. Several New South Wales firms, for example, wish to offer fire-proofed plywood to the public, and architects and engineers frequently consult us regarding specifications for fire-proofed timber to be used in their projects.

Conference is aware that Australian Standard No. A30-1958 - Fire Tests on Building Materials and Structures - includes methods for combustibility, flammability and early fire hazard testing of various materials. Timber and plywood, however, present special problems which we feel require examination including -

(a) The effect on fire retardant retention requirements of:-

(i) Permeability of various timber species and the consequent depth of penetration of the retardant.

(ii) Variation in natural fire resistance between species.

(iii) The mode of action of the retardant, e.g. promotion of charring, flame smothering, etc.

(iv) The inclusion of wood preservatives such as arsenic in fire retardants.

(b) Basic information is needed as to the suitability of the available fire retardants for timber and plywood under Australian conditions.

(c) There is need for a uniform Australian approach, including suitable simple tests for fire retardant efficiency in sawn timber and plywood, which can be used in a forest service laboratory.

(d) The special requirements of various State Acts, e.g. the Timber Users' Protection Act of Queensland, the N.S.W. Timber Marketing Act 1945-52, which in turn requires the setting of certain standards of treatment.

D.F.P. and the C.E.B.S. have expressed willingness to co-operate in certain studies in this field.

All known New South Wales firms dealing with fire retardants for timber have been circularized, and data have been collected as to products available, manufacturers' claims, service tests, etc.

Beesley: Some months ago, this Division received a request from the Division of Wood Technology for advice on acceptable standards for fire-retardant treatments which might be approved under their Act. No doubt Queensland has been faced with the same problem.

As a first step towards establishing these standards, it was suggested that New South Wales should assemble information from probable commercial suppliers on the composition and recommended loadings of their products. They should also be asked to give details of recommended methods of application and to submit evidence of performance effectiveness.

In Victoria, the Department of Health is responsible for the "fire-rating" of building materials and has stringent regulations governing the construction and lining of public buildings. Their method of "fire-rating" is based upon the performance of a single specimen in a modified rate-of-flame-spread cabinet.

The Commonwealth Experimental Building Station has had an interest in fire resistance of timber structures and, in co-operation with the fibrous plaster industry, has developed a timber-framed plasterboard partition with a 1 hr rating; a timber joist floor/ceiling construction with a similar rating; a 1 hr plywood fire-door assembly and a "Stramit" roof deck with exposed timber framing with a 1 hr rating.

Mr. Drysdale, of C.E.B.S., visited this Division early in 1962 and agreed upon a programme of co-operative research with a view to studying:

1. Thermal degradation of timber, with special reference to oxygen supply.

2. The fire-protection of timber columns by means of encasement in impregnated plywood or meshed plaster.

3. The early fire hazard characteristics of plywoods treated with fire retardants.

4. The fire hazard due to veneers on non-combustible backings.

5. The fire endurance of impregnated structural timbers.

In this programme, some progress has been made in the fire-retardant testing of plywoods.

Discussion

Cokley: We have had enquiries on fire-retardant treatment of plywood, particularly for the Melbourne market; also on the effectiveness of treated fence posts against fire. A uniform method of testing suitable for small laboratories is very desirable.

Kininmonth: One of the commercial firms in New Zealand does market a fire retardant treatment, but I do not know what the actual regulations are in this matter.

Huddleston: The University of N.S.W. has a post-graduate student working on the effect of nails in a fire rated ceiling and the holding power of nails at elevated temperatures. The Fibrous Plaster Manufacturers' Association is also interested in getting a 2 hr fire rated ceiling. In addition, they are considering the effects of fixing fire rated ceilings to the bottom chords of roof trusses. T.D.A. propose to carry out certain tests showing that timber used for shade control in housing will be quite satisfactory from a fire point of view. There is considerable opposition in New South Wales to the inclusion of arsenical chemicals in fire-retardant materials, owing to possible danger to fire fighters from arsenical fumes. One difficulty in New South Wales is that the C.E.B.S. has been consulted by authorities framing regulations; the result is that restrictions are often placed against the use of timber without consultation with the Division of Wood Technology. It is clear that some consultative body is necessary to co-ordinate these matters, and I suggest that a committee be set up on this particular matter.

During further discussion, there was general approval that a committee consisting of Messrs. Beesley, Edwards, Cokley and Keogh (C.E.B.S.) be set up, with Mr. Beesley as convenor, to act as a co-ordinating committee for the fire retardant test programme.

Item 4(i)

Recommended Retentions for Waterborne Preservatives*

The committee formed at the last Conference to consider recommended retentions for waterborne preservatives has made a number of suggestions for improvement or alteration to the schedule as originally presented. We have also had correspondence with the New Zealand T.P.A. and with the salt manufacturers.

The various recommendations for changes in the schedule can be summarized as follows.

New Zealand T.P.A. have drawn attention to various differences between our recommendations and theirs and have said "It would be unfortunate if loadings set by C.S.I.R.O. differ from N.Z. loadings". I have replied that our objectives are too dissimilar to expect a completely uniform standard and that we are not unduly concerned at the differences which have occurred.

The main differences are:-

(a) New Zealand has lower building loadings intended to control only Anobium and based only on arsenic or boron content. We are trying to control decay and termites as well as borers.

(b) Their low loading for fence battens and some other purposes intermediate between building loadings and ground contact loadings was set so that plants would not have to install a separate tank to carry preservative of intermediate strength. We cannot accept this as a satisfactory technical reason.

(c) It is difficult for merchants to keep separate more than two or three loadings, hence New Zealand cannot accept our greater diversity of loadings.

New South Wales and Queensland have suggested that:-

(a) Inclusions should be made for Lyctus control. I accept this as desirable.

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*Prepared by N. Tamblyn.

(b) The effect of timber density should be recognized and loadings set with some reference to this factor. I accept this but we are not yet sure how best to calculate loadings for timbers of different density. Mr. DaCosta will add to these remarks shortly.

(c) An alternative figure expressed as per cent. on oven dry weight of the timber should be set, as the original basis of expressing loadings as lb/cu.ft. makes legal control difficult. This percentage loading should be coupled with depth of penetration. This is a difficult requirement but we will try to accept it.

(d) Reference should be made to the effect of preservatives on gluability of plywood. As far as possible, we will incorporate this additional information.

(e) The minimum loading for marine piling should be raised to 2 lb/cu.ft. We accept this.

(f) The 5 per cent. investure penalty for Celcure A should be removed. This has been done.

(g) A statement on legal aspects in New South Wales and Queensland should be included. This statement has been drafted and will be included.

(h) In species with intermediate wood (or outer heartwood), 80 per cent. penetration of sapwood might be permitted. The decision has been reached on this pending further experience with spotted gum.

(i) An addendum giving spot tests for preservatives should be included. We have no objection to this but for simplicity would prefer to omit it.

Preservative Manufacturers. - In general, the loadings are regarded as fair, except in the case of the Boliden K.33 preservative. Hicksons consider that the 0.8 factor for ground contact is too low and they have in progress an extensive series of tests to compare K.33 with Tanalith C. Results are expected to be available about October/November, and it has been suggested that we delay finalization of our recommendations until then.

I have replied that we will welcome these results and that if they indicate that the 0.8 factor is too low, we will be prepared to run check tests and probably to ask another laboratory to double check. However, as we could not accept their results without checking in this manner, we will almost certainly issue the specification later this year based on the 0.8 factor.

Effect of Timber Species on Retentions Recommended*

One of the major difficulties in recommending preservative treatments in Australia is the wide range of timber species involved. A lot of our past thinking and most of our laboratory testing has been on pine sapwood, as has most overseas work. Now we have to recommend treatments for timbers ranging from Pinus radiata and white cheesewood to spotted gum and brigalow, covering an enormous range of densities. Obviously in making recommendations based on lb/cu.ft. we must make some allowance for the fact that 1 lb/cu.ft. in spotted gum is less than half the percentage concentration (w/w) of 1 lb/cu.ft. in P. radiata.

These waterborne preservatives are distributed throughout the cell wall, and therefore it would seem desirable at first glance to increase recommended retentions with density to give a constant w/w proportion. We feel, however, that this would, in fact, mean over-treatment of the heavier timbers. In the first place, we can safely assume that in dense timbers the preservative would leach out much more slowly. We also feel that, in the range of concentrations used in service, the greater amount in lb/cu.ft. present in dense timbers would have a greater toxic effect.

Some time ago we set up laboratory soil-block tests to measure effect of density on threshold for ash type eucalypts, but owing to quite unexpected technical difficulties the results were inconclusive. They did, however, give indications that the threshold was not strictly proportional to the w/w concentration. We are now setting up more elaborate tests with a very wide range of species, and including leached blocks, which should give us an answer this year.

In the meantime, we feel we should not accept a linear relation of threshold with density and suggest as a possible interim measure that timbers be divided into three classes - light (below

*Prepared by E. Da Costa.

35 lb/cu.ft. air dry density), medium (35 - 50), heavy (over 50) - retentions in lb/cu.ft. to be in the ratio of roughly 4 : 5 : 6. Minimum analytical figures for control purposes should be tied in with these, allowing for 2/3 charge scatter and a specified sampling tolerance.

Discussion

Edwards: I would like to express appreciation on behalf of New South Wales for the tremendous amount of work carried out by C.S.I.R.O. on this matter. It will be very worth-while right throughout the industry.

We agree with the retentions suggested by Mr. Tamblyn. It should be made clear at this stage that in New South Wales we frequently use two retention figures for each hazard.

(a) The minimum retention acceptable under the N.S.W. Timber Marketing Act 1945-52 in any one piece of timber.

(b) The recommended retention given to enquiriers. This latter may be set somewhat higher than (a) to meet a particular requirement of the user.

It is suggested that a uniform minimum charge retention of 1.5 lb/cu.ft. be set for Celcure A and Tanalith C treatment of cooling tower fill.

Cokley: The work done by Mr. Tamblyn is very valuable to the industry. The suggested loadings are all quite reasonable; the legal limits for Queensland are generally slightly lower than for New South Wales.

Kininmonth: We are in general agreement with the statement made by Mr. Tamblyn.

With regard to species effect we are planning tests on the fixation of multi-salts in a number of New Zealand species. In the first instance these will be on species that can be penetrated easily and evenly. A further problem will probably be the fixation of multi-salt components in the wood where the normal ratios of components have been upset by "filtering" phenomena.

Concerning uniformity of treatment recommendations in Australia, New Zealand and New Guinea, I think that conditions and hazards vary so greatly between these regions (and also within - Australia particularly), that no point is served by attempting to get uniformity. In fact it is probably undesirable. The only advantage would be in simplifying inter-country, inter-zone or interstate timber sales; but as orders of this nature are normally special orders, it should not be too great a handicap for the supplier to treat to the customers' requirements. However, there should be free interchange of knowledge on which regional recommendations are based.

Thomas: I have no doubt we will be following the recommendations made by D.F.P.

Item 4(j)

Reassessment of Needs of Timber Preservation Industry Re Research and Extension*

It appears to me that the time is ripe to assess critically the future needs of the industry, the areas in which preservation is needed and the means for better educating the Australian public to the value of preservative treated wood.

I feel that primary emphasis should be placed on Pinus radiata, coupled with a vigorous approach to utilization of local species. I feel further that targets should be set firstly on economic grounds and that a combined research approach by members of Conference be adopted wherever this seems desirable.

It is a matter of common knowledge that CCA treatments have not prospered as well as they should. This appears due in part to the tremendous effort needed to inform the public of the value of timber treatments. I feel it is unrealistic to say that such a campaign should be the sole responsibility of the commercial firms involved. We all know the costs would be prohibitive unless spread over a number of bodies. A vigorous campaign, however, by all concerned based on facts and recommending treatments only when these are both technically and economically desirable would do much for better timber utilization.

*Prepared by D. Edwards.

The next point I wish to make is that there is an urgent and pressing need to review in situ treatments, e.g. soil puddling, mayonnaise PCP coatings, timber injection, etc. to remove these practices from the realm of tradition to that of soundly based techniques.

The third point I wish to make is that I feel most strongly that obtaining solutions to the small day to day problems of timber treatment may well be the most urgent need of all. I do not think the present organization of the timber industry is favourable to such work being done within the trade. We, on the other hand, have between us technical resources of a high order and I feel we should make industry aware that their problems are ours. Perhaps this is spoon-feeding, but I am afraid the alternative is lack of speed in the development of a modern industry.

Discussion

Tamblyn: Anything we can do to foster the industry should be done, but there are obvious physical limits to the amount of help that can be given. We are making a vigorous drive at all times for the acceptance of preservative-treated timber, but we have been rather conservative in our recommendations regarding treatment of building timber. If we figure too prominently in publicity, it could prejudice our position as an unbiased observer. I do not think that we can do much in the soil-puddling field because we have little more information than that already known by the P.M.G. and the electricity supply authorities. D.F.P. certainly never refuses help on any enquiries received, but we are handling about all that we can manage at the present time.

Huddleston: Recommendations were required for the design of the dog proof fence between New South Wales and South Australia. At present a steel post manufactured in South Australia and costing 25/0d. is used. Due to sections of the fence being periodically flooded the life of the steel posted fence was considered unsatisfactory and consideration was being given to the use of treated radiata pine posts at 10/0d. A demonstration was arranged in Sydney, and was attended by two South Australian members of the Board. As a result, the Board is now considering replacing all steel posts with treated timber. In New South Wales we are devoting a great deal of time trying to promote timber preservation. We feel that this is a job for all people in the timber industry.

Thomas: We must be careful not to be stampeded in this preservation field. I do not think that the preservation industry requires much assistance from Government Departments. The industry is active and the capacity is well beyond immediate requirements. We must not overlook the cost effect of preservation treatment, and preservation treatments should be promoted only where they are necessary and economic.

Cokley: Unless we work closely with the preservative firms and users, we will reach the position where some mills have the wrong idea regarding timber preservation. Preservation is certainly not a magic answer. Preservation firms do not know the problems nor are they in a position to handle adequately all problems. Guidance is essential to avoid treatment where treatment is not necessary, and realize the problems in treatment of certain species. Education of both the industry and the users appears to be necessary.

Wymond: Considerable publicity from D.F.P. has been given in our Newsletter, but the general lack of availability of treated timber in required sizes does discourage people. This problem will continue until treated timber is regarded as another stock line.

Bryant: I have failed to get pressure treated pine from one Sydney firm after several attempts.

Huddleston: It is difficult to get supplies from the industry, except for large orders. In the boat-building industry, which is quite a large user of timber but in which individuals order relatively small batches at a time, firms have had great difficulty in getting treated material.

Item 4(k)

Future of the New South Wales Pole Test Sites

Beesley: The question appears to be whether the Wyong and Clarencetown pole test sites in New South Wales are still serving a useful purpose, and whether they will continue to do so. I would suggest that the answer is yes. However, they have served their prime purpose which was to demonstrate that preservative treatment gives treated timbers a life comparable

with the most durable timbers available in New South Wales. Now we should use these test sites for a critical examination of certain treatments rather than for demonstration purposes. Our future inspections will differ from those in the past in so far as we will not issue general invitations to attend inspections. Rather, we will examine critically the condition of the poles and try to find out what break-down has occurred and why.

Edwards: We are in general agreement with the proposal made by Mr. Beesley. We inspected these sites in February - March 1963 but found that many of the poles had severe termite attack in the sapwood so that the test is now one of heartwood durability rather than sapwood treatments. We agree that private inspection rather than with representatives of the various councils would be the best form of inspection in the future.

Huddleston: It is very useful to be able to refer a supply engineer to a pole site where he can actually examine poles which have been under test for a period of years.

Item 4(1)

Pole Inspection Practices*

The following statistics, based on data collected by the Electricity Authority of New South Wales from information supplied by thirty Councils, may be of interest. About twelve Councils are yet to be surveyed.

Number of Poles Maintained Per Council

No. of Councils	Poles in Service	No. of Councils	Poles in Service	No. of Councils	Poles in Service
1	2,500	1	12,000	1	28,000
1	3,500	1	14,000	3	30,000
3	6,000	3	15,000	1	32,000
1	7,000	1	20,000	1	35,000
2	8,000	2	25,000	1	60,000
1	9,000	2	26,000	1	75,000
2	11,000	1	27,000	Total poles	618,000

*Prepared by D. Edwards.

Frequency of Inspection by Councils

Intervals in years	1½	2	2½	1 - 3	2 - 3	3	4	5	6	Irregular
No. of Councils	1	8	1	1	6	3	1	1	1	7

Preservatives Used for Maintenance Treatments

Preservative	No. of Councils
Creosote	25
Creosote plus chlordane	2
Creosote plus dieldrin	1
Pentachlorphenol	2

Reported Incidence of Termites

No evidence of termite attack		19 councils
Termites present -		
Many poles attacked	3	
Some poles attacked	7	10 councils
No reply		1 council

The quantity of creosote per pole varies from 1 to 2½ gal, most Councils using 1½ gal/pole. Depth of excavation around pole varies between 12 and 18 in.

Discussion

Dale: The Wolman rot detector is a very useful piece of equipment based on resistance to penetration of a spear point into the poles. A permanent record is obtained by a tracing on carbon paper. Tests carried out by this tool have been confirmed by boring. This could be a worth-while development in pole inspection as it is a non-destructive method of test. We can supply information regarding price and availability.

Kininmonth: Would this apparatus be suitable for detecting early decay in pine? How sensitive is the equipment?

Dale: The equipment is very sensitive; it might not detect incipient decay, but the difference between decayed wood and non-decayed wood in hardwoods was shown very well. It would probably be quite satisfactory for picking up decay in pines.

Item 4(m)

Hylotrupes Report*

The situation regarding Hylotrupes in Victoria may be summarized by saying that of a total of 6,217 imported, prefabricated softwood houses, we have been given details of 1,637 as having been inspected in the last 2 years expressly for Hylotrupes infestation. Hylotrupes damage has been discovered in twenty-four houses, and in eleven instances, dissection of infested timber has revealed the presence of a total of twenty-eight live larvae of varying sizes.

All infestations discovered have been on the larger Victorian Housing Commission estates, the comparative figures being:-

Norlane Estate (near Geelong)	1,252 houses	- 460 inspected; 6 infestations.
Reservoir Estate	350 houses	- 350 inspected; 4 infestations.
Maidstone Estate	553 houses	- 553 inspected; 14 infestations.

It is noteworthy that "Thermo" type houses on the Reservoir Estate were excluded from early surveys, having been fumigated against Sirex on arrival in Australia. However, an infestation in one of these houses was reported by the tenant in 1958, and a further case was discovered in 1959 during routine maintenance. Subsequent surveys in 1962 and 1963 revealed two more infested "Thermo" houses. The other twenty, at Norlane and Maidstone, have been in C.I.B. type units.

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*Prepared by C. D. Howick.

Some interesting facts emerging from an analysis of the infestations are that of the twenty-four discovered:-

Eight were discovered by tenants, two by maintenance and fourteen by surveys.

Seven had no flight holes and seventeen had varying numbers, totalling seventy-six flight holes, of which seven were at Norlane, twenty-five at Reservoir and forty-four at Maidstone.

Twenty-eight live larvae were found in eleven pieces dissected, ten at Norlane in C.I.B. houses, ten at Reservoir in "Thermo" houses which had been fumigated for Sirex, and eight at Maidstone in C.I.B. houses. Sixteen of these larvae were large (200 -450 mg) and twelve small (less than 100 mg).

Two infestations were in bearers, two in ceiling joists, two in doors and the remainder in timbers of small cross-sections such as doorstops and jambs, architraves, cornices, quad and so on.

All twenty-four houses have been fumigated with methyl bromide, but regarding the early discoveries, there was a delay of 2 years or more between discovery and fumigation. Infestations discovered by survey were fumigated quite promptly, but the time lapse between emergence and fumigation is of course completely unknown.

Because we have been finding live larvae as recently as last month in houses that were imported in 1953 and earlier, and as there is no indication that many of these larvae are other than European-born, it would appear that early estimates of 3 or 4 years for the Hylotrupes life-cycle under Australian conditions might have been somewhat erroneous. It is therefore probable that many houses inspected for Hylotrupes and in which no emergence holes were seen, may, in fact be infested.

At a meeting of the Hylotrupes Committee held in Melbourne on 25th June, Mr. Bradley of the Victorian Housing Commission stated that he considered he did not yet have enough evidence to recommend total fumigation of the three main estates to his Minister. The result was that further inspections (commencing 8th July) would be carried out on the Maidstone Estate. We have discussed inspection techniques with the inspectors concerned, and until the conclusion of the current survey no further developments appear imminent.

Discussion

Beesley: Mr. Howick has outlined the present status of the search for Hylotrupes in Victoria and the results it has achieved. In his review of research activities, Mr. Tamblyn stated that we had repeatedly warned the Forests Commission and the Quarantine Branch of our concern over the possibility of Hylotrupes becoming established in Australia.

Nobody will deny that Hylotrupes is one of the world's most serious pests of seasoned softwood timbers. Queensland has seen fit to expend nearly £400,000 on an attempt to eradicate this pest from that State. In 1956 the Acting Prime Minister recommended "prompt action on a national basis".

In Victoria, evidence of Hylotrupes activity was discovered in August 1957, April and September 1958, April and June 1959 and January 1960. Action was taken in February 1960 when these six known cases of infestation were fumigated.

The position in Victoria may be summarized by saying that:

All traces of Hylotrupes infestation so far discovered have been in pre-cut houses imported by the Housing Commission.

Surveys made in the Commission estates at Norlane, Maidstone and East Reservoir have established that active infestion has been and most probably still is present.

Steps have been taken to fumigate houses in which evidence of attack has been found. In recent months, this treatment has been performed soon after the evidence of infestation was detected - but we have no way of knowing how long after emergence occurred was the flight hole discovered.

We have tendered the advice that we consider fumigation of all imported houses in the three estates in question is necessary, and that any further surveys should be concentrated on imported houses of the same origin situated in other localities.

Irvine: Hylotrupes in Australia is primarily a Quarantine matter. Until recently I was doubtful whether Hylotrupes had become established in Victoria, but I now feel that there has been successful reinfestation in the Maidstone Estate, in spite of evidence that the life cycle might extend to 15 years.

There exists a Standing Committee formed by the Chairman of the Forestry Commission on which is represented the various bodies directly concerned with the import of these houses, together with the Chief of the Division of Forest Products and the Director of Plant Quarantine. At the last meeting of this Committee, the Chairman of the Housing Commission required further evidence of infestation before he could recommend to his Minister that Housing Commission houses be given a mass fumigation treatment. The Forests Commission of Victoria has done its best to convince the Housing Commission of the necessity for carrying out adequate treatment. The person who has to make a decision on this problem in Australia is the Director of Plant Quarantine, but he has not made any move at this stage.

Mr. Tamblyn and Dr. Dadswell both agreed that the Victorian Forests Commission had done everything that they could do at this stage.

Huddleston: In April, 1963 the Forestry Commission of N.S.W. began the third series of inspections of 835 imported prefabricated houses owned by the N.S.W. Housing Commission. Details are as follows:

	1956	1959	1963	Totals
New inspections	151	106	27	284
Re-inspections	-	21	58 (to date)	79
				363

No Hylotrupes attack has been detected in Housing Commission dwellings. We are at present considering whether a 20 per cent. random sample is a safe basis for checking the remaining 750 homes. Conference opinion on this point would be helpful. At the same time, a start was made on the third inspection of 57 privately-owned houses in the Sydney area. These houses contain timber from a shipment of Rumanian whitewood in which Hylotrupes was detected. Inspections to date are as follows:

	1956	1959	1963	Totals
New inspections	55	2	1	58
Re-inspections	-	50	36 (to date)	86
				144

No Hylotrupes attack was detected during re-inspection. All houses are to be inspected. Since the first N.S.W. reports of Hylotrupes in 1955, Forestry Commission officers have made some 507 house inspections and 100 factory visits, chiefly to box and case re-sawing mills, importers, agents, etc., at the Commission's expense.

Hylotrupes was detected in two houses, two packing cases and one musical instrument. There were seven suspected but unconfirmed infestations by this insect. The first of the two houses was fumigated by Plant Quarantine at their expense, the second by the Forestry Commission at its own expense. The expense of replacing portions of houses removed for examination was also borne by the Forestry Commission.

The general question of Hylotrupes is such a serious matter in Australia that we cannot argue as to who is going to do the job. Pinus radiata cannot be profitably used without preservative treatment unless Hylotrupes can be eliminated, and this treatment in New South Wales alone would cost several million pounds a year. Much of the timber framing and roof framing in the Sydney metropolitan area is constructed from Douglas fir and the damage which could result could add several million pounds per year to the potential bill for treating Pinus radiata, if Hylotrupes started to cause serious damage. Active action by all Forestry Commissions appears to be essential without considering who will be having to pay for it ultimately.

Chairman: There is no doubt that the Chairman of the Victorian Forests Commission is trying to bring about fumigation of these houses. Fortunately, in Victoria the Minister for Housing is the Minister for Forests, and the Minister is to be approached on this particular problem by the Chairmen of the Forests Commission and Housing Commission.

Ryley: In Queensland, a re-inspection of 2,645 houses fumigated when Hylotrupes was discovered, and 1,500 adjacent houses containing softwoods, has just been completed and so far there is no evidence of re-infestation. Further re-inspections will probably be carried out the year after next. I maintain that all imported houses should be inspected, and if infection is found, all houses in the estate should be fumigated, not only those showing infection. The total cost to date in Queensland has been some £370,000, of which the Commonwealth Government subsidized approximately £150,000. There has been a special allotment of £6 - 10,000 per year for the last 3 years by the Government to the Forestry Department to cover inspections.

Harding: In 1956-57, about 20 per cent. of State Commission houses in South Australia were inspected on an approved sampling basis and no infestations were found. It was intended to carry out a further 20 - 30 per cent. inspection at a later date, but the Housing Commission decided that all houses would be inspected, and have just completed a 278-house inspection. They now report no sign of any infestation at all. Commonwealth Department of Works have some hundreds of houses ranging from Woomera to Salisbury, and they have only just started inspections. However, we should try to keep the right perspective on these things and we should remember that Hylotrupes has been active in Europe for a considerable period and that all the houses have not fallen down; at the same time we should do all we can to keep it out. The possibility of entomological control should also be investigated.

Wickett: Western Australia imported some 2,000 houses in about 1952. At the time of importation, there were signs of Sirex attack, and those houses for which a reliable kiln drying certificate was not available were fumigated with methyl bromide; we do not think any have escaped us, and have not thought that re-inspection was necessary.

Noar: There were not many pre-cut houses imported into Tasmania; we have only been able to trace a couple of dozen, and these have been inspected and no evidence of infestation found. However, our inspectors were not fully trained. These inspections were made 2 years ago, and no further inspections have been made.

Huddleston: Hylotrupes was in South Africa for many years before it became a major pest. First detected in 1941, by 1943 it had spread to such a magnitude that it was necessary to introduce legislation to control it. People from South Africa who have seen the effects of it have told me that houses had actually fallen down from Hylotrupes infection. The total cost of the effect of Hylotrupes attack in South Africa runs into several million pounds.

Bryant: I agree with the view that some attention should be given to biological control of Hylotrupes. However, the Plant Quarantine Branch has only one entomologist and the Division of Wood Technology also has one entomologist, who spends 50 per cent. of her time doing identification work for the Plant Quarantine people, and this position I regard as absurd.

After further discussion, the following motion was moved by Tamblyn, seconded by Bryant, and carried unanimously:

"This Conference is alarmed at the extent of infestation by Hylotrupes in Victoria and recommends that urgent consideration should be given to the fumigation of all houses in any estates where Hylotrupes has been discovered."

This motion to be brought to the attention of the Heads of Forest Services.

A further motion was then discussed. It was moved Thomas, seconded Muir and carried unanimously:

"That this Conference considers that the attention of the Director of Plant Quarantine should be drawn to the need for effective action in all States to ensure that Hylotrupes infestation is not present in imported houses, including those owned by the State or Commonwealth."

Item 4(n)

Developments in the Use of All-Purpose Preservatives*

Prior to June 1961, commercial preservation in Queensland was, with the exception of sap stain treatments and one plant using oil solutions of pentachlorophenol, confined to the use of boron salts by the open tank process. Boron salts however are unfixed and as such the end utilization was limited to internal, non-leachable purposes. At that date the first vacuum-pressure cylinder began operation at Eidsvold. Subsequently plants were installed at Brisbane and Toowoomba and culminated in the operation of an 80 ft x 6 ft cylinder primarily for the treatment of poles and other round timbers. Plants have also been installed at Rockhampton and Ravenshoe. Present charge treatment capacity is in excess of 40,000 super ft with a minimum charge capacity of two charges per day. In view of their water solubility, high fixation and paintability, the copper/chrome/arsenic formulations were preferred.

In commercial application, however, several major problems were found. These were:-

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*Prepared by K. Cokley.

1. Water quality, particularly in respect to pH, hardness and dissolved salts, seriously affected the rate of solubility of the preservative salts.

2. Ambient temperatures - up to 110°F - significantly increased sludging.

3. Certain species such as spotted gum contain extractives which cause significant reduction of the dichromate fraction.

4. The requirement of predrying led to the need for rigid hygiene and the necessity for surface insecticidal and/or fungicidal treatment.

5. As sapwood only is treated and as the volume of sapwood in any charge cannot be estimated accurately and absorptions in volumes are low, this implies that treatment schedules in practice are based on treatment to refusal and the necessity for very accurate measurements of volume.

Subsequent to the initiation of commercial operations, evidence was accumulated to show that:-

1. Penetration of preservative salt into eucalypts and brushwoods was a combination of solution movement and also diffusion of salt. In practice this amounted to a change in concentration of solution equal to approximately 0.02 per cent. - 0.05 per cent. Calculations of absorptions based solely upon solution uptake were in error by an amount approaching 25 - 30 per cent.

   This problem was overcome by calculation of salt loss from the solution before and after treatment. By this means reconciliation of salts is below 5 per cent. and in general approaches 1 - 3 per cent.

2. Reduction of the dichromate constituent caused sludge - accentuated by sawdust in suspension and caused a variability in ratio of constituent. In treatment of certain veneer species, there was a significant reduction in percentage of dichromate. A supplementary effect was in the method of determination of solution

concentration. Normal hydrometric methods were found inaccurate and it is necessary to clarify the solution by suction filtration using an inert agent such as kieselguhr. By this means solution strengths before and after treatment can be determined. Results to date show that although there is an absolute error by hydrometer when compared to analysis, for each plant there is a reasonably constant correction factor varying from approximately 0.5 per cent. to 1.3 per cent.

Three major factors have been determined during both experimental and commercial applications of these treatments. These are:-

1. The degree in inches of vacuum is significant and a critical vacuum of approximately 28½ in. - 29 in. has been found.

2. The time of evacuation, rate of flooding and the rate of pressure application are significant in the treatment of local species.

3. Treatment of green material using extended vacuum has been found satisfactory.

In the laboratory the application of these preservatives resulted in reassessments of methods of analysis, particularly in relation to copper. Treatment solutions were found to contain interfering substances such that accurate results were obtainable only after preliminary separation and extraction; electrolytic separation was found to be unsatisfactory without preliminary separation.

A primary interest in the application of these general purpose preservatives lies in the treatment of brushwoods, particularly in North Queensland. Most of this group contain non-durable heartwoods as well as wide sapwood bands; for optimum utilization it will be necessary to develop a preservative or method of treatment to ensure heartwood treatment.

Item 4(o)

The Desirability of Standard Uniform Spot and Chemical Tests for Determination of Preservative Loading*

The initiation of commercial treatment using multi-salt preservatives has resulted in a need for consideration of methods of assessment of satisfactory treatment. Where the number of samples involved is low and adequate laboratory facilities are available, chemical analyses may be readily carried out. In the field or where the number of samples is high, from a practical viewpoint it is necessary to rely on "spot tests" and these in turn must be able to satisfy the following requirements:-

1. Specificity in relation to the element or radical under test.

2. Satisfactory sensitivity to indicate the minimum limits prescribed.

3. Ease of application, non-sensitivity to the effect of species, e.g. colour, and should be such as to give reasonable results in the hands of field technicians and inspectors.

From a practical aspect, in Queensland multi-salt (copper-chrome-arsenic) formulations are used for three main end uses. These, in order of importance, are:-

1. Anti-Lyctus treatment where arsenic is the primary element, at loadings of 0.03 - 0.04 per cent. As_2O_5.

2. Exterior use above ground level where all three elements are necessary in loadings up to 0.7 lb/cu.ft.

3. Ground-line use where again all three elements are necessary in loadings of 1 lb/cu.ft. plus.

In all cases it is also necessary to define accurately the depth of penetration in relation to some independent physical or chemical criterion, e.g. the depth of starch positive timber. In practice it must be accepted that a semi-quantitative interpretation is placed on the spot test, particularly in relation to anti-Lyctus treatments and a position similar to that prevailing with boron exists. Samples are submitted by timber users, e.g. building

*Prepared by K. Cokley.

authorities, and it is necessary to give a determination as to the quality of treatment. The extent of such demand is indicated by the fact that almost 1,200 such samples were tested by this Department over the year 1962/63. In view of the fact that legislation exists in two States and interpretation is being made by all bodies, e.g. Division of Forest Products, Queensland Forest Service and Division of Wood Technology, the first requirement is that all such bodies use the same standard and spot tests, i.e. there must be uniformity of interpretation and it is for this reason that this matter has been raised.

In Queensland initially the practice was to use:-

1. Chromazurol S as a copper reagent.
2. Diphenylcarbazide as a chromium reagent.
3. Ammonium molybdate as the arsenic indicator.

However it was found -

1. Chromazurol S was satisfactory on pines but in certain cases anomalous results were given on the eucalypts and brushwoods. The sensitivity as a spot was less than desirable and in some instances material gave poor to negative spot tests even though adequate loadings were present. It was found that material after ashing gave satisfactory spot tests even though, when tested in the board, the results were unfavourable. As a result a change was made to an ammonia/rubeanic acid formulation giving more consistent results.

2. Diphenylcarbazide theoretically requires the chromium in the form of chromate and/or dichromate and on present results it would appear that this indicator is really measuring not the total chromium but what may be described as the unreduced chromium.

3. In certain instances it has been found that the ammonium molybdate spot test for arsenic does not react to 0.03 - 0.04 per cent. As_2O_5 - in some tests the colour reaction was at approximately 0.3 per cent. As_2O_5, i.e. there is possible rejection of what is in reality satisfactorily treated material.

In this regard certain trials of pyrocathecol violet showed this reagent to be non-sensitive at concentrations of 0.06 - 0.07 per cent. As_2O_5.

At present the only spot test used for arsenic is the Gutzeit, although the presence of copper does give low results. In all cases tested to date, however, the sensitivity is adequate.

A further aspect is the method of test and the time which has elapsed since treatment. Standard practice in the Department is -

1. If the sample is freshly treated, a thin section is dried in the oven to ensure fixation.

2. As tests on end grain gave exaggerated results and introduced problems of smear, the routine is to cut a section of the board and split it longitudinally. This section is then planed where possible before test. The reagent is then applied to one face and the other requirement, e.g. starch indicators, to the other and a comparison made.

Where so warranted, in the case of chromium, use is made of ultra-violet examination.

A good indicator of penetration has been found to be the heartwood-sapwood indicator, dimethyl yellow. The pH of fixation is approximately pH 5 and this results in a sharp yellow colouration in the treated zone and, at the same time, by the red colour of the indicator, the heartwood zone is defined. Unfortunately this indicator is dependent on pH only and as such any cause of increase in the pH will give a similar result.

In view of the question of differential absorption, a further question arises as to whether it is sufficient to spot test for one element, e.g. copper, and make the assumption that the other elements are there in the formulation ratio. Based on diphenylcarbazide and analysis, there is some evidence to suggest that in the species tested as sawn timber, the penetration of chromium is, in some cases, slightly in excess of copper and chromium and for thin veneer this is markedly so.

Item 4(p)

Problems Associated with the Treatment of Outer Heartwood

Cokley: In spotted gum and in many other species which we use as pole timbers, we have observed a small distinct band inside the sapwood which appears to be showing up as heartwood, although it is showing up visibly before treatment as sapwood to the inspector. Although this may only be ⅛ in. wide, it is possible in sawn timber to get it lying across the full face of the board but, at the moment, we have not had much success with its treatment.

Tamblyn: We have observed this transition area between sapwood and heartwood only in spotted gum but it does seem likely that it may occur in some other eucalypts or other timbers. However, we have seen no reference to it in literature from other countries.

In November 1961, we reported on some preliminary tests made on spotted gum material received from Eidsvold Sawmills in Queensland. The results of our tests on this timber, using a 5 per cent. solution of copper-chrome-arsenic preservative at 200 lb/sq.in. for 1 hr with initial vacuum of 28 in. for 20 min, were as follows:-

Green material: (47 - 53 per cent. m.c.) (oven-dry) - average solution absorption 11.3 lb/cu.ft.

Semi-green: (26 - 37 per cent. m.c.) (moisture meter) - average solution absorption 20 lb/cu.ft.

Dry material: (14½ - 17 per cent.) (moisture meter) - average solution absorption 23.2 lb/cu.ft.

At the higher moisture contents penetration appeared to be patchy and we concluded that for good uniform penetration moisture content should preferably not exceed 20 per cent. in the sapwood when measured conventionally with a moisture meter and corrected for the species. (Blades driven in to a depth of at least ¼ in.)

In almost all specimens treated at the three different moisture contents, we observed a band of light-coloured impermeable wood which we referred to as transition zone of intermediate wood.

It comprised (in our material) about 17 per cent. of the apparent sapwood volume. There was no indication from visual appearance or colorimetric tests that it treated better at any moisture content over the range listed (14½ - 53 per cent.).

We have recently received for further test, material from three Queensland areas and in treating this material will compare long vacuum and slow pressure application with more conventional schedules. We cannot support any suggestion that high moisture contents around 40 per cent. should be tested as they cannot be measured satisfactorily with moisture meters and all our experience with spotted gum and other eucalypts favours moisture content below fibre saturation point for normal pressure treatments with rapid fixing preservatives.

Discussion on Items 4(n), (o) and (p)

Cokley: As we are only a small laboratory, uniformity of testing is essential both within our own Department and also with New South Wales and Division of Forest Products, and in view of the large number of samples that come in from the trade, we must principally rely on spot tests. We feel that it is now necessary for all organizations such as ours to standardize on both the spot test and the interpretation. Last year in Brisbane we handled 1,200 samples from the trade, in addition to those that the Department took, so it is obvious that it would be impossible to analyse every sample.

Tamblyn: I must compliment Mr. Cokley on having achieved a partial solution to the problem of treating spotted gum.

Cokley: We have been using my method both experimentally and commercially on sawn timber since February, and with spotted gum and brown tulip oak the salt uptake using these amended schedules is not significantly different from that with dry material. Calculating uptake in both green and dry material on gallonage gives an error of 25 - 30 per cent. as compared to full analysis. In sawn timber we have absolutely no way of estimating the volume of sapwood. In practice, we therefore treat to refusal and tend to use stronger solutions than perhaps necessary and give close control either analytically or by spot tests. The treatment in terms of uniformity is promising. We have also done some work using non-ionic wetting agents and found that they improved the penetration.

Edwards: I must also compliment the Forest Products Research Branch for their work in this field.

Concerning the problem of sludging at Eidsvold and other plants, I feel that the cylinder should be under cover and that storage tanks should be painted in order to gain some protection from the sun's heat.

We have also had difficulties with spot tests, particularly for arsenic.

Because of difficulties experienced with the use of stannous chloride as a reducing agent in the sodium molybdate stannous chloride spot test for arsenic, we have substituted ascorbic acid for this latter compound ($SnCl_2$).

We now use 5 per cent. ascorbic acid made up at the time of testing by adding one tablet of ascorbic acid (0.25 mg) to ten drops of water. The colour is slightly deeper than that produced by $SnCl_2$ under the same conditions and tends to be a little slower in development. It is less liable to give a positive test when no arsenic or phosphorus are present. Furthermore, it is not acid and is therefore safer to use than $SnCl_2$.

We do not at present have a satisfactory spot test for sodium fluoride.

Kininmonth: I think that the development of types of preservatives suitable for all purposes would be desirable, e.g. a range of waterborne formulations that could be used for all species and purposes and which would not react violently one with another, so that one cylinder could be used for all types of treatment. The idea of one formulation for all purposes is not very practicable from economic as well as technical considerations.

Concerning the desirability of uniformity of spot tests, it is essential that the controlling authority in any region adopts standard methods so that suppliers and customers can carry out their own checks. I do not see any need for inter-region standards although information on the methods and tests used should be freely available. New developments should also be circulated to other regional laboratories; if this is done then each can keep up to date with the best methods availabile, keeping in mind their own special considerations of retentions and species.

Tamblyn: If New South Wales and Queensland would like to suggest a spot test and standardize on it, we would be happy to co-operate.

Kininmonth: New Zealand would be quite interested to co-operate on that basis.

Edwards: I suggest that this might be a matter to be referred to the Timber Preservation Sub-Committee.

Chairman: Then delegated Mr. Cokley to bring this matter up at the Sub-Committee meeting.

Item 4(q)

Premature Attack by Decay or Termites in Treated Poles*

Termite attack in creosote treated S.E.C.V. hardwood poles was found at Mildura late in 1961. Treated poles have been used in the area since 1957 to replace ironbark, grey gum and similar poles which had been vigorously attacked, despite in situ creosote treatment.

An inspection late in 1961 showed that all attack was by Coptotermes acinaciformis, that size of check or split was not a controlling factor in allowing attack and that in situ treatment with creosote did not deter the termites, even when as much as 10 gal/pole was used.

Attack has now been found in twenty-five S.E.C. poles and these have been effectively treated with arsenic (As_2O_3) dust. As a preventive measure, all poles are being progressively treated with ½ per cent. aldrin solution and no attack has been reported in poles so treated. Creosote puddling has been stopped.

All the S.E.C. poles came from one plant which originally used a local creosote, but for the last 18 months has been using a New South Wales' product. There is no apparent connection between the creosote used and the attack.

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*Prepared by F. A. Dale.

Attack has been found in two P.M.G. creosote treated poles from another supplier and in two C.C.A. treated poles, part of a batch installed by the S.E.C. after the first attack. One of these had been explored and one had been substantially attacked in the untreated heart, but in neither case were any live termites present.

Extraction of seventeen sapwood samples from attacked and untouched poles gave creosote loadings from 1.3 to 10.1 lb/cu.ft. but within this range there was no correlation between loading and incidence of attack. However, the serious discrepancy between these figures and the known charge minimum of 12 lb/cu.ft. remains unexplained.

No termite attack has been reported from anywhere else in Victoria or other States where there are now over 300,000 creosoted poles in service.

Another instance of premature attack was the finding of soft rot in the sapwood of a creosoted pole installed nearly 6 years ago in Victoria. Analysis of sapwood from this pole gave a creosote loading of 9.4 lb/cu.ft. Attack was general below ground level and varied from 1/16 in. to ¼ in. in depth. Some other poles at the same site showed surface softening from the same cause, possibly induced by alkaline soil conditions resulting from ash filling. However, no attack of any sort was found in 120 creosoted poles of the same age in the metropolitan area, which were examined as a result of finding this attack.

Discussion

Huddleston: As a result of this premature attack, the P.M.G. are tightening up on their pole specifications, particularly in regard to checks along the length of the pole. Recently the P.M.G. ordered the burning of 570 poles which had been rejected. We inspected these poles and found that apart from a few with end checks outside the specification, there was no reason whatsoever why these poles should have been rejected. When I approached the P.M.G. about this, they insisted that they could no nothing as they were worried about termite attack starting through these checks.

Bryant: We have had radiata poles treated at 90 lb/sq.in. attacked through checks by termites.

Dale: This has been the experience in one case in South Australia, and is why they are not happy about low pressure treatment of radiata.

Item 4(r)

Biological Deterioration of Poles During Seasoning and Control of Blue Stain*

This problem is one which deserves a great deal more attention on the part of the industry. Early troubles due to borer attack in seasoning of eucalypt poles have been controlled by spraying, but recently we had a serious problem in decay of sapwood of eucalypt poles in Brisbane. Many poles stored only 3 to 4 months had so much decay that they were rejected on strength grounds. Brisbane has had an exceptional year climatically, but the same problem may occur, less severely, in other years and other areas. Spraying with Na PCP is to be attempted at the plant concerned but may not solve the problem. We have a greater potential problem in the air seasoning of Pinus radiata and Pinus elliottii, since these species may decay rapidly. We would like to ask about New Zealand experience on this. We suggest that a close check be made of the incidence of decay in both pines and eucalypts, as it is possible that weakened poles could be put into service. Also, there is a possibility that blue stain and decay in P. radiata may lead to gross overtreatment of some poles, raising cleanliness problems with creosote, and giving misleading charge average records.

For all these reasons, we feel that more attention should be paid to method of blue stain and decay control in logs. Seasoning Section has had considerable success in the control of blue stain by water sprays but this method cannot be applied when drying is required as with poles, and also with logs for particle board. They have had very disappointing results with chemical control tests run for comparison. These tests used P. radiata logs felled in December and end-coated with Preservax immediately. Two to five days after felling, a 3 in. length was docked off each end and the logs were dipped in a 2 per cent. Na PCP 2 per cent. borax solution for 30 sec and stored in the open. All "bark-on" logs blue-stained badly. "Bark-off" logs checked, but did not blue stain.

In view of these results and reported failures elsewhere, we would like to obtain the opinions of other delegates on the effectiveness of chemical control and the seriousness of the problem.

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*Prepared by E. Da Costa.

Discussion

Edwards: Regarding control of sap stain and decay in pine logs, some years ago we stored barked and unbarked logs in the forest and subjected them to a series of sprays, designed along the same lines as were successful in the southern U.S.A. Preservatives used were sodium pentachlorphenate and creosote, and logs were sprayed within a few hours of felling. Both chemicals failed to control sap stain in all cases, in all four seasons. We came to the conclusion that some other factors must be involved, and are not convinced that a simple sodium pentachlorphenate spray is the answer; it would need to be a more sophisticated formulation. Regarding the D.F.P. tests on log storage, we have circularized the pine mills in New South Wales advising them of D.F.P. results to date, and asking them would they be prepared to take part in a larger test.

Cokley: We will shortly be doing a full-scale test on 400 slash pine poles to test this point. In a test at Toowoomba where poles were dumped temporarily in a borax solution, the alkalinity on the surface was enough to cause precipitation when the poles were treated with a copper-chrome-arsenate solution.

Kininmonth: Some tests have been done in New Zealand on the use of boron compounds as a dip treatment, and variation in time of felling to time of treatment has been included. It was concluded that boron treatment was very effective as an anti-sap stain, provided it was done as soon as possible after felling. Where treatment is done later, you get a very clean surface but the inside of a log below the surface is badly attacked by sap stain. We are not particularly concerned with blue stain - except for its part in incipient decay. Our climates are much cooler and damper than yours and our problem is to get the timber dry before we get decay starting. The maintenance of high moisture contents in the infected areas gives patches of low loading on treatment. The problem of seasoning round pine for preservative treatment has now come to a head in New Zealand. We find that the standard of stacking and yard layout is not as good as it could be - some people are giving a spray treatment of 2 per cent. sodium pentachlorphenate. Although this is not done with sufficient thoroughness, and all surfaces are not sprayed, it is a start. We feel that if a yard is well laid out and stacking practice is good, we get good enough air circulation to give sufficient air drying to stop blue stain becoming a large problem.

Tamblyn: I saw some material that was felled at Rabaul. It was cut in the morning, sawn, dipped in 1 per cent. penta and stacked out in the afternoon, and yet below the surface of this wood, it became badly sap stained.

Harding: In our northern forests, we get attack by Ips grandicollis through the bark within 2 or 3 days of falling, and it brings blue stain infection with it. I do not know whether it exists in other areas, but it creates a very big problem in utilization.

Huddleston: We have found that unless dipping or treatment is given very soon after falling, you do not get adequate protection. We have seen pine at Tumut that was dipped shortly after sawing, but was blue stained up to within about 1/32nd in. of the surface.

Edwards: The main objection to blue stain in round timber in New South Wales arises where the timber is intended for particle board.

Tamblyn: We are concerned about fungal attack, whether it is staining or decay. Our Timber Mechanics Section is determining the minimum size for poles, based on sound sapwood, and we are wondering whether the calculations now being arrived at will hold, if in fact these poles are attacked by staining fungi.

Item 4(s)

Tests of Queensland Scrub Wood Timbers for Sugar Tram Sleepers*

For these tests we received from Q.F.S. samples of eleven different timbers. These were intended to represent material from three different trees, with all specimens cut in the heartwood, so that we could determine the treatment characteristics of the timber likely to be used in rail sleepers.

Unfortunately a considerable amount of sapwood or intermediate wood was received, and it has not been possible to determine the permeability of the heartwood in some species.

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*Prepared by N. Tamblyn.

Results of treatment at 200 lb/sq.in. with creosote (Lowry schedule) and copper-chrome-arsenic (full cell treatment) were:-

brown quandong	-	negligible heartwood penetration.
yellow boxwood	-	sapwood only supplied.
tea tree	-	good heartwood penetration - promising species.
damson	-	a considerable amount of sapwood present; results doubtful - needs re-testing.
red tulip oak	-	unsatisfactory heartwood penetration.
yellow walnut	-	sapwood only supplied (presumably).
brown salwood	-	about 12 lb/cu.ft. in heartwood of fairly small specimens; doubtful if sufficiently permeable.
Johnstone River hardwood	-	uncertain if all heartwood; some loadings fairly high (12 - 20 lb/cu.ft.) with waterborne; needs re-testing.
canary beech	-	all sapwood) cannot judge permeability of heartwood.
pink wandoo	-	all sapwood)
white carabeen	-	all sapwood)

A report has been prepared and is at present being duplicated.

Discussion

Dale: We had trouble with red tulip oak with the standard indicators for penetration, which appeared to be less than the pick-up indicated.

Ryley: Brown salwood is a species that I consider too valuable for sugar tram sleepers; it is being marketed as a substitute for teak.

Tamblyn: I apologize for the slowness in getting these results out, but I would like to see some of these species that are reasonably promising treated and put into a track.

Ryley: I will look into the matter of getting some of these species treated and installed; Tully would probably be the best place, as they are in the most trouble for sleepers.

Item 4(t)

Preservative Effectiveness of Australian Creosotes*

With the great increase in the use of creosote for pressure impregnation of transmission poles since 1957, more attention has been paid to the quality of the creosotes being used. In 1962 a special Committee of the Standards Association of Australia, on which the Division was represented by Mr. Johanson, undertook the improvement of the K. 55 specification drawn up in 1936, and to assist this revision, we agreed to carry out evaluation tests on various creosotes available to treating plants.

One of the major lines of investigation was a direct evaluation of the preservative value of the creosotes against decay, using a standardized American method developed largely at Madison and issued by the American Society for Testing and Materials as standard ASTM D1413 in 1961. In this method ¾ in. sapwood cubes are impregnated with various retentions of the creosote under test and given a severe accelerated weathering by drying at 50°C for 14 days, during which time the blocks are soaked in cold water for 2 hr on each of 9 days, an approximate estimate being made of the loss of creosote during the 14 days by the loss in weight of the blocks. They are then exposed to attack by specified wood destroying fungi in a soil-block test and the amount of decay (as loss in weight) of each block determined. By plotting the amount of decay against initial retention of preservative for each block, we can estimate the lowest initial retention which would have completely stopped decay and this is referred to as the "threshold value" for that creosote.

Our ASTM tests are by no means complete but the implications of our early results are so important that we have decided to obtain your opinions on the results using Pinus radiata sapwood and the main creosote test fungus Lentinus lepideus strain Madison 534. The table gives the approximate threshold values for a wide range of creosotes and the losses of creosote during weathering (given for a 6 lb/cu. ft. loading which happened to be used in all tests) and, as a matter of interest, some physical and chemical characteristics of the creosotes. The results shown are subject to slight alterations for various reasons (e.g. we are still investigating the best statistical method of deriving a treshold value from our data). We are also conducting tests with mountain ash and spotted gum sapwood; with more severe weathering and

*Prepared by E. Da Costa.

other methods of weathering; with larger specimens and with other test fungi. When these results become available we will be in a better position to draw final conclusions, but we do not expect them to change the picture substantially.

These results are still incomplete and have not been brought to the notice of the Standards Association Committee, nor to the manufacturers whose products we are testing. While we feel that it would be impossible to discuss the matter properly without mentioning names, we must ask that you regard the results as confidential, and take particular care that they are not reported to creosote manufacturers, treatment plants, or creosote buyers at the present stage.

The table shows a very wide variation in threshold values. This is disturbing when it is remembered that almost all the creosotes meet the present K. 55 specification, and that all except No. 12 (an experimental creosote/tar mixture) and No. 13 (a brown coal tar) have been commercially available to treating plants.

What do these laboratory evaluations mean in practical terms? I think that the ASTM test gives a reliable comparison of the probable effectiveness of different creosotes in preventing decay of poles in service. This may not be a proportional comparison, e.g. creosote 1 will be much more effective than creosote 9 in service, but it may not necessarily take 3 parts of No. 9 to give equal performance to 1 part of No. 1 on the field, as it does in the laboratory.

While we are confident that ASTM comparisons of different creosotes will hold in service, it is much more difficult to interpret any ASTM threshold value in terms of anticipated service life. This involves correlating laboratory results with field or service data, which are difficult or impossible to obtain.

I feel that, until we learn a lot more about laboratory weathering and about field results, we should allow a wide safety margin between ASTM thresholds and service recommendations, particularly for our highly toxic but relatively impermanent vertical retort tar creosotes. I find it difficult to accept a fortnight's ASTM weathering as equal to 40 years in service as a pole despite the vast effect of specimen size.

In the second place, the 12 lb/cu. ft. retention usually recommended is only a nominal one based on the charge average. We recognize that even under good treatment conditions, some

poles may have retentions only two-thirds of the charge average, which could bring them below threshold values. Moreover, we have evidence that in some cases the "charge scatter" is much wider than we expected and a few poles may have only 5 lb/cu. ft. It is very disturbing to think that some poles with only 5 lb/cu. ft. of creosotes like No. 7 - 11 may be now in service, but since it is impossible to track them down, we can only keep our fingers crossed.

Looking at the table, we can see that although high thresholds are not correlated with distillation range to any extent, they are clearly correlated with low tar-acids figures. It is possible that insistence on a minimum tar-acid content of, say, 15 per cent. (for vertical retort-tar creosotes) in place of the present 5 per cent. would exclude the poorer creosotes. A lower requirement would suffice if it were confined to phenolic groups in the boiling range above 230°C. This proposal, however, may not be acceptable to manufacturers. Until we can complete research we are now planning, on the relative contributions of various fractions to preservative efficiency, we cannot be quite sure that this requirement would be completely successful, nor can we be sure that some simpler requirement would not be enough. In other words, it would only be a tentative interim attempt at a solution.

In my view, it would not be feasible to use an ASTM type test as part of a Standards specification or a legal requirement. The test is too difficult and requires too much mycological organization to be used readily by producing companies and we would not be able to carry out such control tests in this Division. Other standardized tests (possibly the new British standard BS838-61) might be more practical and it might be possible to arrange for some official testing laboratory to carry out tests for a fee, although the long test period of up to 6 months would be a difficulty. Our research here will, we hope, eventually enable us to correlate threshold values with more rapidly determined chemical and physical properties of the creosote. However, we just have not got the field and service data which would enable us to fix a maximum threshold value equivalent to 40 years' service. This will eventually be obtained as better field data on known creosotes arrive from here and overseas.

Finally, I should point out that these ASTM tests are only part of the job of evaluating a creosote. They refer only to effectiveness against decay; we must also do tests of anti-termite activity, cleanliness, penetrating power, and absence of sludging. Mr. Johanson has prepared some notes on another important aspect, the effect of creosote quality on penetration.

COMPARISON OF AUSTRALIAN CREOSOTE OILS

(ASTM EVALUATIONS USING P. RADIATA AND LENTINUS LEPIDEUS DFP 7519)

Test Creosote	Tar Acids (%)	Per Cent. (w/w) Distilling in Range (°C)				Test No.	ASTM Test	
		0 - 205	0 - 230	0 - 315	0 to Final Temperature		Loss of Creosote in Weathering*	Threshold Value
1	19	8.1	23.9	66.6	88.2 - 370	2	61	3.0
2	(17)‡	(0.8)	(6.2)	(58.8)	(79.0 - 355)	2	51	3.3
3	(>18)	(4.3)	(13.7)	(62.4)	(94.3 - 380)	5	50	Approx. 4
4	20	6.0	21.4	62.5	90.7 - 370	1, 2, 3, 5	45 - 49	3.5 - 5
5	-	4.2	28.2	77.0	95.4 - 370	3	70	4.8
6	20	10.8	49.7	90.6	-	1	79	4.9
7	7	3.81	23.3	76.9	93.3 - 335	5	63	Approx. 8
8	9	1.23	19.7	79.2	96.4 - 370	5	68	Approx. 9
9	-	1.41	16.0	67.2	85.5 - 355	1	60	9.4
10	6	4.79	23.3	77.5	92.9 - 340	3	67	>10
11	-	1.41	12.4	77.5	93.5 - 345	3	71	>10
12	20	2.0	7.6	42.2	84.9 - 380	2	34	3.0
13	19	3.3	18.3	53.7	81.5 - 370	1	46	5.5
SAA - K.55 specification								
Present	5	6	40	85				
Proposed	5	6	25	75				

*Percentage of creosote lost from blocks with 6 lb/cu.ft. initial retention.

‡ Data in brackets supplied by manufacturer.

Brown Coal Tar Creosote*

We have for some time been interested in the preservative properties of brown-coal-tar creosote (BCTC), a by-product of the manufacture of town gas from brown coal by the Gas and Fuel Corporation (Victoria). The material appears to be promising but an objection could be raised to its pitch content and the tendency to produce a somewhat dirty surface due to bleeding of tarry material.

For further testing, a creosote which is considered suitable for commercial production has been prepared by pilot-scale distillation. We have pressure treated messmate stringybark and mountain grey gum poles to 20 lb and 10 lb/cu.ft. loadings estimated on sapwood volume. These poles will be periodically examined for their weathering properties and cleanliness.

In addition to decay tests, penetration properties of this BCTC distillate have been compared with commercial creosotes from black coal tars. In one of the tests using hot and cold bath treatments, carefully matched sapwood and heartwood specimens of mountain grey gum and messmate stringybark were placed into preheated creosote at temperatures of 50°C, 70°C, 80°C, 90°C and 96°C. It was found that at higher temperatures, including 90°C and 96°C, sapwood of both species retained about 18 per cent. more by weight when treated with BCTC. Although the differences in retentions in heartwood specimens are smaller, amounting to about 15 per cent., these differences are also statistically highly significant.

Matched sapwood specimens of grey gum and messmate and heartwood of radiata pine were pressure treated for 1 hr at 50 lb/sq.in., 100 lb/sq.in. and 200 lb/sq.in., at a carefully controlled temperature of 180°F. The creosotes used were BCTC distillate, Victorian and New South Wales. The differences in up-take between creosotes were small but definite trends were established at 100 lb/sq.in., showing that retentions of BCTC in grey gum were significantly higher than those of the other two creosotes. In radiata pine the uptake of BCTC and Victorian creosote is significantly higher at the 1 per cent. level than that of N.S.W. creosote.

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*Prepared by R. Johanson.

At 200 lb/sq.in., for all three species, BCTC and Victorian creosotes gave higher uptake than the N.S.W. creosote and this effect was significant at the 1 per cent. level. When these retention/weight values were calculated to corresponding unit volumes by adjusting for specific gravity of the three creosotes the differences in uptakes were reduced but were still against the N.S.W. creosote.

It was thought that these differences in retentions might be reflected in the tar-acids content of creosotes. This hypothesis was tested on matched sapwood specimens of the two eucalypt species by treating them in tar-acids-free residue oils of BCTC and Victorian creosotes. (The tar-acids content of the two creosotes are 22.7 per cent. and 18.8 per cent. (w/v) respectively.) Treating at different temperatures by the heating and cooling cycle as before, the results obtained indicate that without tar acids retentions are similar in both residue oils.

In a further test using the above treating procedure, a direct comparison of retentions was made between intact creosotes and their tar-acids free oils. Although the values are not yet statistically analysed, indications are that results will be highly significant in favour of intact creosotes. At this stage it appears that under the conditions employed, tar-acids make a small but definite contribution towards penetration of creosotes in the sapwood of grey gum and messmate stringybark and in the radiata pine heartwood.

Discussion

Bryant: We are very grateful to the Division for making this information available to us at this stage. I have long suspected that these differences existed. Much of the work done 20 years ago on our creosotes, when they did have a higher toxicity than they do at the moment, could lead us into false conclusions regarding present-day creosotes, which is very disturbing.

Tamblyn: We would like some guidance from the Conference as to what we should do about this. The creosote with a threshold retention of 10 lb/cu.ft. is being sold largely for preservation of poles and perhaps 50,000 poles will be treated with it in the next 12 months. Its penetration appears to be below par and its threshold seems dangerously high; when one considers that many poles are going into service undoubtedly with loadings below the threshold, we have a big responsibility to take some action. The very large capital investment makes any move very difficult.

Chairman: Mr. Da Costa said that this could be mentioned at the Standards Association Committee meeting where these firms are represented.

Huddleston: The right procedure is to take it up with the S.A.A. and in New South Wales at least this information will have a marked effect.

Bryant: Do you place any significance on the difference between the field samples and official samples; for instance, how much greater than 10 was the threshold of samples 10 and 11?

Da Costa: I do not know; we were not expecting such high thresholds and the experiment was not designed to cope with them. In those creosotes the threshold is certainly above 10, but we do not know by how much. I believe that the differences are such that 7 and 8 are better than 10 and 11. Statistics, at the moment, are trying to work out a method of computing threshold values mathematically, so that significance tests can be applied. Creosotes, of course, vary as they are not a standardized product.

Chairman: Are you repeating these experiments?

Da Costa: We are in other timbers, but probably not in pine. Also, if the creosotes have a threshold above 10, I doubt if it is worth determining whether it is 12 or 14; the fact that it is above 10 is sufficient.

Tamblyn: We have already checked these results. We, in fact, had these results before the Pole Symposium in March, but we did not release them then, as we deliberately waited for them to be re-checked.

Huddleston: I believe this should be placed before the Standards Association as soon as possible; these results are most disturbing, particularly as the P.M.G., for example, while specifying a nominal 12, are accepting retentions below that.

Thomas: I agree with what has been said. In relation to the poorer creosotes, do they comply with the old K.55 or to the amended specification?

Johanson: They comply with the proposed amendments to the 1936 K.55.

Cokley: Is there any chance of tying this creosote variability in with premature failure in treated poles?

Dale: We have not been able to do so through lack of information.

Item 4(u)

The Future of Durability Tests*

In past years, Preservation Section has carried out a great deal of research on the natural decay resistance of timbers. Some of these projects have been set up largely because of their scientific interest, although they have possible economic implications (e.g. work on the chemical bases of natural durability), whereas others have been prompted largely by some immediate economic problem, although they may have some scientific interest (e.g. work on the durability of "creamy" karri or of "powderbark" from Western Australia and general surveys of the decay resistance of different timber species). We are now wondering whether some aspects of the applied side of this work may change with the increasing use of preservative treatment for timbers in ground contact.

We are continuing the inter-species testing (e.g. we are preparing to install extensive stake tests of natural durability and wish to compare some of our extremely durable species with each other and with elite species from overseas), but would like to know of instances where there is considerable economic interest in the decay resistance of a species or in the comparative decay resistance of a group of species. Similarly, we are thinking of doing more work on the variation in durability within certain species of particular economic interest (e.g. spotted gum poles or sawn red gum) but would like to know of species where there is an immediate economic importance of variability.

We feel that with increasing preservative treatment, the major applied interest in natural durability may tend to be in moderately durable timbers which may be used for external building timbers rather than in highly durable timbers used in ground contact (e.g. the durability of pine heartwoods or rain

*Prepared by E. Da Costa.

forest timbers used in external joinery). Testing timbers for this type of use requires different laboratory techniques and we may have to rely more on panel exposure tests of the type Dr. Rudman is already using for radiata pine weatherboards. Here again (as well as for ground contact timbers) we invite your suggestions as to the species of most interest to you. With our heavy programme of existing work, we could probably not test them immediately but once we know the problems we might, with your collaboration in collecting and exposing material, be able to get them into test before the next Conference.

Discussion

Rudman: We have examined the radial variation in extractive contents and fungi-toxicity of heartwood extractives of jarrah. After confirming that decay resistance in jarrah is dependent on the presence of toxic heartwood extractives, we have shown that the deterioration in decay resistance in the standing tree with time, that is aging, is associated with a fall in toxicity of the heartwood extractives. This fall in toxicity is tentatively ascribed to polymerization of extractives to less toxic dimers, trimers and tetramers, etc., possibly under the influence of free acid released during autocatalysis of O-acyl groups.

Huddleston: Regarding the future of durable species, we have been particularly concerned in New South Wales at the development in the use of preservative treated poles. The P.M.G. have laid down that all poles shall be preservative treated, and other authorities are thinking of doing likewise. The economics are based on an expected life of 50 years; the effect is to wipe out some of our desirable pole species because they have insufficient sapwood to give what is considered a satisfactory thickness of treated timber. In one area, the contractor has refused to cut white mahogany because it has a thin sapwood and the P.M.G. would not accept it. In white mahogany and certain other species, we have poles which give a 50 year plus life, without preservative, and there is no reason why we should put the additional cost of timber preservation on to them. We should be careful when we speak about preservative treatment and durability of species that we do not damn the species that have given excellent services in the past.

Bryant: Gay has found significant differences in the palatability of wood from suppressed trees of blackbutt to

Coptotermes acinaciformis. These differences have led us to collect material from some seventy samples from three groups of trees based on dominance of the stems, for an extensive series of tests which he is shortly commencing. This may tie in with Dr. Rudman's work.

Rudman: We are testing, in exactly the same way, the termite resistance of jarrah. We have already tested the decay resistance of cypress pine from New South Wales and Nyasaland. We are also testing the termite resistance of this cypress pine. Results to date indicate that rate of growth has very little effect. In most durable trees you tend to get wood near the heart which is not so durable and in fast-grown trees where the inner growth rings are wider, there will be more of this wood.

In the future when we get more fast-grown poles, the heartwood may not be as durable as the heartwood available in the past.

Chairman: It appears that there is still a need for durability tests, testing the variability and testing species that are not in use at the moment.

Da Costa: We are interested in the economic problems that are arising due to durability requirements.

Bryant: This question needs a lot of thought, and perhaps the Preservation Committee could consider it. However, this would exclude those States that are not represented on this Committee.

Bamber: I would like to stress that it is very important in this type of study to be very sure of the absolute age of the material one is working on. A suppressed tree might be the same size as a much younger one alongside it.

Rudman: We have recently requested trees of varying age within the limits that foresters can determine them. Species testing involves considerable work and we wish to know whether the information you have from all sources is adequate for your needs, or whether there are more problems which need answering.

Cokley: What are the findings on the outer heartwood of spotted gum?

Rudman: When we looked at the spotted gum problem in 1958, the problem then was to decide where the sapwood lay in poles for treatment. There are two types of sapwood, one we call inner and the other outer; we found that it was all treatable and was all decay-susceptible and therefore must be treated. It now appears that there is also a further narrow band - 1/8 in. to 1/4 in. wide which is light coloured and appears, from results to date, to be outer heartwood. Previous tests on outer heartwood indicated it to be reasonably durable.

Da Costa: We have done rough scout tests on a few pieces showing this typical transition zone, and first results indicate that it is more durable than sapwood.

Chairman: The Preservation Committee should investigate the species that should be tested in the near future, and indicate the tests that are desirable at the next Conference.

Item 4(v)

Extension of Heart Rots in Treated Poles*

This is a problem to which we will have to give much more attention in the future. There are five questions to be answered:-

1. How common are heart rots in poles for treatment?
2. How many would extend seriously in service?
3. Are they likely to be controlled by present treatments?
4. What control measures could be adopted?
5. What standard of rejection should be adopted?

It seems likely that many, or even most, cases of heart rot will survive in treated poles since these are never completely dried out, and they may extend rapidly enough to shorten the life of the pole. We must remember that extensive heart rot beneath a sound exterior is a major safety hazard.

*Prepared by E. Da Costa.

It is unlikely that present treatments would kill heart rots in treated poles. Some tests here with commercial treatment of old poles for salvage show that creosote gives remarkably good penetration into actual areas of rot, but there is probably some margin of incipient decay which is not penetrated. This will not be sterilized by heat but may be sterilized by fumigant action. With waterbornes, there is unlikely to be sterilization of margins by diffusion. We could improve chances of sterilizing poles by (a) prolonged heating when using creosote; (b) more fumigant action in creosotes; or (c) using diffusible fungicides in waterbornes. None of these seem very attractive, though all are possible.

The standard of rejection should therefore be that any pole showing even a trace of heart rot should be rejected (or ? heat sterilized). The implications of this recommendation depend largely on the answer to the first question: How frequent is heart rot in treated poles, especially in low durability messmate or marri? Can we get some surveys made to get accurate answers for the different pole species?

Discussion

Da Costa: What does the official standard say about heart rot in poles?

Huddleston: The present specification permits clean pipes in poles, and the interpretation of this is left to the inspector. I would assume that some rot is associated with it. In any case in a pole with no pipe, but incipient decay, the pole is accepted.

Harding: What is the suitability of radiation treatment for heart rot already existing in a pole.

Da Costa: This treatment would be effective, but it is not the sort of treatment that could be done in the field.

Huddleston: Some years ago, a number of poles inspected on behalf of the N.S.W. Railways showed that the decay that was present in poles put into service was extending.

Item 4(w)

Multi-Salt Diffusion Treatment*

A clearer picture has emerged of the performance of boro-fluoride-chrome-arsenic diffusion preservative since its first introduction into New Guinea about 7 years ago. As far as we know it is giving satisfactory protection to klinki pine building timbers at Port Moresby and other areas where conditions are more hazardous than generally experienced on the Australian mainland. Testing against termites has been carried out in a forest area in Victoria, and here too, in an exposure period of 5 years, the complete formulation containing B-F-Cr-As has given full protection against termites. No specimens were attacked despite deliberate cutting to expose wood in the core. By comparison, treatment with boron and sodium fluoride mixture, omitting arsenic, produced heavy termite attack. These tests were made under cover to simulate conditions in the sub-floor area of a house.

The boro-fluoride-chrome-arsenic diffusion preservative has now been patented as a single dry-mix preparation and is freely available as a partial dry mix, in which boric acid is supplied separately, from four lincensees, including the recent applicant Stauffer Chemical Co. Up to the present, the commercial use of this preservative has not been encouraged in Australia for treatment of building timbers. In the case of radiata pine weatherboards we feel that the fixed preservatives of Cu-Cr-As type are preferable because of the general lack of priming of the end grain. Generally, boron and fluoride components in known diffusion formulations do not fix at all or only slightly and are thus unsuitable for service where there is a leaching hazard.

Since the last Conference we have developed other diffusible formulations capable of giving highly concentrated solutions and of fixing to some extent after diffusion. One formulation is based on three components B-Cr-As with Cr and As mostly fixable, while boron remains in a leachable state. Our interests are centered on developing diffusible Cu-Cr-As types and some progress has been made in this direction and a patent application has been lodged.

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*Prepared by R. Johanson.

It becomes abundantly clear, however, that under some conditions, depending on the wood, ordinary diffusion concepts could not be applied to heavy metal radicals. While still being in an unfixed state they could be effectively immobilized by the simple process of adsorption. In contrast components such as boron and fluorine do not suffer from such a disability and diffuse comparatively freely. Laboratory application of these preparations to species which are relatively impermeable at high pressure, even at 1,000 lb/sq.in., has shown that limited envelope penetration is possible.

In situations where limited protection is all that could be obtained, diffusible preservatives containing fixable components in a treated envelope may have applications which perhaps hitherto were not fully appreciated.

Discussion

Cokley: Variability in treatment due to a variety of causes is serious, but we are pleased to hear of combination of salts which may result in a general purpose preservative. We have no difficulty in immunizing spotted gum heartwood - the problem is once you get the preservative there to keep it there. From our point of view we would like to see this work continue.

Chairman: Isn't there a future for diffusion treatment for rain forest species?

Cokley: No, what we can do with diffusion treatment, we can do better and more cheaply with boron treatment, considering the end uses.

Item 4(x)

Activities of Commercial Pest Control Companies*

This item has been included on the agenda because this Division is perturbed both at the malpractices in which some commercial pest control companies engage, and at the amount of contact work it necessitates for ourselves.

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*Prepared by C. D. Howick.

It would seem that the field of pest control which lends itself most suitably to questionable practices - many of which involve outright fraud - is that of the control of insect pests in seasoned timber. It is a subject on which the general public is lamentably uninformed and therefore grossly susceptible to fraudulent practices. Whilst we are of the opinion that the pest control industry may well perform a necessary and useful service in fields such as legitimate termite eradication, we cannot condone the unsolicited so-called "free" inspections by itinerant self-styled "experts" which may result in the householder, or more often his wife, signing a contract for a sum of £15 to £60 for treatment of borers which may or may not be present. This month's edition of the magazine "Choice" gives some examples.

Illustrating two local instances, we might mention an enquiry we had from a small Victorian country town where a resident had been told by the representative of one of these companies that his house was infested by Hylotrupes and quoting £140 for eradication. A sample of the affected timber was forwarded to us, and damage found to be Lyctus attack with live Lyctus larvae in the piece. In another case, a housewife in a Melbourne suburb was offered a written guarantee as an added incentive. This guarantee, which was in small print, read "We the undersigned guarantee to carry out the abovementioned treatment for the sum of £38". Many other guarantees are apparently equally valueless.

This constant battering of the householder is doing a grave disservice to the public image of timber. The manufacturers of competitive materials are making capital out of it by advertising their products as being "rot-proof and immune from borer attack".

Some suggestions to improve the situation are:-

1. Better and more readily available technical instruction for all engaged in the industry. Other States might well follow the example of New South Wales and issue an appropriate diploma.

2. The registration of all organizations engaged in the industry and the licensing of their operatives. The conditions for receiving a licence could depend upon holding a recognized diploma plus suitable experience. The licence could be revoked in cases of proven malpractice, and registration of the organization be

liable to suspension in cases of unethical conduct. Standards of ethics could be policed by a trade association.

3. A widespread publicity campaign to alert the public to what is going on. We have seen the current issue of "Choice", Journal of the Australian Consumers Association, in which an expose of several companies was printed. Unfortunately, this magazine is not universal in its distribution.

We know that most authorities represented here are well aware of the problem and we invite comments.

Discussion

Huddleston: I agree with everything Mr. Howick has said. A recent innovation of one of the larger companies in New South Wales is to start a street-to-street canvas. Their technique is to give a free inspection, every inspection producing a job which is quoted for at a substantial figure, with discount if it is done while the unit is in the street. We were approached by the Australian Consumer Association to help expose these practices, and while we would not be on their committee, we agreed to inspect any houses which were in dispute and to give an accurate report. As a result of our assistance, the article subsequently appearing in "Choice" resulted. The publicity resulting from this article, including press and radio articles and reviews, has caused considerable upset in the industry. An association has been formed with the aim of controlling some of the malpractices common in the industry.

I have given instruction for inspections, when requested, to be carried out, and if the Commissioners agree, I propose to hand the results of inspection, together with the incoming letter, to the Police Department, to see if they want to take any action. Legislation should ensure that all inspections are carried out by qualified people, and should lay down what these qualifications are; also, they should make it an offence for such a person to give an untrue report. In addition, it should be an obligation of these pest control companies to bring under Government notice the existence of any pests which are likely to have an effect on the economy of the country.

Irvine: The position in Victoria is probably no better or no worse than that existing in New South Wales. I have received many queries asking whether certain treatments are effective or, in fact, if they are required. In response to my request to the treating companies to show me six houses in which treatment was absolutely necessary, I found there had been old Lyctus attack in one, and no evidence that treatment was warranted in the second. On telling the house owners that they had wasted their money, I received a letter from the treating company threatening me with legal action if I continued to make such statements; however, I continue to make them. These two cases were the only ones offered to me by the companies concerned. I know of only two companies in Victoria who do door-to-door canvassing. Regarding Mr. Huddleston's proposals, I believe that it is our duty as one facet of the timber industry to do something to protect our product.

Ryley: The situation in Queensland is similar to that in New South Wales. I do not know how many companies there are, but police have investigated the activities of some of them. Some companies are very small and consist only of a salesman and a telephone. There are certainly a lot of operators who should be controlled in some way, although we have not thought just how they should be controlled.

Harding: We have substantially the same thing going on in South Australia. In one case where a big price was quoted for treatment, we arranged for our entomologist to inspect the property and it was found that treatment was unnecessary. We have suggested at various times that people come forward and give evidence against these companies, but most are afraid of victimization. Wherever possible, we give instructions to people on how to do their own treatment where it is necessary.

Edwards: Since 1955 a pest control course has been operating at Sydney Technical College. Some 180 students have passed through this course, which is now being offered as a correspondence course and will be available to operators in States other than New South Wales. The Sydney Technical College has also published a book on Australian pests of the home and industries which is very sound.

Chairman: It seems to me that it is up to the States to take their own action. We have done what we can in Victoria, and we have arranged for country newspapers to print the stories directly. We can pass on to you the experiences we have had.

Howick: There is one reliable pest control company in Victoria which pays for its operators to take the correspondence course in New South Wales.

Item 4(y)

The Effectiveness of Emulsion-Type Preservatives for Surface Application*

Because of numerous enquiries resulting from extensive advertising by overseas manufacturers and distributors of proprietary emulsion cream preservatives, a preliminary test was initiated to determine the penetrating properties of one such preservative, "Woodtreat 55" manufactured by Preservation Developments Ltd. of London, under licence to Wood Treating Chemicals Co. of America. The active constituents of the preparation are pentachlorphenol and dieldrin and the emulsion is such that subsequent painting of timber treated with it is unlikely to be satisfactory.

For the test, duplicate hand specimens of each of eleven timbers - radiata pine sapwood, and heartwood of Douglas fir, coachwood, brush box, three species of mangrove and four eucalypts - were used. They were seasoned and dressed to a convenient uniform size. Each specimen was lacquered on one end and two faces and the preservative applied to the unlacquered faces at the recommended quantity of 1 lb/18 sq.ft. of surface area and to the unlacquered ends as a coating ¼ in. thick. An oil-soluble dye was incorporated in the emulsion to show depth of penetration.

One specimen of each pair was cut after 1 month and the second after 7 months and examined for longitudinal, tangential and radial penetration. After 1 month, radiata pine sapwood and Douglas fir heartwood showed longitudinal penetration from the end grain surface from about 1 to 1½ in., while on the tangential and radial faces, penetration of up to ¼ in. had occurred. In all remaining timbers, penetration was negligible. After 7 months there was little or no change in the penetration pattern, and there was still less than ¼ in. penetration from the end grain in eucalypts.

We view with suspicion photographic evidence of penetration of this preservative as shown in advertising, as our experience is that it migrates very rapidly over a freshly cut surface and this, of course, gives a false indication of penetration. This ability to spread widely over surface area may give this sort of emulsion some application for in situ treatments on bearers, etc., but as

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*Prepared by C. D. Howick.

a general preservative, it does not appear to have any great scope apart from treatment of radiata pine sapwood. We cannot be certain that the penetration pattern obtained in heartwood is indicative of sapwood penetration in hardwoods.

The P.M.G. Department has included this preparation in two small field tests using groundline bandage treatments. It was applied to pole stubs from 15 in. below groundline to 9 in. above it and covered with a layer of polythene-faced sisalkraft paper which was stapled to the pole. These tests commenced in January 1963 and as yet no inspections have been made.

We ourselves used Woodtreat 55 in a short test of a similar nature and found it too sloppy to give satisfactory coverage on a vertical pole.

We are interested to know whether other authorities represented at this Conference have had any experience with this type of preservative and whether their findings are similar to ours.

Whilst on the subject of widely advertised proprietary preparations, we have had a great many enquiries regarding "WATCO" products. Our very limited tests have not substantiated the maker's claims, and as we know the Division of Wood Technology has had various dealings with these preparations and their manufacturers, we hope they may give the Conference the benefit of their experience.

Effectiveness of Surface Application of Dieldrin and Chlordane Emulsions Against Termite Attack*

The effectiveness of surface applications of emulsions of dieldrin and chlordane in preventing termite attack on susceptible timber was tested in the following way.

A number of boxes measuring 3 in. x 3 in. x 6 in., and with one open end, were made from ½ in. alpine ash. Six were dipped in 1 per cent. dieldrin emulsion, drained, and dried, six dipped in 2 per cent. chlordane emulsion, and six left untreated. The boxes were exposed around two mound colonies of Nasutitermes exitiosus in a random manner, being supported at least 1 in. clear

*Prepared by F. Gay, Division of Entomology, C.S.I.R.O.

of the ground on a wooden billet embedded in the soil, and protected from the weather by enclosure within a piping and fibro jacket. The primary object of this method of exposing the samples was to simulate conditions in the sub-floor area of a building.

The samples were installed in April 1955 and their condition as regards termite attack recorded at intervals of 10 - 18 months thereafter. At the first examination in August 1956, that is after 16 months' exposure, all the untreated boxes had been destroyed by termite attack, four of the six dieldrin-treated boxes showed slight attack or more, as did five of the six chlordane-treated boxes. Attack on all treated boxes continued steadily and by December 1959 all the chlordane-treated boxes had been destroyed. The last of the dieldrin-treated boxes was destroyed in November 1962.

The average length of life for the three groups of boxes was: untreated, 16 months; 2 per cent. chlordane emulsion treated, 27 months; 1 per cent. dieldrin emulsion treated, 71 months.

Discussion

Huddleston: We have tested the Watco material and have been threatened with legal action as the result of these tests. At the present time, although we know the material is no good and have satisfied ourselves on this point, a lot of the staff are engaged on various extensive tests to make sure. Firms such as these can put organizations such as ours to considerable expense by having to test products which we know cannot stand up to the claims made for them.

Cokley: We ran into trouble with Watco in Queensland. Fortunately we were aware of the results of N. S. W. tests, and as a result, all their claims are being withdrawn in Queensland.

Huddleston: In New South Wales it is an offence to sell preservatives containing certain chemicals unless the formulation is registered with the Department of Agriculture, and this applies to pentachlorphenol.

Item 4(z)

Penetration of Preservatives in Hardwoods and Softwoods*

(a) Hardwoods - Eucalypt Sapwood

In pressure treatment with hot creosote or in the hot and cold bath treatment with creosote, rounds of E. regnans and E. obliqua are almost exclusively penetrated in the longitudinal direction, there being no penetration in the radial direction and only very slight evidence of tangential movement in the outermost growth rings of E. regnans. Nevertheless, in commercial size rounds there is plenty of opportunity for creosote to enter the vessels at places other than the ends of the rounds. Using end-coated rounds we have been able to show that quite an amount of end penetration of sapwood may take place through checks, not necessarily into the broken end of a vessel, but possibly also into adjacent cells. The actual amount of creosote which may enter a vessel by the latter pathway is obviously dependent on the number of adjacent damaged cells, but in general the amount of creosote entering would be less than that which would enter through the broken end of a vessel.

Microscopically, the creosote is not entirely restricted to the vessels in the sapwood, but finds its way into some of the surrounding tissues, the distance being dependent on the period of the pressure cycle.

Using similar conditions, but more polar solvents or, more correctly, solvents of greater swelling ability such as formamide, water or ethylenediamine, the overall pattern is similar, that is, movement in the longitudinal direction is the fundamental pathway, but in addition a secondary pathway, i.e. penetration out from the vessels, is given greater opportunity. For the solvents listed above, the penetration out from the vessels is basically radial in nature. With increasing swelling property of the solvent there is an increase in the penetration which takes place subsequent to pressure treatment.

It is, therefore, concluded that:-

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*Prepared by P. Rudman.

1. Movement in the longitudinal direction is the means by which the above eucalypt sapwoods are treated.

2. Small checks are beneficial.

3. Better distribution is obtained if a swelling agent is present.

(b) Softwoods - Radiata Sapwood and Heartwood

Results with radiata rounds under treatment conditions which match commercial schedules indicate that longitudinal to radial to tangential penetration of aqueous solutions is roughly 2 to 1 to almost zero, but may be as high as 10 to 1 to almost zero. Thus in rounds where the sapwood is about 4 in. thick, the sapwood (including that sapwood adjacent to the heartwood) is treated by penetration in the radial direction if it is more than about 2 ft from the end of the log.

In the heartwood, somewhat similar ratios apply, except that the rates of penetration are much less, and the differences between early wood and late wood become more apparent.

In dried large rounds, little penetration of the heartwood takes place, and in the short time during which the log is under pressure in a commercial treatment, penetration is usually restricted to the outer growth rings of heartwood; treatment of the early wood is somewhat patchy, that of the late wood more uniform. In sawn timber there is a better chance of obtaining more satisfactory penetration because the heartwood can be treated from two radial directions, that is from the sapwood side and also from the pith side. Even so, heartwood treatment is erratic and there is frequently evidence of radial wedges, the cause of which is as yet unknown. Because of sloping grain, penetration in sawn heartwood in the longitudinal direction is of greater importance, particularly in the late wood, since the heart late wood is fairly permeable. Penetration along the rays is very erratic, but on reaching a late wood band redistribution of the preservative can take place in a longitudinal direction, further permeable rays then being located and so facilitating movement into the next inner band of late wood.

Causes of Poor Penetration. - The first case was that investigated by Wardrop and Davies of this Division, in which radiata was readily penetrated by creosote but not by aqueous preservatives. They concluded that a hydrophobic layer was present within the wood which impaired penetration of water.

We have investigated a further example of poor penetration of radiata; this time fence posts did not satisfactorily treat with creosote at 90 lb/sq.in. for a period of 1 hr. This was found to be due to the accumulation of a hot water soluble gum in the outer 1/16 in. of the saplings, so resulting in an impervious membrane around the sapling. The time of felling and the previous tree history could have caused this, since it would probably be related to the starch content of the outer sapwood.

Treatment of Radiata Heartwood with Creosote. - An examination of the retentions of creosote by laboratory samples of radiata heartwood from five different localities after a pressure period of 21 hr has indicated that creosote retention is strongly correlated with the inches of late wood per year (not percentage), the greater the number of inches per year of late wood, the greater the retention of creosote.

Conclusions. - It has been found that: -

1. In radiata rounds and sawn timber the sapwood is predominantly penetrated in a radial direction.

2. In radiata heartwood both radial and longitudinal penetration pathways are important. Even so, poor distribution is usually obtained, particularly in the early wood.

3. Retention of creosote in laboratory samples of radiata heartwood may be associated with the amount of late wood laid down per year.

(c) General Factors which Influence Penetration

Vacuum. - A good vacuum is desirable and should enable better distributions to be obtained in some timbers.

Viscosity. - The lower the viscosity the better the penetration, and lowering the viscosity from 1.8 cS, which is the figure for creosote at 180°F, to about 0.25 cS, which is about the figure for the solvents

used in the Cellon process, theoretically should result in a sevenfold improvement in penetration depths. In practice it is claimed that improved penetration is obtained with the Cellon process.

Time. - In many cases greatly improved penetration patterns would be obtained if longer treatment periods were allowed; this is particularly important with refractory timbers, e.g. the heartwood of eucalypts or radiata. Longer time does not necessarily mean more even distribution.

Pressure Fluctuations. - The use of pressure fluctuations with semi-green timber can give marked improvement in penetration.

Discussion

Wardrop: We agree in general that the path of penetration is as Dr. Rudman has outlined, both for polar and non-polar liquids and for vapour. The important point is, however, that the path is always through the pits - even in softwoods where the pits are aspirated - not through the cell walls. This is the most important factor governing the path of penetration.

Kininmonth: With Douglas fir we get considerable variation in longitudinal impregnation, suggesting that the pits are sometimes not only closed but sealed.

Tamblyn: In many relatively impermeable softwoods, where pits are aspirated, long pressure application does result in penetration, indicating that these aspirated pits probably leak very slowly and that preservatives do pass through them.

Bamber: I am pleased to see that in Dr. Rudman's observations on creosote, he has confirmed several points which were reported by Mr. Bryant at the last Conference with respect to the movement of oil into P. radiata, namely that lateral penetration proceeds preferentially through the ray parenchyma and late wood tracheids.

We feel that the ready penetration of the ray parenchyma is due in some way to the nature of its cell wall which appears with light microscopy to be, in the sapwood, a primary wall without lignification.

Harding: We can supply all the material Dr. Rudman requires.

Hanson: Dr. Rudman said that small checks are important in penetration of a pole; are there sufficient small checks in a hardwood pole to be significant, or would it be worth incising?

Rudman: For poles of commercial sizes there are probably sufficient checks which expose the ends of vessels without the necessity for incising.

Item 4(aa)

Deterioration of Weatherboards, Including Radiata Pine*

Two surveys of deterioration in P. radiata siding have been attempted. The first in War Service homes in and around Sydney; the second in dwellings and schools in Victoria.

The results of the Sydney survey have been circulated in the form of a D.F.P. Laboratory Report which included some recommendations for the repair of the affected houses. Briefly, the Sydney survey showed that in thirty-three War Service homes, 231 decayed boards were found. In general, each patch of decay recorded was of sufficient extent to justify some remedial action. This survey, based on a sample known to be affected, differs fundamentally from the Victorian survey, which was more like a random sampling. It is noteworthy that, in Sydney's thirty-three houses, no decay was found in the top third of the walls (where eaves gave protection against rain-wetting) nor in ends of boards where there was protection from an architrave (as around a window or doorway). Hence, it is reasonable to conclude that rain-wetting was a causative agent of the first importance in New South Wales.

In the Victorian survey, members of the Division were asked to report any homes which they knew to be sheathed with pine so that arrangements could be made for an inspection. The State Department of Education also supplied a list of schools where one or more class-rooms had been sheathed with radiata. Hence the units to be inspected were picked more or less at random

*Prepared by J. Beesley.

The scope of the survey, as it now stands, is as follows:

VICTORIAN SURVEY AND INTERIM RESULTS

Date Erected	Number of Buildings Inspected	Locality	No. Showing Decay		
			Normal Condition	Due to Faulty Practice	Total
1932-51	6 houses	Creswick	2	3	5
	15 houses	Ovens Valley	6	3	9
1951-56	7 schools	Melbourne	2	2	4
1952-57	8 houses	Melbourne	2	1	3
	3 houses	Ovens Valley	1	-	1
	1 house	Creswick	-	-	-

As the major part of the Victorian survey was conducted on private houses, some of which were well painted, considerable care had to be taken to avoid damaging the property in a way which might offend the owner. Hence, it was not always possible to explore fully the extent of any decay detected. However, it is most unlikely that any significant decay was overlooked during the survey.

The general impression gained from the survey was that P. radiata made satisfactory weatherboards and siding for use in most parts of Victoria but that it was less tolerant of misuse than some other species. However, in a surprising number of instances, faulty building practices did not appear to have had any ill effects within the first 5 - 10 years of service. From the condition of the schools examined, the integrity of the paintwork did not appear to have a significant effect on the performance of vertical siding and no structural differences were observed which would account for the presence of decay in some structures and not in others.

For convenience, the seven schools included in the survey may be treated as a separate group. All had been erected between 1951 and 1956 and were in the Melbourne metropolitan area. Almost without exception, the only painting to have been done was the original painting. Hence, the exteriors were in poor condition with as little as 10 per cent. coverage remaining on some walls. Where the paint was very poor, the boards had warped, twisted or checked. All buildings had been sarked with "Sisalation" or some similar material.

In spite of the poor condition of the paint on the schools, or perhaps because of it, only two schools showed decay in the siding which could not be attributed to poor construction or poor maintenance. At both schools the decay was on walls with a southerly aspect. One was fully exposed to the weather and the other, in rather worse condition, was partially sheltered by a nearby building. In neither case were the affected boards closer than 12 to the ground, nor was the air-circulation around them restricted. In the worse case of the two, decay had occurred in 15 - 20 per cent. of the boards on one wall but was restricted to the lowermost 4 - 6 in. on all but a few.

At several of the schools, conditions conducive to decay were observed, but no decay could be detected. At one school asphalt pathways had been built up to cover the ends of the vertical boards; at others, gardens and flower beds must have increased the hazards to which the boards were exposed.

The survey is limited, at present, to thirty-two dwellings and a tool-shed at Ovens owned by the Forests Commission. Decay was discovered in eighteen of these thirty-three structures. In seven of the buildings, the decay was due to some major fault in building practice or to gross neglect of normal maintenance. Only preservative-treated or specially durable timbers could be expected to tolerate such conditions of service. In the remaining eleven dwellings, the decay had occurred under what might be termed "normal conditions of service". Eight of these eleven houses had been erected before 1951 and three since that date.

Details of the "normal service" decay may be summarized thus:

Houses erected before 1951 - 21, with 8 affected
Houses erected since 1951 - 12, with 3 affected.

All houses erected before 1951 had horizontal weatherboards.

Decay occurred in four cases in mitred corners, two cases in open joints, and three cases in bottom weatherboard (mainly due to "splash" from stormwater).

Two of the "affected" houses erected later than 1951 had horizontal siding, with appreciable decay in mitred corners, and one had vertical siding with several boards affected for 6 - 8 in.

It is considered that in only two of the forty structures included in this survey would the cost of replacing decayed wood, and associated work, have approached the estimated cost of preservative treatment for the siding for the whole structure. In the remainder of cases where decay was present, repairs would not have cost more than £3 - £4 at the outside, and much of it could have been remedied with a simple patch.

Since the original report was prepared, a group of three houses, completed in January 1956, has been brought under notice. These three houses are of identical design, with vertical siding.

Inspection in December 1962, showed that extensive decay was present in each house, and in associated outhouses of similar construction. The majority of the damage was restricted to the lower ends of the boards, extending upwards for about 4 - 6 in. but in a few cases more extensive rot was present. The condition of these houses was so bad that the owners (Myers) have had the timber siding covered over with fibro-cement sheet.

Discussion

Edwards: Consideration of twenty-five authenticated reports of decay in Pinus radiata weatherboards in privately owned buildings in the Sydney area showed that decay usually became apparent in 2 to 5 years. Over the same period, seven reports of decay in baltic, four in cypress pine and four in oregon weatherboards were also investigated.

Nearly all damage was most marked on the weather exposure (southern side) and occurred mostly at inadequately protected corners and butt joints. Sarking was a contributory factor in a few cases.

We feel that provision of proper cover moulds is perhaps the most important single step in controlling such decay, together with end priming of butt joints, and good design.

We have discussed moulded plastic cover strips with I. C. I. The problem is to get a material equal in service life to timber.

I personally feel that treatment of radiata pine and similar timbers for external use is extremely desirable, and that advantages of treated pine should be publicized. Undoubtedly good building

practices would reduce much of the decay hazard. Builders and architects frequently object, however, to the appearances of cover strips.

All cases from New South Wales reported above were horizontal boarding.

Huddleston: It would be interesting if Mr. Beesley could take forty-three houses at random sheathed with any timber, and examine the incidence of decay. I feel it would be very similar to that in radiata. Decay is mainly at butt joints or at corners which are not properly covered in all four species we have surveyed. Water can find its way through a butt joint and behind the boards below it. This may cause the studs to decay when non-durable timber is used. We should be consistent, and when non-durable timbers are used, either for studs or weatherboards, some form of cover, probably moulded plastic would be best, should be provided over the butt joints.

Threader: Until the Myer houses were discovered, the lending people were as convinced as we were that radiata performed as well as any other species. The lending authorities now feel that they cannot depend on end priming, and therefore ask for treatment, and we do not feel disposed to oppose this.

Thomas: There are many radiata houses in our State, particularly departmental homes, and we have had virtually no trouble. Much of the trouble taking place is due to faulty building practice, inadequate maintenance, and climatic conditions. Undoubtedly it is desirable, provided the cost can be overcome, to have radiata pine treated when used externally. The influence of lending authorities in Victoria has unfortunately spread to South Australia where some of the authorities are insisting that radiata pine be treated.

Tamblyn: In the Sydney War Service homes most of the boards examined showed a very high growth rate. We believe that the boards which decay are those which have high water absorption and low density, and that this accounts for the scattered nature of the trouble. While I agree that improved building practice would probably render radiata serviceable without preservative treatment, we do not see much chance of ensuring end-priming or covering of joints. It would take a very long period to change building practices. We believe that end-priming alone would reduce decay hazards greatly, but do not think that it would be done consistently; thus we do not contest any recommendation that radiata be pressure treated.

ITEM 5. TIMBER MECHANICS

Item 5(a)

Review of Research Activities

I. D.F.P. *

(a) Basic Programme

The detailed programme of the Timber Mechanics Section may be referred to in the Division's Quarterly and Annual Reports, and only brief comment on the listed projects will be made here.

Standard Tests. - Recently, a substantial part of our standard testing has been on New Guinea timbers, with some co-operative work also on Fijian species. We have now published reliable data for 174 Australian species, and we have reliable data for about 65 New Guinea species and about 21 other Pacific area species. We also have less extensive strength data of about 300 other species. This impressive total of nearly 600 species reflects the efficiency of our methods and compares with the 100 species for which data are published in the U.S. Wood Handbook.

Joints in Timber Structures. - A number of types of joints have been studied, including nails through hardboard, plywood and solid timber, and glued joints, particularly in solid timber, but also some with hardboard and plywood used as webs. Work has been done also on metal gussets of the gang-nail type, which are being studied to some extent on a co-operative basis with an industry-service group, and other work on perforated metal plates in which the short punched teeth act as spikes in securing the gusset to the timber.

Scantlings. - Studies in this field fall into two groups. The first has involved both a very extensive review of the strength of scantling tested in North America, as well as Australia, and an investigation of our standard test results on about 80 well-represented species. In general, all these data support the thesis that there is a strong correlation between strength and stiffness, and this is independent of the commercial grade of the timber and its species. If this is confirmed by additional tests of scantling

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*Prepared by J. D. Boyd.

of various grades and over different spans, it will be helpful in simplifying our recommendations on sizes of members of various strength groups and grades in connection with the use of sawn timber in light timber framing. Subject to confirmation of the relationship just outlined, it may be desirable to amend the recommendations on working stresses given in the Timber Engineering Design Handbook, to take account of the fact that wood of low grade tends to have low stiffness. This would be contrary to the original conclusions of the U.S. Forest Products Laboratory.

The other part of this subject concerns the practical application of the strength-stiffness relationship in mechanical grading. This will be referred to in a later item.

Poles. - Some additional testing of poles has taken place. This includes the P.M.G.'s newly proposed minimum sized poles (14 in. girth for hardwoods) and also some tests to determine the effect of shaving radiata poles.

Timber Engineering Developmental Studies. - Developmental studies have been made on a range of truss designs for houses and similar light frame constructions, and some for industrial use. Roof pitches concerned range from 5 to 27°, and spans from 15 to 35 ft. I-beams and box beams have also been designed and tested. The results of this work are apparent in the extent to which timber trusses are now being used, particularly in the eastern States; for example, in Canberra 60 per cent. of the houses are roofed with trusses, and several manufacturers elsewhere are each making about 10,000 trusses per year.

Long-Duration Tests of Members and Structures. - Studies of long-duration testing of model columns have continued. Other tests have been carried out on a range of different designs of roof trusses, and others again on nailed joints.

(b) Standards Association Activities

Much time has been given to the preparation of material for a S.A.A. code of practice on light timber framed construction. Work on a specification of design loads for buildings has also taken considerable effort, and we are included in a Committee on design and construction of low pitched roofs. We are also involved to a substantial extent in providing constructive criticisms on many other local and overseas draft standards.

Recently, it was pointed out to the Executive of the Timber Industries Committee of the Standards Association that it may be desirable to review standards for structural grading of timber, to ensure that they are up-to-date and likely to achieve efficient utilization. It is felt that the basic reference of strength to that of the clear material of the pieces graded, as made in existing grading rules, is unrealistic and unsatisfactory. Further, for jarrah and karri the basic data are out of date.

More efficient timber utilization will involve the pinciple of stress-grading. For timber marketed according to species, such as jarrah and karri, and specially for plantation grown or fast regrowth timber, stress-grading is more rational, as it can make the best practical allowance for the qualities of material available.

(c) New Laboratory Building

A timber-framed laboratory building of two storeys, with columns at about 24 ft centres, is proposed for the Division on the site between our canteen and the bridge. Approximately 15,000 sq. ft. of floor area will be provided. Considerable effort has gone into design and developmental studies of the structural units.

With our timber design it was estimated that 2½ times the floor area of the concrete building proposed by the Works Department could be constructed at the same cost. The timber design provides for a very reasonable fire rating. The contract for the timber building should now have been let.

The proposed construction is novel, and it is hoped that it will provide a good demonstration of the efficient use of timber in large office buildings. We also propose to use timber as effectively as possible, and in a variety of forms, for the partitioning and other finishings.

(d) Proposed Institute of Timber Engineering

This will be the basis of a later contribution by New South Wales, but it is also an important project of this Section. Considerable effort has been exerted to encourage the timber industry to take responsibility for grading timber, and developing standards of quality for engineering structural units. I have also suggested that the industry organize a design and inspection service to promote the development and ensure its reliability.

The need for such an organization arises from the very large number of requests for assistance on structural proposals that are received by the Timber Mechanics Section. It is impracticable to meet all these requests. Further, it is considered that the industry should assume the major responsibility for such work, so that the Section is free to undertake research.

Industry now appreciates this position, and proposes to create a responsible body. I addressed a conference, which was representative of all States, and held in Melbourne to decide the aims of such an institute. Since then, the States have separately considered the framing of a constitution. The separate proposals are to be collated and the draft constitution approved by another Australian representative meeting.

Another representative meeting during the 5th All Australia Timber Congress considered means of co-operating on a somewhat wider basis to co-ordinate the overall promotion of timber in Australia, without cutting across the basic interests of the States as represented by the T. D. A., sawmilling and merchant associations. The Directors of T. D. A. from Perth and Sydney are now framing a draft constitution, and a plan of organization and finance for such a body.

(e) Plywood Board Technical Engineering Staff

The Section has been involved in meeting requests from the Plywood Board for very considerable technical information to help promote plywood. Examples of our work include the provision of design data for concrete formwork and for glued plywood box-beams.

However, it is quite impracticable to do necessary research on plywood (as well as on other materials with which we are concerned), and also to provide the technical assistance requested. To overcome the difficulty, the Plywood Board has now appointed an engineer to prepare technical data and manuals as well as to meet many of the special design requests which previously were passed to us from architects and builders interested in using plywood.

(f) Lectures on Timber Engineering

The most recent series of twelve post-graduate lectures on timber engineering was given in Perth. We continue to give lectures in the final year of the course for the degree of Master

of Engineering Science at the Melbourne University. Other individual lectures have been given to architectural faculties in Adelaide and Melbourne Universities.

In addition to the lectures to the timber industry, including a series on structural timber technology given in Perth and Adelaide, special lectures have been given to various groups, including one on plywood used structurally (in Melbourne); one on pole frame buildings (in Wagga); and one on modern developments in timber engineering (in Ballarat).

Mr. Pearson of this Section, who has recently commenced an overseas study tour concerned with timber engineering, gave two lectures on aspects of this subject in South Africa.

(g) Conferences

A number of conferences of note have been attended since the last Forest Products Conference. These have all involved the preparation and presentation of papers. In 1961 the Australian Building Research Congress was attended, and a paper on "Promising Developments in Light Timber Building Construction" was presented. At the recent Pole Symposium, a paper was given on the pole strength investigation. At the 5th All Australia Timber Congress, two papers were presented, one on Australian research on the load-bearing capacity of timber, and the other, given in co-operation with Professor Stern, was on light timber building construction in Australia.

At the Tenth Pacific Science Congress I presented a paper on "Developing the Structural Use of Native Timbers - Important Technological Factors". The recommendations in that paper were subsequently adopted as the basis of planning the timber mechanics programme of the Philippines Forest Products Laboratory. The substance of this paper was also presented subsequently at the F.A.O. Conference designed to help developing countries.

At the Pacific Science Congress, I was made responsible for framing the resolutions of the Forestry Division, including the Forest Products Section; these finally became resolutions of the Congress. These resolutions may be of interest as they could have a bearing on forestry and forest product developments in the Pacific area in the years to come.

Resolution 1. - Inevitably the future uses of wood will involve planning the economic conversion of trees to meet the changing needs of populations. This will include structural and architectural applications of wood in various forms, as well as pulping and other chemical processing. Rational forestry must recognize these basic, long-term considerations of future utilization in present planning. Therefore it is recommended that future Pacific Science Congresses place greater emphasis on the interaction between forest products technology and forest management.

Resolution 2. - It is considered that efficiency in forest products research throughout the Pacific region could be increased significantly through early and regular interchange of programs of work and results of research, particularly in respect to species strength testing. Also, mutual benefit would result from such data being collated by a central agency having access to experienced wood technologists able to offer constructive suggestions for future research work in the region. Therefore it is recommended that the F. A. O. of the United Nations be asked to sponsor this development.

Resolution 3. - Watershed, forest, and range lands of countries of the Pacific area cover a substantial and often a major part of the land area.

The management of these resources involves the intensive application of many scientific disciplines, and has important and often critical consequences to the economics of the various countries, and the well being of their people.

Therefore it is recommended that the Chancellor of the East-West Center and the Board of Regents of the University of Hawaii consider the economic and ecologic significances of watershed, forest, and range lands in the Pacific Area as they formulate the program of the East-West Center, and that they provide for interdisciplinary graduate training in physical, biological, and social sciences as related to the solution of problems of managing watershed, forest, and range lands.

II. New Zealand*

(a) Standard Mechanical Properties

Species testing of standard and sub-standard (2 x 2 cm) specimens has been continued as follows:

Pinus radiata. - A random sample from nineteen 40-year old trees in Kaingaroa Forest. Special tests were also carried out on the effects of hydrolysis at 150°C and over, and of phosphate fertilizer on this species.

P. contorta. - A random sample from thirty-four 33-year old trees in Karioi Forest.

P. ponderosa. - Tests of green material from six 48-year old trees in Dumgree Forest, Marlborough. Tests on pole-sized material from forests in Southland have been started recently.

P. elliottii, P. lambertiana, P. patula. - A small amount of testing is being done.

Larix decidua. - Testing was completed on a total of thirty-three trees from six sites, four North Island and two South Island.

Cedrus deodora and Sequoia sempervirens. - The major consignments completed.

Eucalyptus spp. - To date random samples of twenty-two species from five major districts in North Island have been tested. With a few exceptions, they are somewhat lower in weight and strength-for-weight compared to Australian material.

Miscellaneous. - Limited tests on thirteen Fijian species (for New Zealand industry interests), and on several Cook Island species; 25-year old teak was outstanding among the latter.

(b) Gluing, Lamination, Etc.

The four main aspects comprise: factors in gluing, exposure testing, the influence of defects and end joints on laminated

*Prepared by C. R. Hellawell.

members, and the strength of full-sized commercially produced members. Pinus radiata is the major species but some two-species combinations, with radiata, are being studied. Information has been prepared to assist in the preparation of a code of practice for glued lamination.

Exposure Tests. - The study of treated and untreated P. radiata jointed with U.F., M.U.F., R.F. and P.V.A. glues continues under interior and exterior exposure conditions. A preliminary study of exposure resistance of laminated crossarms is expected to be extended.

Moisture Content Effects. - A study of the effect on immediate bond strength of moisture content at gluing, and moisture changes after gluing, was completed. It covers four major species (P. radiata, Pseudotsuga taxifolia, D. cupressinum, B. tawa) and five glues (U.F., M.U.F., R.F., Casein, P.V.A.) but a report is not yet available.

Influence of Defects. - Strain gauges were used to analyse the bending of five P. radiata beams with artificial discontinuities: the importance of distance from neutral axis was demonstrated.

Beam Tests. - Thirty commercial beams with 8 x 2 to 12 x 6 in. section have been tested to date.

(c) Round Produce

Posts. - An article "The Strength of Fencing Posts" (N.Z.F.S. Reprint No. 29) reports the results of cantilever tests on six species, and comparative tests on concrete. No further work on post sizes is planned.

Poles. - Tests of green and treated poles of Larix decidua, Pseudotsuga taxifolia, Pinus radiata and P. nigra(laricio), to provide a basis for specifications and design strength data, were completed during the period. Some notable points are:

(i) the strong relationship between pole strength and basic specific gravity or modulus of rupture of small clears from the outer zone (1 in. deep in this study);

(ii) the risk of degrade by fungal infection during seasoning of pine species under unfavourable conditions;

(iii) loss of strength due to high temperature processes, particularly steaming of green material under pressure;

(iv) the minor effect of knot groups or nodes (carefully trimmed) when stress is computed on the basis of effective diameter.

The extensive study of radiata pine is being prepared for publication.

A study of Pinus ponderosa (South Island forests) has been started and offers scope for testing indirect methods of evaluating pole material.

(d) Mechanical Fasteners

Tests with New Zealand Pseudotsuga taxifolia are being made. The relatively fast growth rate and high contrast between density of late wood and early wood are complicating factors; also nailing tests indicate low resistance to splitting compared to radiata pine.

(e) Miscellaneous

A working draft of a specification for timber pallets was prepared for the Pallets Committee, N.Z. Standards Institute.

Two reports (available for restricted circulation) on a study of 9 x 2 in. New Zealand Douglas fir planks, including proof-testing by static and impact loading, were prepared for the Scaffold Planks Sub-Committee, N.Z. Standards Institute.

A prototype truss of all-glued construction with laminated members and plywood gussets was proof-tested and an article published (N.Z.T.D.A. Bull., May 1963).

A report is available (for restricted circulation) on the evaluation of methods of developing shearing resistance in composite timber-concrete construction with radiata pine. Shear plates are superior to castellations, but a new method devised, using metal dowels, is more convenient and about equivalent to the plate method.

Discussion

Booth: Most of our research projects are covered under separate agenda items. Routine testing has been centred around Pinus radiata and E. grandis which are currently of considerable interest to the Commission's programme. In addition, we do advisory work on the engineering use of timber, and designs in timber and plywood. There is in Sydney a tremendous up-surge of building and an increase in interest in composite structures of wood and plywood. We spend a considerable amount of time advising architects on the use of timber in modern buildings.

There has recently been an increase in the use of timber as an auxiliary structural material in the erection of large buildings. For example, Douglas fir is being used by one firm for form-work props rather than steel. We also participate in Standards Association Committee work.

Thomas: Are there any data available on the shaving of radiata poles?

Boyd: Data have been obtained from extensive samples of shaved poles, but the analysis has not been completed. Preliminary analysis indicates that the effect of shaving is much less than appeared from the exploratory tests. One difficulty in interpretation arises out of our efforts to limit the size of sample; however, I feel that there is much less strength reduction than the 40 per cent. originally suggested.

Item 5(b)

Acceptance Tests for Flooring

Boyd: A considerable problem has developed in relation to the standard acceptance tests for flooring. For example, a request was received to state the standards of acceptance in relation to finger-jointed radiata pine flooring, and we subsequently had a request for end-matched radiata flooring. About that time a large manufacturer of end-matched hardwood flooring was told that the lending authorities would not advance money on the cost of flooring going into housing if it were end-matched. This manufacturer has

been producing end-matched flooring, which apparently has been giving entirely satisfactory service, since about 1937.

We were in the difficult position of saying what should be the accepted standard of acceptance for flooring. We did have a basis for testing flooring which had been used over quite a number of years. It was a "go or no-go" type of test, and if there were no failure in the floor, the flooring passed. This original test was prepared after a considerable amount of investigation by C. E. B. S. We have had no particular reason for querying it previously because, in earlier years, ordinary continuous T. and G. flooring passed the test quite easily and difficulties only started to arise with end-matched flooring.

I was particularly concerned when it came to appraising end-matched radiata, because I felt that the fact that flooring would pass this test in many cases and yet fail at a few other points was not a very good reason for rejecting flooring, unless this particular test could be completely justified, and unless there was some tie-up with the number of failures and the probability of this load occurring. In most houses, the loading is very light for most of the time and hence it is undesirable to enforce standards of performance which are unlikely ever to be required.

We therefore decided to make a statistical investigation of the number of failures and corresponding loads, using a large number of pieces of end-matched flooring and also to reconsider the loads which the C. E. B. S. had previously proposed as the basic level of acceptance for flooring. Data from this investigation are still being analysed, but I feel that the C. E. B. S. method must be changed. We cannot afford to overlook the fact that many millions of lineal feet of end-matched flooring have been used successfully over the last 20 to 25 years, yet this would be rejected under the C. E. B. S. standard. Therefore we must come to a compromise involving our experience and an analysis of the loads that might occur and also the methods of testing that should be undertaken.

Huddleston: How do you hope to tidy this up?

Boyd: Firstly, the load to be applied must be lowered; secondly, the floor must not be thrown out just because there is a failure at one point. It is not good enough to do a test on a critical area and decide that the floor is good or bad. We need a statistically based test to give a standard allowing a certain acceptable low probability of failure.

Huddleston: This test is peculiar to C.E.B.S. and has never had the status in New South Wales of a standard test. We have never agreed with it or used it, but if anyone goes to the Experimental Building Station for advice, that test is used, and flooring often branded as unsatisfactory as a result. We should have a proper Australian standard for acceptance tests and the matter should be referred to the S.A.A. Other tests should be submitted along with the C.E.B.S. test for consideration by a Standards Committee.

Boyd: That is broadly what we intend to do.

Item 5(c)

Acceptance Tests for Doors

Boyd: A standard is being prepared for flush panel doors and the matter has been referred to us to suggest the acceptance limits. We are in rather a difficult position in that we have tested a considerable number of doors for housing authorities and others over the years and, as a result, we have tended to say that a door seems to be similar to others we have tested which have apparently given reasonable service, so it is probably satisfactory.

However, the Standards Association is proposing to put quite definite limits on some properties, and I am doubtful whether these limits can be justified on either our tests or experience. We need careful consideration as to what are the basic factors that must be met in such standards, whether these are quoted officially or not. There is quite a range of stiffness, puncture resistance and other properties, and I would like to see the various organizations represented here collect information concerning doors which might be on the borderline or less of serviceability. The Standards Association appear to be drawing up minimum levels which could be 50 per cent. higher than they ought to be.

Huddleston: We do collect that information as a matter of course. I am concerned that we might be encroaching on the realm of the Standards Association Committee, which will inevitably make requests to the various organizations for comment and suggestions.

Boyd: The point I make is that we are not in a position to state what is acceptable and should be collecting appropriate information. The assistance of as many people as possible is advantageous. My proposal is not intended to cut across the activity of the S. A. A., but to facilitate their operation.

Item 5(d)

Vibrational Characteristic Standards for Floors*

For houses, the usual strength and stiffness criteria used in the design of suspended wooden floors led, as far as is known, to the construction of floors of satisfactory quality. No complaints have been received regarding excessive "springiness" of floors, ground or upper, built in conformity with Pamphlet No. 112. However, investigations conducted to prove the adequacy of design of components for the Division's proposed two-storey all-timber building suggested that long-span floor joists might require a further criterion of design, namely a criterion of dynamic response.

Seven 24 ft span full scale model floor beams of composite timber-hardboard construction were fabricated and subjected to dynamic loading (by dropping a weight from a fixed height) under a variety of conditions. Results were obtained in the form of autographic recordings of the vibrations of the floor at a single point. Some difficulty was encountered in interpreting the results of the tests, and it appeared that there was a need for a more fundamental approach to the whole problem. However some general conclusions from the exploratory investigations were as follows:-

1. Amplitude of vibration and rate of decay were two significant characteristics in assessing the "feel" or comfort of a floor.

2. The more stiffly a series of joists were tied together by flooring and cross-beams, the smaller was the amplitude of vibration but the longer the decay period.

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*Prepared by J. D. Boyd.

3. Compared with dead weights of the same order of load, the presence of a person on the test floor substantially increased the decay rate.

4. Herring-boning does not reduce the amplitude of vibration to the extent that is achieved with cross-beams. However in tests in which the joists were covered with T. and G. flooring, herring-boning appeared to damp out vibrations faster than did the cross-beams.

5. Partition walls erected to form an office on top of the floor surface significantly improved the dynamic response of the floor by reducing the amplitude of vibration and increasing the rate of decay.

6. Plywood flooring significantly improved the characteristics but it is doubtful whether the improvement would be sufficient to warrant the extra cost of plywood over ordinary T. and G. flooring.

Although some work has been done overseas to try and relate floor "springiness" to comfort, little appears to have been done to establish design criteria for the dynamic response on floors. From the present tests it has been suggested that a floor capable of damping out vibrations in 1 sec or less would have a satisfactory "feel", whilst one requiring more than 1½ sec to damp out vibrations would appear uncomfortable. This is not, however, at this stage a firm conclusion.

Discussion

Booth: This could be important if the current efforts in Sydney to produce timber floors with a fire rating are successful, as it could be a means to get architects to accept wooden floors for other uses.

McConochie: Has the laying of a sub-floor at an angle to the surface floor been tested?

Boyd: No, but we have tried several ideas which may give the same characteristics - the use of plywood is one. A heavy plywood flooring was equivalent to a heavy sub-floor plus

a wearing surface, but we doubt if we could justify this economically. We alo tried fixing a hardboard ceiling to the lower side of the joists. This had the same improving effect as a sub-floor with respect to dynamic characteristics, but its value was marginal. We tried different methods of damping, including the effect of placing wall partitions on the floor.

Subjective assessment of this floor by a number of people was very variable; some said it was springy, some said it was acceptable. People involved in a test of this sort tend to be hyper-critical or too analytical. An open floor area is not a good indication of what might happen in practice as heavy furniture, partitions, etc., affect the result. Thus, while we originally had doubts of an open floor's acceptability, when we applied these factors we found the floor was, in fact, acceptable.

Bryant: Would the restraining effect of adhesives in the tongue and groove affect damping?

Boyd: Theoretically it should make a little improvement; this is illustrated by the damping effect of plywood flooring.

Booth: I suggest comparisons be made with flat slab buildings, as it is known that these vibrations occur in concrete flat slabs. Partitioning in these buildings gives damping and these factors would give an indication of acceptable vibration.

Boyd: I am aware of the work in concrete buildings. We propose to extend our studies to assess floors generally, and obtain an impression of acceptability levels from people who are not consciously assessing the floor. We might test some houses - two-storey and others - and we have made a number of tests around the Division on different classes of floors. We may not get very far unless we make this an extensive fundamental study.

Item 5(e)

Factors Affecting the Strength of Plywood

Boyd: The work we have undertaken is not very far advanced. The data have not been fully analysed, so we cannot give information on the complete project. We have studied the use of plywood in structures in relation to the effect of defects

such as splits and gaps in plywood on shear strength, and there is an indication that these are significant, but probably not of very great significance. The dense plywoods do not have the increment of strength in shear over the less dense plywoods that we anticipated from tests conducted overseas and used as a basis of recommendation in our Handbook, and we are concerned with this.

Booth: We are also concerned with the question concerning high density plywood, as in New South Wales plywood is made of spotted gum, and we have estimated that its strength is often below a Group D plywood; its stiffness also leaves much to be desired. Tests made by simulating plywood construction by machining small laminations from solid timber have shown that strength is what would be predicted, according to the properties of spotted gum, and we conclude that the lower strength is principally the result of the poor quality of veneer from high density timbers. In order to calculate the strength you need a different set of constants for use with the rolling shear parameters which are normally copied from work done overseas on Douglas fir. These high density plywoods fail in bending by rolling up of the very loosely peeled cross bands and unless that can be overcome we cannot fully realize the intrinsic strength of the species.

Boyd: Peeling characteristics are included in our study, but the work done is little more than exploratory. The only predictable characteristics of plywood in relation to species strength of the timber is shear, but this is a long way out. However, this is a purely exploratory result.

Huddleston: The Senior Lecturer in the School of Building in the University of N. S. W. would be very interested in the work done by Mr. Boyd as he is working on very similar lines.

Boyd: He is reasonably familiar with the work we are doing generally, but whether he is familiar with this particular project I am not certain. I suggest that you mention to him that we are working in this field.

Item 5(f)

Development in the Production of Prefabricated Building Components*

There has been a marked development of prefabrication of building components in the Sydney area which is spreading to some extent to other centres. The development in Canberra is also having an influence on building practice in New South Wales. The most important Sydney development is the nail plate and trusses produced by a Sydney manufacturer.

Production evolved from the manufacture of trusses from softwoods using U.S. designs employing nailed casein glued gusset plates essentially similar to the type of truss widely used in Canberra until recently.

The firm developed their own nail plate which can be inserted into green or dry hardwood using their own press and truss clamping plant. They have had suitable stresses established for the plates in test and now offer a series of trusses in softwood or hardwood (group B) as desired. They also produce the nail plates and sell them to plants in Melbourne and Canberra which have installed truss making equipment supplied by this firm.

Another firm in Sydney is making trusses which combine timber in the top chords with steel bottom chords and web members. These have been produced for some time and are apparently successful.

There has also been some development and restricted use of a nailed or bolted joint truss using seasoned 1 in. hardwood intended to be used at 18 in. spacings.

Another firm is planning manufacture of trusses using nail plates of U.S. design in both Queanbeyan and Sydney. Use of both softwoods and hardwoods is envisaged.

The use of glued nailed plywood box beams is also now established. A large project builder has a successful design in which a beam 40 ft long x 14 in. deep supported at various points runs along opposite long walls of the house. These beams are made from phenolic resin glued plywood and resorcinol adhesive. Shear is developed between webs and flanges by the combined action of nails and the adhesive.

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*Prepared by H. Booth.

The above developments refer only to repetitive components. In addition to the above the production of plywood girders, special shapes, portal frames and stress skin panels to architects' details is well advanced and becoming fairly common. An interesting recent example is the portal frames made for the summer house at the Canberra lakes project used during the Queen's visit. These frames were prefabricated in Sydney and transported to the site by road.

Discussion

McConochie: In Queensland there are six firms manufacturing trusses at present; they are all hardwood nailed trusses, there are no glued softwood trusses as yet. The designs are as recommended by C.S.I.R.O., but have been modified to meet local requirements. The trusses are manufactured from thicknessed members of unseasoned eucalypt species of strength group C or better and struts and bottom chords are 3 x 1½, remaining members 4 x 1½. A satisfactory proportion of short length timber is being used, which would otherwise be difficult to sell. The first firm to manufacture these trusses used gussets of ¼ in. tempered hardboard and 1¼ in. x 12 g. galvanized clouts. These gussets are supplied pre-cut as a recovery from damaged sheets at the local hardboard plant. Due to some doubts as to the suitability of hardboard, some manufacturers are now using the gang nail plate connectors. There is an expanding demand by builders for trusses now that their use has been accepted.

Wickett: We have had half a dozen new sawmill buildings over the last few years, every one of which has been a steel frame job. The only large building in timber to be erected recently in Western Australia is our new sawmill at Dwellingup. It has a 62 ft clear span with 12 ft cantilever.

Huddleston: One of the reasons that the sawmilling and timber industry in New South Wales is going to steel is that they get service. If they want a building with a 60 ft span they can be quoted a price and have it delivered. They cannot do this in timber.

McConochie: A firm in Brisbane has put out a catologue quoting prices on timber trusses up to 40 ft span.

Item 5(g)

Need for Uniform Code for Methods of Test and Performance of Prefabricated Structural Building Components

Booth: Prefabricated components such as trusses are being widely used in cottage and other work and the use of these components will increase.

The present tendency is for lending and regulatory authorities to accept particular designs on the results of tests which are planned to simulate actual use conditions.

The question of what constitutes an acceptable acceptance test urgently requires clarification, and agreement between States and the authorities concerned.

Subsequently the general methods of test and loading conditions could be embodied in an Australian standard but at the moment there does not seem to be sufficient clarity and agreement to standardize procedure.

At present, the known extremes of test loads range from 2½ times dead load to 10 times dead load plus 3½ times live load.

The question of duration of loading also urgently need clarification. With timber structures this aspect is of paramount importance.

We suggest the Division of Forest Products should prepare a proposal, initially covering roof trusses and fabricated beams, based on their own experience and incorporating overseas experience where relevant so that discussion and agreement, if possible, can be reached in the near future by testing authorities.

Boyd: I agree in principle with Mr. Booth that we need standards of quality for this type of production. When you compare the 10 times dead load requirement of the standard in New South Wales with any overseas standard of 3 times, the situation is ludicrous. This approach can do a lot of harm to timber. It is unfortunate that it has been promulgated by the Government at the instigation of a research organization. The document is a very poor one and is subject to serious criticism in many places.

To help to overcome the situation that has arisen, we must inform the industry more effectively of the significant factors. We can only formulate an ideal standard when we have more experience than we have now, but we can do something right now. The main factors cannot always be anticipated on the basis of laboratory experiment only. We are doing short and long duration testing in the study of trusses and applying a proof test which we feel would give an adequate indication of the capacity of the truss to stand up under long duration loading equivalent to service loading. We have found that some have failed. Handling factors are also important as hardboard can be broken through excessive flexing and other fasteners sprung loose. Careless hammering can also break away the edges of hardboard or cause bruising. The type of nail is also important. We are in a position to indicate what we think are minimum proof tests, but the range of such tests should be examined. For example, should we have weathering tests or flexing tests?

The question of grading of timber in trusses is a vital factor. It is hoped that the Institute of Timber Construction will take the responsibility of setting standards of quality of material and construction and police these standards within the industry. At this stage I feel all research bodies need to get together to discuss the direction in which we should be aiming.

Bryant: Mr. Boyd's suggestion is the only practical one at this stage. It is most desirable that D.F.P. take the initiative to call a meeting of interested parties. This would meet our requirements at this juncture.

Huddleston: We have several different methods of proving trusses. We know that a truss was designed by the manufacturers merely on the sizes they considered appropriate, and because one particular truss was passed by the Forestry and Timber Bureau it was accepted as a Government-approved truss. We should urgently lay down a universal test which can be applied by all authorities; this could then be modified as we get further information. I would also like to see Mr. Boyd's suggestion acted on.

Item 5(h)

Proposed Institute of Timber Engineering Construction

Huddleston: Arising from an initial conference in Melbourne, a number of State Committees have been set up to form an Institute of Timber Engineering Construction. It appears that it will be a long job getting agreement between the States and at Commonwealth level. New South Wales now proposes to adopt the Articles of Memorandum which they have had prepared. This will be sent to other States with the suggestion that they do the same. We are concerned at suggestions that the Engineering Institute be tied up with the proposed National Promotion programme suggested at the Adelaide Conference. We envisage the Institute of Timber Engineering more in the nature of a quality control institute, although it will be interested in promoting the engineering use of timber. It has been suggested that T. D. A. should build a church instead of a home next year and this was felt to be more a job for the Timber Engineering Institute. There is now an urgent need for some means of quality control in timber engineering by an organization within the trade so that checks and control can be exercised in the engineering use of timber. It would be unfortunate if the moves at present taking place were delayed by discussion of the possibilities of combination with the proposed National Promotion programme.

Boyd: The question of the Institute is a broad and complicated one. After the Melbourne meeting, all States were to return within a month a proposed constitution. The manufacturers in Melbourne want progress quickly on this, and this is probably so elsewhere.

It might be easier to bring the Institute into being through a broader concept of timber engineering and promotion. There are many factors apart from the timber engineering aspect which need technical consideration: such things as building regulations and by-laws, sound insulation, fire ratings, etc., would be best considered by the same organization. Promotion means getting over the effectiveness of a product, in this case through quality control and provision of a design service. The other aspect of working to standards and having an inspection service must be agreed to by industry. We have had standards for structural grading for many years, but industry takes little notice of these. Unless industry accepts the standards as their responsibility and something for their benefit, then we cannot do very much. Therefore an Institute representative of industry, and getting all the technical support we can give is the only way of effective progress.

Item 5(i)

Methods of Evaluating the Physical and Mechanical Properties of Timber Samples Obtained for Elite Tree Selection and Criteria for Selection

Booth: Our efforts, apart from those on radiata pine, are centred around E. grandis. Using a mortis chain sampling tool we were able to obtain from selected elite trees a 2 in. square piece of timber from the bark to the pith which was the sample with which we worked.

We regard shrinkage and density of considerable importance, and we thus sought a rapid method for determining shrinkage. It involved cutting a slice ¼ in. thick along the length of the sample from bark to pith, machining a clean face on one side, and using a technique which we developed for the waterproof gluing of green timber, we put a series of dots on the machined face forming a grid pattern at 4 mm intervals. We then ruled cross marks on the surface of the spots after machining them flat, and using a travelling microscope determined the co-ordinates of these points. We then found that we could air season this slice in approximately a week in a warm place, after which we re-measured the co-ordinate positions. We were then able to recondition the sample and re-measure the points, after which radial and tangential shrinkage was only a matter of machine calculation; furthermore, it was obtained for all the zones in the piece. The pattern was later changed to give zones about 0.4 in. apart.

We have compared these figures with flooded gum samples from the same area, type and age of tree, and the results are very similar - same magnitude and same pattern - and we now have in progress tests on matched samples from the same tree to compare with our rapid method. We determined basic density with chips and for other mechanical properties we did a series of compression tests, obtaining ultimate compression strength, but we were not happy about the validity of these latter results because of the small size of the specimens.

Nicholls: I was interested to hear that the sampling device devised by us is being used. The larger sample is essential for the type of work undertaken by Mr. Booth. For any particular species there will be a different set of criteria, and just because in our publication we comment mainly on radiata, it does not necessarily imply that the criteria are suitable for other species.

I do not feel happy about the shrinkage methods you used as there may be constraint along the length of the piece obscuring true indications of actual shrinkage. I also wonder at the ability to standardize from specimen to specimen when only drying to air-dry conditions, whereas we have always done our shrinkage measurements based on oven-dry condition.

We have obtained very good correlation between mechanical properties such as crushing strength, and density and work can be saved by establishing a correlation between properties and structure. We have not been active in assessment, but have been finalizing work on heritability and are starting work on effect of environment and change of environment on wood properties using genetically equivalent material. The only large project dealing with assessment was that concerned with Pinus pinaster, where we looked at differences between the four races. The findings showed that there were no great differences except in density.

Kloot: Has any attempt been made to correlate the basic density of these tiny specimens with compressive strength?

Booth: No. We did not get good correlations between density and strength with flooded gum.

Huddleston: Our experience during the war in testing spruce for aircraft indicated that while there was shown to be a general correlation between density and strength, there were notable exceptions.

Bryant: We were planning to investigate the heritability of shrinkage and basic density of this species and we made our selection on the basis of trees with highest and lowest shrinkage and density. Unfortunately, grafts from our selected trees on to stock in Canberra and Coff's Harbour died.

Huddleston: If flooded gum is to be sold economically it must be sold in a high-royalty class; it is a low density timber and therefore will be regarded as low value hardwood. It must therefore be sold as a cabinet timber in order to find a high price class for it.

Booth: In our shrinkage test, we sorted out elites which showed high collapse; also we picked out those elites which showed a better ratio of tangential to radial shrinkage. With regard to

Mr. Nicholl's comment on the restraint of shrinkage, we considered this problem. It must be remembered that all methods of shrinkage measurement are arbitrary, and that the degree of restraint in an inch specimen is very different from the restraint when seasoning, say, a 6 in. wide board. Provided you establish a good correlation between a conventional and a new method you have done enough.

Bamber: Regarding the size of core taken when sampling, one must reconcile the fact that other methods may cause considerable injury to the tree compared with the 11 mm core. On the other hand, foresters allow us to take an 11 mm core quite happily, and while we have not correlated statistically the results from the 11 mm core and the large sample, we feel that we can use a number of 11 mm cores and therefore should get the same result.

I would also ask what properties we should aim at in the assessment of trees of P. radiata.

Chairman: (i) Spiral grain; (ii) density; (iii) tracheid length.

Nicholls: We must place on record a vote of thanks to the Forestry and Timber Bureau when they recently used the Brown method to supply us with 495 samples.

Harding: Concerning excessive damage to the tree, the 3 x 2 samples we take are over-grown quite well in about 12 months, and we are not greatly concerned with injury. We use a double brace, modified bits and a modified bow saw. Two men can carry this quite easily and do the job as quickly as and better than machine tools.

Item 5(j)

Machine Grading of Radiata Pine

Booth: To assist in utilization of radiata pine in structures, the Division of Wood Technology has recently undertaken a study of the applicability of machine grading to scantling grades of pine.

The study has embraced some New Zealand grown, but mainly N. S. W. southern highland material of 4 x 2 section D. A. R. Machine grading on the flat has been carried out at 6 in. intervals

using a testing machine and the pieces broken at selected points to give a continuous range of deflections versus bending strength.

At the same time visual grading was carried out to requirements of 376, 377.

The main results summarized show:

1. Visual grading sorts the timber effectively into strength classes and gives working stresses of the same magnitude as recommended by D.F.P.

2. Correlation between deflection and strength in bending is good. (Correlation coefficient above 0.7 - showing that radiata is eminently suited for machine grading.)

3. Useful yields of material having 1 per cent. stresses of 2,000 lb/sq.in. can be obtained and about one-third of the sample yields material having 1 per cent. working stresses of 1,500 lb/sq.in.

4. A machine incorporating the results of the study has been designed and will be made commercially.

It is proposed to extend this work to improve grading of radiata and to consider the problem of grading of hardwoods.

Discussion

Boyd: I support the contention that we should know something of the potentialities of application of such machines. It is important to appreciate the big difference between laboratory correlations obtained on strength/stiffness ratios and correlations that might be expected from normal operation of a machine based on this principle. Apart from mechanical problems, the distortion of the timber can be very critical in the measurement of small deflections necessary for effective operation of the machine. Unless there is some way of separating the measurement of distortions, which are the chief characteristics of the timbers with which we are most concerned, gradings by the machine may be very misleading. There is a serious danger that if machines are put on the market with the hope that they will work because of a laboratory

correlation, they could do more harm than good. It is most important that we solve practical problems on an actual machine before we say whether it will work in practice.

Kloot: At the last two Conferences we have reported high correlation between modulus of rupture and modulus of elasticity of radiata pine, in fact, we have found slightly higher correlation than D. W. T. We recognized the difficulties that arise from distortion when we first started designing the machine about 6 months ago. We first assumed that the bow or spring was a simple curve and designed the machine on this assumption. However, the assumption proved quite wrong and we then decided to try cyclic loading tests, which we found worked quite well, but the maximum rate at which we could feed the timber was about 60 ft/min, so we decided to drop the idea. When then proceeded on another line, based on the way we thought the Potlatch machine operated, viz. by the machine memorizing the distortion in a piece of wood, and when measuring distortion at the loading point, correcting for initial distortion. However, we were wrong in this interpretation, but the basic principle is correct, and our work on the principle is very encouraging.

It should not be overlooked that the most efficient mechanical stress grading is to carry out a mechanical test which has the end use of the timber in view. The development of a general purpose machine is not easy and the machine will not be cheap. However, a machine to test timber for a specific end use can be much cheaper. We have already demonstrated the feasibility of a mechanical stress grader for crossarms which would cost no more than £100 or £150. Similarly, a machine to test ladders would not cost very much. In regard to timber for trusses, it is not essential that every section of every member of the truss should be the maximum stated grade, maximum strength should be where the bending moment is a maximum. Timber should be of high quality at the joints and some complementary visual inspection is necessary as you cannot press gang nail plates into knot clusters. It is feasible, therefore, to construct a machine to stress grade timber specifically for the top chords of trusses, and possibly this would be much cheaper than a machine to grade timber irrespective of its end use.

Huddleston: In view of the possibility of rejection for distortion on the job, it is obvious that machine grading will not eliminate the need for visual inspection, which would be done prior to the machine.

Boyd: I anticipate that the operator of the grading machine will recognize things that will cause distortion in subsequent use and reject such pieces. Although the emphasis has been on grading of engineering timber, it is much more important to get this grading accepted for ordinary scantling timber. Lending authorities in general require much heavier sizes than are necessary, as they consider all material as common grade. Such a machine will overcome this problem, and allow material to be used much more efficiently in conventional construction.

Booth: What has been said confirms our view that radiata pine is very suitable for machine grading. There is much published information overseas on softwood timbers which show excellent correlation between modulus of elasticity and strength. The only problem preventing us using this correlation is that of machine development and I would be very surprised if we cannot solve the mechanical problems of development. In Sydney there is a good market for oregon scantling, but if New Zealand could treat and grade radiata scantling, they could no doubt get their material accepted on the Sydney market. We must see whether this machine grading approach will work on other timbers, as we will still be using a lot of hardwood scantling.

ITEM 6. TIMBER SEASONING

Item 6(a)

Review of Research Activities

I. D.F.P.*

(a) General

No major changes have occurred in the basic seasoning programme since the last Conference. However, I can report progress in all areas, with some phases now reaching the stage of economic evaluation, publication and application by industry.

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*Prepared by G. W. Wright.

(b) Air Seasoning Studies

Continued high priority was given to work on the fundamentals of air seasoning for the reasons given in the previous review. This work has two broad objectives - one to determine the intrinsic importance of stack variables, and the other to establish basic principles for yard design.

Stack variables currently under examination comprise: (i) stack covering; (ii) sticker thickness; (iii) stack foundations; and (iv) board spacing. Variables still to be studied comprise (v) stack width; (vi) stack height; and (vii) stack flues.

So far, we have published several analyses of data obtained , and have made interim assessments of their economic value. These are, of course, available for reference. Because seasonal effects are so important in this work, most studies have been repeated on a seasonal basis, so that final assessments have had to wait on the passage of several weather cycles.

We are now satisfied that stack covering gives a return of not less than two to four times its cost in crowded yards in seasonally wet areas. Their value for open yards is at present under study. In general, a sticker thickness of ¾ in. looks about the best choice for 1 in. thick stock in compromising between air drying rate and subsequent kiln productivity, although ½ in. thick stickers may be more economic for narrow stacks, and this possibility is being examined. The important point is that with ½ in. stickers, kiln capacity goes up by about 15 per cent. when a partly air dried stack reaches it, and kiln costs drop by about the same amount. Studies on stack foundation design, and the effects of board spacing, are not sufficiently advanced, as yet, for positive conclusions to be drawn. There is no doubt the work is paying dividends, judging from results in the yard where most of it has been done (and where air drying times have so far been reduced by about one-third), and from reports from companies which have installed yards to recent recommendations.

Work on the fundamentals of yard layout - based, as you know, on a model study approach - has now largely passed through the phases of (i) instrumentation and the calibration of equipment; (ii) the development of experimental techniques; (iii) the determination of air flow and pressure patterns in, and around, commercial stacks; and (iv) model similitude studies to make sure of a model design with behaviour characteristics similar to that of a full sized stack.

For the next phase, a large wind tunnel is at present under construction so that selected field conditions can be reproduced, as required, on a model basis, and air flow and drying patterns obtained for any conceivable combination of parameters.

These studies will pin-point optimum layout arrangements, including the effects of such factors as ground topography, stack orientation, material accessibility, proximity of buildings, and of course, yard productivity.

(c) Predrying

Work on predrying and predryer design has remained active, with the main emphasis in recent months towards its application for round timbers, e.g. hardwood poles and radiata pine rounds for particle board flaking. In this latter connection, drying studies to establish rate data in terms of diameter classes for a throughput of 36 million super ft per annum are in hand. The next step is the development of a predryer design for this task. I also notice that interest in predryers has extended to New South Wales and New Zealand, and I think their use will extend for pre- and post-drying for preservation treatments for large section material.

We also held further sessions of the Predrying Conference in Tasmania, much, I believe, to the mutual benefit of industry there and our research programme.

(d) Presteaming

Presteaming studies since the last review have shown that karri, black bean, and a Fijian Serianthes may now be added to the ash eucalypts to increase the list of responsive species, with the pretreatment giving a reduction in drying time of about 20 per cent. in each case. On the other hand, brush box and satinay proved unresponsive, and for these species the treatment is not recommended. Amongst native timbers listed for presteaming studies are spotted gum, Sydney blue gum, blackbutt, tallowwood and red mahogany, but possibly some of the States might care to take over this work.

Because of the considerable use of merantis in Australia, we have undertaken to do studies on several of them, and specially selected, authenticated material is due to arrive here any time from Malaya.

(e) Kiln Schedules

Fairly extensive kiln schedule studies were carried out on brush box and satinay with the object of improving the drying behaviour of these difficult, important species. Presteaming, as indicated, did not improve drying time. In fact, if anything, it tended to accentuate degrade. However, presoaking in a solution of sodium chloride and urea gave improved dried quality, and some further work on this would seem justified. Perhaps New South Wales or Queensland would care to do something further on this.

The seasoning behaviour of a very considerable number of Fijian species was determined, and kiln schedules developed for them. Some of them would seem most suitable for board and joinery purposes.

(f) Dimensional Stabilization

We now have a fairly good picture of the influence of chemical concentration on the effectiveness of polyethylene glycols and glycerol in dimensionally stabilizing typical Australian species in the sawn form. A standard concentration range from 5 to 50 per cent. has been used. Work to date shows that pretreatment in a 50 per cent. solution of one or other of the chemicals virtually eliminates shrinkage in radiata pine - both sapwood and heartwood - also in tulip oak and coachwood, which means that these species may be fully seasoned at their green size with, presumably, no possibility of trouble from moisture gradients, drying stresses, drying degrade, or subsequent movement in the wood even under adverse use conditions.

With this concentration, shrinkage in karri was also reduced from 15 to 3 per cent., and that in mountain ash from 31 to 9 per cent. In the case of radiata pine, concentrations as low as 10 per cent. reduced shrinkage by one-half or less

The next phase of this work comprises an examination of the effects of concentration on warp and checking in pieces of commercial size, and an assessment of the economics.

(g) Collapse and Recovery

Work on collapse and its recovery also remained an important field of work for the following reasons: (i) because of the inadequacy of present techniques fully to remove collapse - we

have estimated unremovable collapse at something like 5 million super ft/annum valued at £½ million; (ii) because a residual collapse after treatment affects the satisfactory utilization of some species; (iii) because we still know comparatively little about some facets of the collapse problem - for example, the extent to which a genetic or tree pattern exists, the influence of pre-reconditioning treatments, the kinetics of collapse formation, and even the phenomenon of recovery.

Recent work has, therefore, centred on (i) improving the reconditioning process by a clarification of the effects of steam pressure and preheating; and (ii) the prevention of collapse by work on the induction of liquids at various surface tensions, or by pre-freezing, or the formation of gas bubbles in the capillary system.

Present work aims at a clarification of the effects of wood constituents on collapse formation, and the extent to which these are responsible for collapse intensity or fixation. For example, it is now clear that they are accentuated by acid hydrolysis, and that they are also associated with a marked decrease in the percentage of acetyl groups. We are particularly interested in clarifying the part played by lignin.

(h) Pole Drying, E.M.C. Studies and Log Storage

This review would be incomplete without mentioning two of the Section's main research projects, namely, our pole drying, and our equilibrium moisture content studies; and I should also mention an important short-term study, namely, degrade control in hardwood and softwood log piles during storage. As these are the subject of separate items, they require no elaboration now.

(i) Immediate Future Research

By the time of the next Conference, we expect to have several new projects under way. They include (i) a comprehensive study on the drying of radiata pine, including the effects of some growth factors and their control; (ii) studies on kiln aerodynamics, and we expect these to lead to the formulation of basic kiln design principles; (iii) exploratory studies on solar heating for kilns; and (iv) work on chemical seasoning for check-susceptible species, with special attention to the control of hygroscopic and corrosion characteristics.

With the return of Dr. Kauman from Chile - perhaps in August, 1964 - we also hope to do something worth-while with studies on the movement of liquids through wood, particularly on the mechanisms concerned, factors affecting permeability, and the improvement of permeability.

(j) Conferences

I attended the 8th British Commonwealth Forestry Conference which was held in Nairobi in June, 1962. On my return I prepared a short statement, and hope to have a comprehensive report available for distribution shortly.

(k) Technical Assistance to Industry

In general, requests for technical assistance to industry are as heavy as ever with some 2,000 to 2,500 enquiries a year, quite apart from demands for kiln design, plant layouts, plant surveys, McCashney burner designs, our training commitments under F.A.O. and the Colombo Plan, and our Australian Seasoning Correspondence Course. However, much of this work has a secondary research value in keeping us well posted as to the gaps in industry's technology, and the priority with which they should be dealt.

(l) Staff

With respect to our professional staff, this has improved about one-third since the last Conference with the addition of two Experimental Officers, and this has made a very considerable difference to the amount of research we have been able to handle.

As indicated, however, we have been temporarily short of a Senior Research Officer since Dr. Kauman took a 2½ year assignment with F.A.O. in Chile in December 1961. We have used part of his salary to finance a Fellowship in timber seasoning for the Latin American Countries.

II. New Zealand*

(a) Drying of Pressure Treated Radiata Pine

It has been the general experience in New Zealand and also in industry in Australia, that radiata, after full cell pressure treatment with waterborne preservatives, dries much slower than untreated timber; in the 2 in. thickness drying can take twice as long.

Early work showed the difference in drying rate to be due primarily to pit aspiration or some similar phenomenon reducing the rate of transfusion of moisture through the wood. The preservative chemical has a slight retarding effect.

Further work has been carried out to determine more accurately the mechanism involved. Tentative conclusions are that:

(i) moisture content before treatment has a significant effect on post-treatment drying rates;

(ii) variations in preservative loading have a slight influence on drying rates;

(iii) the drying of quartersawn boards is retarded more than that of flat sawn boards;

(iv) degree of saturation is important.

From developments under item (iv), efforts are being made to determine acceptable treatments by the Lowry empty-cell process to avoid the high saturations of normal treatment.

(b) Drying of New Zealand Grown Eucalypts

Sawn timber of nine species has been dried and, in general, seasoning problems are due more to aspects of growth stresses than to straight drying degrade.

(c) Pick-Up of Moisture in Kiln Dried Timber

Some work has been done on determining pick-up in radiata pine kiln dried to 12 per cent. moisture content and exposed in block

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*Prepared by I. Kininmonth.

stack to higher e. m. c. conditions. While the bulk of the stack is relatively stable, surface boards and overhanging ends pick up rapidly to approach the prevailing e. m. c.

(d) Air Drying Studies

Similar trials to those of D. F. P. are being carried out. With comparatively narrow stacks of relatively permeable timbers, covered stacks have not always dried faster than uncovered but the covers are particularly beneficial in timber 2 in. thick.

(e) Minor Species

Pinus cantora, one of the numerous minor Pinus species growing in New Zealand, has been kiln dried and is similar to radiata pine.

(f) Drying of Radiata Pine

Work has continued on the effects of drying variables on distortion in radiata pine.

(g) Kiln Design, Etc.

There is considerable interest in the application of forced air drying principles and in the design of small cheap kilns for conditioning of air dried timber.

Discussion

Huddleston: We are suffering an acute staff shortage in our Seasoning Section. Mr. Marshall carries out a tremendous range of duties with only one assistant. Besides trouble shooting for all branches of industry, we are engaged in air seasoning studies in air drying yards and are also concerned with training of operatives. We have been giving a lot of attention to problems associated with the drying of brush box, but in many cases commercial operators will not follow our suggestions as they believe them uneconomic, so that we have to adjust our recommendations to the circumstances. Our Seasoning Section is very active, although we cannot do many of the investigations we would like to.

Ryley: Most of our work to date has been extension work, including over 3,000 tests for moisture content per year. We will be doing a lot of work in the next 2 years on our plantation species. This is mostly being used for case production and it is necessary that it be dried.

Thomas: Concerning the drying of treated poles, there are some difficulties with both pre- and post-drying.

Wright: One sawmiller in Mount Gambier has, in effect, been predrying radiata poles in about 10 days, but this could possibly be reduced to 5 days if only drying for treatment. Predrying costs a little more than air drying, and covered air drying stacks would be more economical if the desired result is attained.

Kininmonth: We have given predrying round produce a lot of thought in recent months and could make even kiln drying economic if the poles could be handled economically.

Wright: We are looking at the possibility of rolling poles on to a kiln or predryer truck and passing the air longitudinally along the poles through the spaces; this looks promising, as the result of tests in our small kiln.

Cokley: In the case of predrying, we did an experimental run on the predrying of blackbutt poles and degrade was much more severe than with normal air drying. Popping and growth stresses were important in this case because of small size poles. What would the effect of stabilizing chemicals be on preservative treatments?

Wright: We have not tried combining them, but this is quite possible. We have only investigated straight diffusion treatment for chemical stabilization. There is probably no reason why they should not be combined in a pressure treatment.

Booth: I did a mill trial of polyethylene glycol treated veneer of coachwood and white birch. We did immunize with sodium fluoride. The gain in recovery made it economic, but gluability was a problem.

McConochie: We have recently completed an experimental sawmill in which we have a new kiln and reconditioner which can be used over a wide variety of conditions.

Item 6(b)

E.M.C. Survey

Finighan: Since the last Conference, most of the field work on the proposed e.m.c. study has now been completed. You may recall that the main project which was initiated at the Conference before last was the attempt to relate e.m.c. to meteorological data. The aim was to develop regression equations where data from any part of Australia could be applied to the equations and e.m.c. values obtained. This field work is mainly completed, and since then some supplementary studies have been carried out: (i) in Como, Western Australia, at the request of the Western Australian Forest Service on ten W.A. species; (ii) in New Guinea at Port Moresby eight species are currently under test; (iii) a small experiment has been carried out at Mount Isa by a private individual using material supplied by the Division. These are mainly c-operative projects, the respective Forest Services doing the observation and D.F.P. doing the data processing and mathematical analyses.

To refer to the main study again, the analysis of the huge amount of data that were accumulated has followed two distinct lines: (i) the mathematical analysis to determine the regression equations: this required the use of the electronic computer at the Melbourne University and is not yet finished; (ii) a graphical and statistical examination of monthly and seasonal figures so that values could be provided almost immediately of the range of moisture contents observed during the period of study. These, of course, are not necessarily the most accurate values that will become available because they were taken over a 3 year period only. Checks were made on all specimens that were exposed, true oven dry weights are being calculated and all corrections which might have to be applied to observed readings are now available. In some places we plotted all readings against time, which gives a very good picture of the daily, weekly and seasonal range and fluctuations.

Regression equations were developed for all stations, thicknesses and species, and the checking of the equations against observed results is almost complete for ¾ in. material. Predictions were quite reasonable, except at Alice Springs and Broken Hill, where we struck trouble during periods of rapid relative humidity change.

We intend to re-examine the data, omitting Alice Springs, to see if the prediction is improved for all other stations. This will possibly enable us to put out an intermediate report, after which we will look further into the reasons why Alice Springs does not fit in.

The other large study which we carried out was the indoor study under unheated conditions in domestic houses. This was done in Sydney, Melbourne and Como, Western Australia, and when the outdoor study is complete we will try to relate the indoor e. m. c. values to the outdoor weather.

Other small studies include the effect of surface finish on the variation of moisture content, and the effect of the direction of cut on the e. m. c. values. Current e. m. c. work includes a survey of poles in service; untreated, waterborne treated and creosoted poles are being tested to a depth of ½ in., 1 in. and 1½ in. at heights of 3 in. and 5 ft from the ground on the north and south sides of the pole. While the study is not yet complete, a distinct aspect effect is observed at all times of the year, the south side of the pole being considerably wetter than the north side. We are also getting quite interesting figures on how long a pole remains wet 3 in. from the ground at all depths. One of the problems at the moment is to determine the effects of the waterborne preservative and the creosote on the moisture meter readings which we have taken.

Discussion

Cokley: The problem of using moisture meters with treated poles has still to be overcome.

Kininmonth: With the loadings of waterbornes used together with the high moisture content of poles, it is probably beyond the capacity of a meter.

Edwards: Are any figures available on the variation of moisture content of poles in service related to height above ground line?

Finighan: No conclusions have been drawn as yet as we are waiting on analysis. Four seasons have been covered; i. e. readings at 3-monthly intervals. Rain showers in winter, of course, mask true moisture meter reading. We are using 3 in. nails driven in by hammer; sometimes pre-boring is necessary. We have been checking this by taking m. c. samples with the Dale plug borer.

Item 6(c)

Classification of Degrade

Huddleston: At a Conference about 7 years ago a Seasoning Committee was set up and one of its tasks was to classify seasoning degrade into several classes such as slight, moderate or heavy. We have need for some standardization, and I would like to know what the position is regarding this classification at present?

Wright: This was discussed by the Seasoning Sub-Committee of the British Commonwealth Forestry Conference and is reported in Communications 3 and 4 of that body. Ratings for all Commonwealth countries have been listed by this Committee and table of comparisons has been summarized. The United States and ourselves use much the same classification. We also did some work on techniques for rating degrade in veneer in which we gave each type of defect a numerical rating; for example, face checking 1, through checking 2, and so on. In addition, we made a rating for the extent of that form of degrade. The product of these ratings gave us a quality rating. This work forms the basis of our D.F.P. Reprint 304. The National Building Research Institute at Pretoria is also investigating this.

Item 6(d)

Investigation Into High Temperature Drying of a New South Wales Hardwood*

In drying most N.S.W. hardwoods from green, the initial temperatures are kept quite low, of the order of 110 to 120°F. Overseas, considerable investigations into drying at superheated steam temperatures, viz. above 212°F, have been carried out, mostly successfully. Amongst these was at least one eucalypt species, E. globulus.

One of the main disadvantages of using these temperatures was the severe deterioration of the kiln. This appears to be the principal reason why these fast drying schedules have not come into wide commercial use.

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*Prepared by P. Marshall.

The more or less normal range of kiln temperatures for hardwoods is from 120 to 180°F. In order to decrease the drying times using high temperatures, and yet avoid severe deterioration of the kilns, it was decided to investigate the drying of hardwoods commencing around 160°F for the green timber.

Blackbutt (E. pilularis) has been investigated, and was found to dry satisfactorily from the green condition without degrade at this temperature. The schedule eventually found successful for 1 in. thick timber was as follows:-

Green	160°F - 10°F
30 per cent.	160°F - 20°F
25 per cent.	160°F - 30°F

The recommended schedule is as follows:-

Green	140°F - 10°F
40 per cent.	150°F - 20°F
30 per cent.	160°F - 30°F

It can therefore be seen that the principal difference is in the early stage of drying. The higher temperature results in a 7 day drying period (on a 24 hr drying cycle) against the normal 9 - 10 days, a 20 per cent. decrease in drying time..

This is to some extent of academic interest only, as the common practice is to air dry hardwoods to 25 per cent. or lower, and then kiln dry.

However, one quite interesting fact arose from this investigation. The average shrinkage figures obtained from the high temperature drying were 4.1 per cent. (radial) and 11.4 per cent. (tangential), and after reconditioning were 2.4 per cent. (radial) and 5.4 per cent. (tangential).

The published figures are as follows:-

	Before Reconditioning		After Reconditioning	
	Radial	Tangential	Radial	Tangential
D.W.T.	4.6	7.6	3.8	5.7
C.S.I.R.O.	7.3	9.7	4.7	6.4

From the appearance of the boards some collapse had occurred. Although this took place at a high temperature (160°F), the timber reconditioned quite satisfactorily. Although the boards had the usual slightly distorted appearance of collapse, after steaming for 6 hr they regained their normal rectangular shape.

Discussion

Wright: We did some work on ash eucalypts with superheated steam drying at temperatures up to 240°F on material in both green and partly air dried condition. With the green material of these heavily collapse-susceptible species we got severe honeycombing, and very severe collapse which could not be removed. The quality in most runs was so bad that we looked at the possibility of partial air drying, and then finishing off with superheated steam drying, but again the quality was markedly inferior compared to that from orthodox kiln drying. However, less collapse-susceptible species may well respond to high temperature or superheated steam drying, particularly after air drying. In general, our schedules are conservative, as the quality of operation varies tremendously. Results overseas indicate that superheated steam drying is not really established or accepted by industry, despite initial publicity.

Huddleston: One of the main objectives of this work is to speed up drying time. Cost of kiln drying is rising steeply and anything we can do to save 20 per cent. in drying time is well worth-while. If published schedules are conservative, how high can we push them, assuming competent operators?

Wright: We have gone about as far on the recognized species as we should go, and I suggest the States pursue the matter further if they wish. Even with Pinus radiata, which is probably the species best suited in Australia to superheated steam drying, it has not been accepted, mainly because by speeding things up you tend to get high moisture gradients, and big differences in moisture content between individual pieces, giving a dry range of, say, from 6 to 20 per cent.; if material goes into use with this wide range then you run into trouble. In any case, the drying time with the elevated schedules now in use is not much more than that by superheated steam drying.

Chairman: I feel we have the responsibility to investigate the effect of high temperature drying on hardwoods in general, and to establish the basic information on selected hardwoods.

Huddleston: In New South Wales we are doing all we can with the staff we have. Our kilns are fully occupied with ad hoc problems for which we must keep them available, and it is extremely difficult to tie them up on long schedule work of this type. I feel we must rely on D.F.P. in this regard.

Kininmonth: Improvements in our experimental techniques have allowed us to make a better assessment of the optimum drying conditions for any particular timber. Most recommended schedules are conservative but it is one thing to get a faster schedule in the laboratory, and another thing to convert it into a commercial schedule. Commercial operators tend to dry New Zealand timbers on a more conservative schedule to avoid possibilities of degrade.

Item 6(e)

Kiln Operator's Course

Huddleston: We are still having trouble concerning the kiln operator's course, which may be a legacy from the temporary suspension some time ago. People have told us that they cannot be enrolled with D.F.P., and ask if we can take them for a course of instruction. It is now impossible for us to take any more, and we must know definitely if the kiln operator's course is to continue, or must we make alternative arrangements? The Technical Education authorities in New South Wales propose to arrange a certificate course covering kiln operation and operation of preservation plant, on a 3-year basis.

Wright: Since March we have enrolled thirteen students; we have thirty or more currently doing the course. There was a hiatus before that when we felt the quality of the course no longer met the needs of the industry. We have now re-written three key lessons and the course is functioning as previously; I am surprised to hear that people have been approaching D.W.T. We are in the process of writing to people whom we previously could not accept, telling them the course is now available.

Chairman: I welcome this approach by the N.S.W. Technical Education Department; I think this is the proper way to handle such courses. These correspondence courses are a tremendous drain on the time of our staff. The more you can do to encourage the N.S.W. Technical Education Department the better.

Huddleston: This is certainly a function of the education authorities, and you may feel inclined to say that from 1964 or 1965 the course would be discontinued. It is then almost certain the N.S.W. Education Department would commence a course next year. If I had a statement to the effect that you would discontinue the course from a certain date, I am sure the course would be provided.

Turnbull: Would it be limited to operators in New South Wales?

Huddleston: It would be class instruction, hence would be limited to N.S.W. operators, but the Director of Technical Education has undertaken that they will provide any correspondence course for which enrolment of about fifteen students can be guaranteed. I understand they would enrol people from other States and overseas as well. I will get more information and advise you of the position.

Item 6(f)

The Use of Drying Sheds and Oil Burning Kilns*

(a) Drying Shed

At the Tenth Forest Products Conference a paper was presented on an experimental forced air drier used to dry plantation timber. Since then a commercial unit using this principal has been built. It is installed at Woodland Woodworks Sawmill at Gympie.

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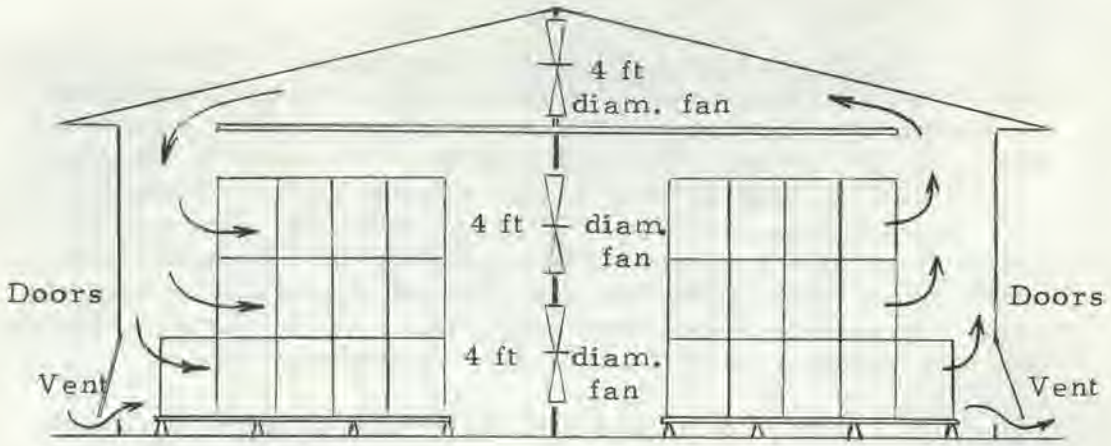
*Prepared by N. McConochie.



All material from this mill is air dried to 18 per cent. To improve drying a shed has been built in the air seasoning yard and as much stock as possible is dried under cover. The shed is 54 ft long, 36 ft wide and 13 ft high. It is divided into six bays 9 ft long. One bay has been enclosed to form a drying room and the sketch above gives a section through this room.

The 4 ft diameter fans are placed above each other in the middle of the room. There are thirteen stacks placed on each side of the fans and the total charge in the room is approximately 9,000 super ft. The doors are fitted with vents near the bottom to allow some of the air to be exausted and fresh air to be drawn in. The fans are reversed on 2 hr cycles. The fan above the ceiling is used to draw air from the charge and circulate it in the space below the iron roof so that any available heat can be absorbed by the air. To ensure that all the air goes through the stacks, they are covered with sisalkraft, which is fixed to the baffle around the fans.

The unit has not been operating long enough to give any indication of the effect of this type of drying over ordinary air drying under cover. It is anticipated that this mill will be one where proposed seasoning studies will be carried out.

(b) Oil Burning Kilns

Indirect Fired (Plantation Timbers). - The demand for kiln dried plantation grown material is continually increasing and as the mills where this material is sawn are electric powered, steam is not available for kiln heating. The cost of electricity is too high for heating so that other cheap automatic heating systems had to be devised. This led to the development in Queensland of a low cost oil fired heating unit. Air and the products of combustion are mixed together and ducted into the kiln. The system does away with boiler and boiler attendants and can be run at night completely unattended.

To date units have been built with capacities ranging from 3,000 super ft to 15,000 super ft per charge. The small units have been developed for the case millers and the large kiln for a processing plant.

The small kilns use diesel fuel in the furnace while the large installation uses furnace oil. The temperature of the small kilns is controlled by means of a thermostat which operates the burner, while in the large kiln contacts have been fitted to an indicating thermometer to control a motor operating the burner. The humidity is controlled in the small units by means of evaporating pans in the burner flue. Water is admitted to the pans when the humidity falls below a predetermined level in the kiln. This is done by means of a wet bulb thermostat controlling a solenoid valve in the water supply and vent control motor. In the large unit water sprays are used inside the kilns and these are controlled through a motor valve and contacts in the wet bulb thermometer. The vents in this kiln are also controlled by these contacts.

Direct Fired (Hardwood). - In this type of kiln, which is used to dry 1 in. brush box boards, the oil burners burn directly into the kiln air stream. This kiln was built by a mill whose site is alongside a swamp and difficulty was experienced in air drying to below 15 per cent. at certain times of the year, and the kiln is not required to operate continuously. For these reasons the kiln design had to be one which involved minimum capital cost and have a capacity of 6,000 super ft. The kiln was built of ash bricks with cross shaft fans and two small oil burners were placed in the side wall of the kiln 6 ft from each end, and 4 ft above the hobs. Humidity control at present is difficult but could be controlled with a water spray over each burner so that steam can be generated and mixed with the air to increase the humidity as desired.

A steam heated kiln of conventional design using an automatic oil fired steam generator to supply the steam has been built recently in Queensland. The reason the oil fired unit has been used is that the mill waste is not available to fire a boiler. This kiln is of 8,000 super ft capacity.

Another kiln was an electric and steam kiln. The kiln is a conventional electric cross shaft kiln. A small boiler was installed for reconditioning and it was decided to install a set of copper coils in front of each fan and use steam during mill hours and the electric elements at night. This method is operating very satisfactorily.

Discussion

Huddleston: A kiln of this type is installed at Glen Innes, but we have found that the moisture distribution at the end of drying is very scattered. One or two charges were dried from the green, but final condition was not satisfactory because of variation of moisture within the charge. In drying partly air dried timber it is reasonably satisfactory.

McConochie: The unit installed at Glen Innes is not the same as units referred to here; it was designed by one of the large oil companies.

Kininmonth: The drying shed is basically a forced air drying unit, and a similar unit has been installed in New Zealand. Timber is placed with a fork lift through an open end, and a large number of fans at the other end pulls air straight through. Good results have been obtained on moderately permeable timbers. Because of free air flow, power costs are low.

Wright: This is in effect unheated predrying and whether you add heat or not depends on climatic conditions. In southern parts of Australia heat is necessary, but in the northern parts of Australia it is not necessary.

Huddleston: I feel there is room for more investigation on unheated, forced-air drying, particularly in the northern parts of New South Wales where they have high humidity and fairly high temperatures.

Brennan: Furnace gas heating could be a sound proposition, as once the building is erected and the fans in, it requires little more capital to convert it into a normal predrier, particularly by using an oil burner. The suggestion of solar heat gain from the roof is most interesting; have any temperatures been taken to see what heat is collected?

McConochie: Not as yet, as the unit has been running only a little over a month. Further work will be carried out if the initial results are verified.

Item 6(g)

The Economics of Kiln Heating by Furnace Gases*

To help us assess the place for furnace gas heating on an economic basis, several graphs are presented which compare (i) steam heating, and (ii) furnace gas heating, on the basis of the heating and the labour charges only that each involves. These graphs do not, therefore, show total drying costs, but only those parts of these costs as contributed by each form of kiln heating. They do, therefore, enable a direct comparison of the economics of the heating media, as all other common costs are excluded.

The units of cost included in each case allow for:

(i) overheads on the heat generator - 20 per cent. in the case of steam heating, and 23 per cent. in the case of furnace gas heating on the capital invested;

(ii) overheads on the kiln heating surface if any (steam heating only) at 20 per cent.;

(iii) power costs related to these (fan to distribute furnace gases);

(iv) labour costs for attention to the heat generators and kilns only, i.e. not including that for stacking; and

(v) fuel costs.

*Prepared by G. W. Wright.

Four basic cases have been assumed, and these costs calculated for each case for several sizes of kiln installation, as size of plant can considerably affect heating cost.

The four cases taken are -

(i) 1 in. hoop pine kiln dried from the green condition in either 2 or 4 kilns.

(ii) 1 in. hoop pine kiln dried after partial air drying to 20 per cent. m.c. in either 2 or 4 kilns.

(iii) 1 in. radiata pine kiln dried from the green condition in any number of kilns from 1 to 8.

(iv) 1 in. hardwood kiln dried after partially air drying to 25 per cent. m.c. in any number of kilns from 1 to 8.

All costs shown are expressed on the basis of "cost per 100 super ft of timber dried". For the purpose of these estimates kiln charge capacity has been taken as 8,000 super ft per kiln, and kiln working time as 5 days per week over 24 hr per day.

Capital investments in installed steam boiler cost - including boiler house, fuel storage and fuel feed - have been assumed as follows:

For one kiln	-	£4,000
For two kilns	-	£6,000
For four kilns	-	£10,000
For six kilns	-	£12,000
For eight kilns	-	£15,000

Capital investments in oil burning furnaces, ducting from furnace to kiln, furnace gas distribution fan, and furnace control equipment has been estimated at £1,250 per furnace per kiln, received as a package unit on site. An additional charge of £500 per furnace has been assumed to allow for installation costs, including the costs of foundations and weather protection, oil storage, and any power connections, etc., which may be necessary. It has been assumed a separate furnace is required for each kiln, as this is understood to be the position at this stage.

The cost of oil has been assumed to be £25 per ton.

The labour assigned to each case is shown on the graphs. The cost of labour has been assumed at £1,000 per man.

The double vertical lines shown in the bar diagrams of cost for hoop pine drying indicate what are regarded as the minimum possible costs in each case. In the graphs for kiln drying green radiata pine or partly air dried hardwoods, curve B can be regarded as showing the minimum possible costs for steam heating, and curve Y the minimum possible costs for furnace gas heating.

It should be recognized that in the costing for furnace gas heating, no provision has been made for kiln attendants at night, although this is automatically provided for in steam heating because of the presence of boiler attendants. Further, that furnace gas heating provides only nominally for steam production for kiln humidifying purposes: it is believed present arrangements in this system do not provide sufficient steam for reconditioning to remove collapse, for warp removal treatments, or for adequate stress relief or moisture conditioning treatments.

Discussion

McConochie: These kilns do gain in a saving in the initial cost of plant. For a unit of 6,000 super ft capacity, the cost of machinery is under £2,000 although we do not know the exact price. A new automatic boiler alone would be considerably above this figure. If a mill has steam to spare, a steam-heated kiln is ideal and the oil fired kiln could not compete with it.

Wright: The amounts I allowed for prime heaters for steam heated kilns were as follows: £4,000 for boiler cost of 1 kiln plant - this is very conservative; £6,000 for boiler cost for 2 kiln plant, and so on. I wanted to make sure there was no bias towards steam heating. I also included the overhead on the cost of steam pipes in the kiln. The amounts I charged for prime heaters for furnace kilns were: £1,250 for cost of furnace as a packaged unit, plus about £500 for its installation. On the basis of 4 kilns, capital cost of prime heaters for steam kilns would be £10,000, and for furnace kilns £7,000.

Kininmonth: One or two oil-fired kilns are operating in New Zealand, but generally costs are much higher than original expectations. High oil cost in New Zealand is the trouble.

Cokley: The main use of these units is at the small mill where air drying conditions make it impossible to get down to e.m.c. The usage of oil is actually less than theoretically calculated due to circulation and a certain amount of heat exchange.

Item 6(h)

The Efficacy and Economics of Rees Type Burners as Compared with McCashneys

Wickett: In Western Australia, the McCashney burners have not been built exactly to design and for this and other reasons they have not been found satisfactory; those which have been built are now in disuse or even dismantled. However, there is a need for burning both fine and solid waste. The makers of the Rees-type burner do not have information which is exactly applicable to Western Australian conditions, and I would like to have some comparison of the types.

Liversidge: Extensive studies on the Rees-type burner have been undertaken by the Engineering Experiment Station of Oregon State College, and these have been published. Of the reports I have heard of Rees burners in Australia, all have been satisfactory with one exception, which may have been due to factors other than the burner itself. The Rees-type burner is capable of handling loads far in excess of the McCashney, and also larger sized pieces. However, smoke from the Rees could be more than comes from a McCashney. We understand that Rees agents are instructed that these incinerators should not be built in built-up areas because of the discharge of smoke. However, it has been reported that the Rees type will give virtually smokeless burning if the load is steady and air supply adjusted correctly. Cinder ejection can be very variable, and their efficiency is apparently largely dependent upon standard of maintenance; this applies to all burners. The cinder discharge from a Rees burner is said to be higher when the waste is light material such as sawdust or shavings. On the other hand, the McCashney is designed to cope

with light-weight material, and is ideally suited for this type of work. The Rees burner is probably best where the waste is large in quantity and includes large section material.

Huddleston: In the case of a Rees burner required to burn sawdust only, the m.c. was so high that the burner went out. It is definitely not satisfactory with sawdust only, but if larger waste is coming through as well it could be all right.

McConochie: The life of McCashneys in Queensland has been very short, in some mills little over 12 months, and some mills handling hardwood are going to the Rees burner. I can confirm that the Rees will not burn sawdust on its own, but off-cuts and sawdust together burn very well. In future mills, solid waste and shavings will go to the Rees; where sawdust only is burnt, the McCashney is likely to be used.

Wickett: Most mills have large quantities of heart to get rid of and I cannot see the sense in cutting large pieces of heart into small sections to go into a McCashney. The Rees-type of burner is the only practical means of incinerating these large pieces.

Elsey: There is a large number of McCashneys in Victoria. I have noticed that if the sawdust supply comes irregularly, it can accumulate in base of McCashney type burners and cause trouble. Two sawmillers in Victoria have converted McCashneys into a square type incinerator with a forced draught underneath in order to burn intermittent loads of sawdust.

Liversidge: In the larger size McCashney, under-fire air is included in the specification. In Queensland the breakdown of brickwork in some incinerators was largely due to the presence of borax in the waste and, possibly, overloading. Maintenance charges are inevitably higher where there is a high proportion of borax and it may be necessary to go to some other form of burning. In Western Australia high maintenance cost could have been due to faulty brickwork, bricks of low grade, or to the fact that burners were not adjusted to standard specification.

Chairman: I do not see that the Division can do any work on the Rees-type burner, but we could possibly write something up in the Newsletter.

Wright: When we have investigated complaints about the performance of "proprietary" incinerators, the Division has had

to point out that it would be infringing manufacturer's rights in handling the problems. This would apply in the case of the Rees-type burners. In respect to the McCashney, we are of the opinion that it fulfils a special need, and that we have gone as far as we need go in its development.

Huddleston: Both the Air-cool and Rees type incinerators are backed by organizations prepared to give service as soon as they are made aware of the need. I do not think there is any need for D.F.P. or D.W.T. to take any action.

Item 6(i)

Seasoning Behaviour and Properties of Karri and Mountain Ash for Poles*

As indicated at the 1961 Conference, as part of our overall pole seasoning research programme, experiments related to reduction of drying degrade in poles were commenced. These have been directed at the effective control of this problem in mountain ash and karri, in view of the economic importance of these species and their tendency to severe splitting during drying. Poles of both species have been rejected by pole-using authorities due to their tendency to check badly both along the barrel and at the ends. It was felt that if means could be found to dry these species within acceptable degrade limits, then similar methods could be applied to less susceptible species.

We have endeavoured to view the problem as a whole, i.e. in the light of features which would permit maximum benefit to be derived from subsequent preservative treatment in these naturally non-durable species. The following brief comments will relate firstly to seasoning behaviour, and secondly to treatment characteristics of mountain ash and karri poles.

(a) Seasoning Behaviour

Barrel Checking. - Experimental results indicate that barrel checking can be controlled more readily in mountain ash. Acceptable poles of this species have been dried to moisture content values suitable for preservation treatment after lying at

*Prepared by J. E. Barnacle and F. J. Christensen.

stump for 3 months, after felling and barking in December. After lying at stump for 18 months, insect attack was only slight and fungal deterioration appeared to be negligible in poles raised clear of the ground. The dried quality of poles from trees which were girdled or arsenically poisoned some months before felling was similar to the control group. The arsenical treatment facilitated barking, and prevented insect attack under bark before felling.

Results of scout tests made in Western Australia on forest drying of karri indicated that an improvement in dried quality of poles was obtained; nevertheless, results were not considered satisfactory. We feel that further forest drying work incorporating some of the suggestions made later in this contribution could be useful with karri.

For both mountain ash and karri, dried poles virtually free from barrel checking have been obtained in Victoria by soaking green poles in a near saturated solution of common salt for up to 4 days before air seasoning.

End Splitting. - Two types of end splitting have been observed during drying. First, the usually more severe splitting which originates from the centre of pole ends, as extensions of felling shakes or growth stress splits. End coating alone does not appear to hold splitting of this nature but, in conjunction with "C" irons driven into the ends, a considerable measure of success has been achieved in reducing "end popping".

The second type of end splitting encountered is that which extends from the periphery inwards, and is caused directly by shrinkage of the sapwood. This type of checking may be a problem only with karri.

Collapse Checking. - Collapse checking has been observed to occur to a much greater extent in dried ash poles both at the ends and internally. It is considered, however, that these checks may assist in distributing preservative in the heartwood during preservative treatment.

Drying Conditions. - Mountain ash poles have been dried successfully under either summer or winter conditions by the methods mentioned, and it is expected that a drying trial will be undertaken on a semi-commercial scale in the near future. With karri poles, however, it appears necessary to keep moisture gradients in the sapwood as low as possible, hence it is considered

preferable to commence drying in winter rather than in summer. Further, covering of stacks is regarded as essential and end shields may also be necessary. If drying of karri poles is commenced in summer, it is felt that the deleterious effects of low relative humidity drying conditions would have to be counteracted by use of a measure such as a salt soaking treatment before drying.

The possible advantages of pole stack covers can be illustrated by the following case. In an uncovered single layer of karri poles air dried November to June, and exposed to autumn and winter rain, the average moisture content of the sapwood on the upper (exposed) surfaces was invariably higher than that on the lower surfaces. In one case, values were 37 per cent. and 25 per cent. respectively. In addition, the average sapwood moisture content of these specimens was very little different from that in similar material air dried under cover from April to June. The above figures relate to the worst conditions likely to be experienced in an uncovered pole stack, but they still emphasize the following points:

(i) waste of drying time due to rain wetting;

(ii) the impossibility of accurately determining the moisture content of poles by a "spot" moisture meter reading;

(iii) the probability of wet spots causing uneven preservative treatment, with the attendant danger of premature failure;

(iv) aggravation of checking and splitting due to repeated wetting and drying.

(b) Preservative Treatment

As both species require presentative treatment after drying, and have decay and termite susceptible heartwood, tests have been carried out to determine penetration and retention of creosote in sapwood, and penetration in heartwood. Results indicate that:

(i) Total sapwood penetration is attainable in both species.

(ii) Acceptable preservative retentions, based on sapwood volume, are easily attained in the sapwood of ash poles at a pressure of 200 lb/sq.in. for 1 hr, without an initial vacuum.

(iii) Acceptable preservative loadings are attainable in karri sapwood provided an initial vacuum is used. The effect of an initial vacuum on loading seems to be greater than that achieved by raising treating pressure from 200 to 300 lb/sq.in. for 1 hr.

(iv) Heartwood penetration is extensive and deep in mountain ash, but very slight in karri.

Possible Effects of Drying on Pole Performance. - Checking in the heartwood of mountain ash poles would probably be beneficial rather than detrimental, since additional penetration of the heartwood can be achieved through such checks at 200 lb/sq.in. In view of this, preservative treated mountain ash poles may prove to be the preferred pole species in areas of high termite hazard.

Since the heartwood of karri is susceptible to biological attack, but is practically impenetrable at 200 lb/sq.in., it is possible that large checks or splits in the butt end could be hazardous since poles of this species will be used practically always in termite infested areas. However, the presence of common salt (if necessary fortified with water soluble arsenic) in the heartwood of salt soaked poles may prove helpful in deterring termite attack.

Since it seems advisable to avoid severe end splitting in karri, and since results indicate little benefit in terms of preservative retention if poles are dried from approximately 30 per cent. down to 20 per cent. in the sapwood, it is suggested that over-drying of karri poles should be avoided in order to minimize drying degrade. Although it may be argued that poles dried in this manner could split after preservative treatment, it is considered that the presence of creosote will retard the rate of subsequent drying and moisture pick up after treatment and, hence, minimize further checking.

Discussion

Bryant: We would like to see this work extended to blackbutt and flooded gum poles at some future date.

Chairman: This could probably be planned in co-operation with D.W.T.

Wright: Two fissile species were chosen for this test to see if general principles could be evolved. Promising treatments could then be extended and tried in other species.

Barnacle: Ash and karri appear to have different splitting characteristics; ash appears to be unique, but karri splits in a manner similar to E. goniocalyx and E. viminalis.

Cokley: It would be extremely dangerous for us to suggest bush drying in Queensland, as severe bostrychid damage does occur where drying takes place in the bush. Blackbutt has been rejected as a pole species as growth stresses make it impossible to season satisfactorily without major degrade. We have a special problem with waterborne treated poles; when they leave the treatment plant and are used immediately in areas of extremely low e.m.c., severe opening up has occurred. This aspect requires special consideration for Queensland conditions.

Barnacle: With mountain ash, if the bark is left on, we tend to get attack by cerambycids, but if the trees have been killed with an arsenical poison, insect attack is eliminated. I feel there is a big need for stack covers when poles are dried in the bush. On re-drying after preservative treatment, earlier shakes will suffer, and I suggest the use of C-irons to restrict opening up in poles going to dry areas.

Item 6(j)

Log Storage*

In many sawmills where seasonal logging makes it essential to accumulate logs over the summer period to provide for winter cutting, losses due to degrade in the log dump can often represent 10 per cent. or more of sawn recovery. In an attempt to reduce these losses, this Division recently carried out a study in which a number of protective measures were investigated on groups of logs held in a Victorian mill. The results of this particular study were reported in the July 1963 Forest Products Newsletter. The logs used were Eucalyptus gigantea and the protective treatments were as follows:

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*Prepared by R. M. Liversidge.

(i) spraying of the log ends with Shell timber dressing compound "L", which is a heavy petroleum grease dissolved in power kerosene;

(ii) spraying of the log ends and log exposed surfaces with Shell timber dressing compound "L";

(iii) spraying of the log ends with Shell timber dressing compound "L" and providing weather shields to protect the ends of the pile from sun and wind.

(iv) complete coverage of log pile with outdoor vinyl plastic film;

(v) spraying of the log ends with Caltex Timbersealer, which is a microcrystalline wax emulsion in water;

(vi) hand coating of the log ends with Shell Otina "C", which is a heavy petroleum grease;

(vii) complete cover with water sprays.

In addition, a further pile with no protection was used as a matched control. All test piles were placed in the yard during December 1961 and, after 10 months' storage, all groups were milled into boards and palings and the respective recoveries obtained. An assessment was then made of the economic value of each treatment when applied to a typical yard holding some 2 million super ft of logs. It should be pointed out that since the log piles 1 - 6 were of relatively small size an adjustment was necessary to make the recoveries applicable to a full size mill dump.

The Newsletter article shows in Table 2 the estimated cost of the various treatments and the losses incurred with the various groups in excess of those experienced with the water-sprayed logs, which proved to be the optimum treatment for the stored material. The water sprayed logs were completely free from barrel checking, but some end splitting did occur as a result of growth stresses and the 5 per cent. loss in recovery from the water sprayed logs when compared to green logs fresh from the bush can be attributed to this.

The test involving the holding of logs under plastic film was not completed since the plastic film failed after 4 months' use, leaving logs exposed for the rest of the holding period. At the time of the plastic failure, the logs were free from degrade but some fungal growth had occurred despite the initial spraying of the logs with a 2 per cent. penta. solution before the cover was placed in position. The value of the water spray in reducing log degrade was most marked and there is no doubt that this is an extremely efficient way of holding logs during the summer. Of the end coatings tested, the best was the hand applied Otina "C" which reduced the losses incurred with the sprayed coatings by about 50 per cent. The use of shields to protect the ends against sun and wind also proved very beneficial.

Following the success of the water sprays in reducing degrade in hardwood piles, a study was commenced to determine the effect of water spraying on the control of blue stain and checking in Pinus radiata logs. To determine the most efficient method for reducing storage degrade in this material, four test piles were set up, each containing about twenty-four 10 ft logs, the average diameter of which was approximately 10 - 11 in. Half the logs in each pile were barked and the others left with the bark intact. The treatments given to various piles were as follows:

Pile 1. No log treatment or protection provided. This acted as the control pile.

Pile 2. No log treatment but held under continuous water sprays.

Pile 3. Each log given a 30 sec dip in a 2 per cent. penta. plus 2½ per cent. borax solution, but no other protection provided.

Pile 4. Each log given a 30 sec dip in the penta. and borax solution and held under a continuous recirculating water spray.

Barked and unbarked logs were withdrawn from each of the test piles after storage periods of 3½ months and 5½ months and the effects of the treatments on the log quality are as follows:

All logs held under water sprays were free of both blue stain and checking, irrespective of whether they were barked or unbarked, or had been dipped or not dipped.

In the piles stored without water sprays, all unbarked logs showed severe blue stain but no checking, and all barked logs showed severe checking plus slight blue stain in checks, irrespective of whether an initial dip had been given or not.

This test is continuing and a final examination will be made within the next month or so.

Discussion

Edwards: We have been so impressed with results obtained by these tests with radiata pine, that we have circulated them to all pine sawmillers in New South Wales, asking if they would be prepared to take part in a larger scale test.

Kininmonth: We are not greatly concerned with degrade in logs because conversion is generally more rapid than in Australia, and conditions less severe. However, during the Christmas shut-down period, log storage could be a problem and one large mill tried out a water spray during such a period. This used about 10 gal of water/min/1,000 cu.ft., and was able to prevent blue stain during this period. The droplet size in the spray had to be fairly big to save it being blown away.

McConochie: In Queensland the water spray method is not entirely practical, particularly in South Queensland where they handle brush box and turpentine. With these species, wax end coatings appear to be giving satisfactory service.

ITEM 7. UTILIZATION

Item 7(a)

Review of Research Activities

I. D.F.P.*

Advisory work in utilization is continuing at a rate of about 1,500 enquiries annually. Since the last Conference, experimental cutting and finger jointing have been developed in the laboratory and heavy commitments carried out in field investigations on sawmilling.

(a) Properties and Uses

Liaison is maintained with other officers of the Division and studies of publications continued in order to keep records of properties up-to-date for reference in replying to questions on suitability of species for individual purposes. The series of printed notes has been expanded and these are effective aids to our service procedure.

Lecturing commitments have been maintained to Melbourne University, to Forestry Schools, and to groups of students, apprentices, teachers and trade representatives.

(b) Sawmilling

Advice to industry in connection with sawmill design, sawmilling techniques and operational problems is continuing and expanding.

In the past 2 years extensive field studies have been carried out in North Queensland and Western Australia and individual sawmills visited elsewhere. On the Queensland work a series of reports was issued to the Department of Forestry, Queensland, and the North Queensland Sawmillers' Association. These covered the most important individual species in the North Queensland region and specified groups of cabinet woods, constructional timbers, and forest hardwoods, in which yield, sawmilling time and value of output were correlated with volume of log. Prediction tables were included in the reports for mean logs in nominated girth classes as a basis for computing log values. Further reports on 25 individual sawmills have been sent to their managers.

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*Prepared by R. F. Turnbull.

The Western Australian studies covered 14 sawmills converting jarrah. A comprehensive report was made to the Sawmillers' Association in which the operation of the different items of sawmilling equipment and the influence of the various practices on volumetric recovery, monetary return, and man-day production rate were analysed. Companies operating the individual mills were each supplied with reports detailing individual performances and containing recommendations for increasing man-day productivity. Further studies were carried out at three large karri producing centres and general problems of sawmilling and marketing Western Australian timbers investigated. These latter studies have yet to be reported. Information collected in Western Australia was supplemented by data obtained in eastern States and used to evaluate the effects resulting from the employment of flitching carriages. This work has been reported recently in the Australian Timber Journal.

The experience gained in the foregoing field work has been applied in preparing addresses for Aus. T.I.S. Conferences and the All-Australia Timber Congress, in drafting publications for trade journals and for consulting. Our knowledge of sawmilling has been considerably expanded.

Intentions to prepare courses on sawmill engineering have been modified because of plans developing within the industry to launch schemes for training present and potential managers of sawmills. In collaboration with a panel of Aus. T.I.S. Council, outlines for courses have been drafted and further details prepared for the inauguration of courses by the Tasmanian Department of Technical Education. The Division has become committed to the preparation of texts on "Wood the Material" and "Production - Sawmilling" which together comprise half of the courses that may extend over 5 years.

In addition, we plan to run discussions for a group of sawmill managers from Western Australia late in 1963.

Power studies conducted in Victorian sawmills and co-operatively with the Division of Wood Technology in New South Wales sawmills have reached the end of the planned series. Data require analysis and reporting.

For a co-operative project on Fijian timbers, the machining characteristics are being assessed and progress reports have been prepared.

We intend to study the influence of sawing techniques on yield by quantity and grade, on distortion, and on rate of conversion, with small and immature logs of pine and hardwood.

(c) Saws

Studies on circular saws in sawmills carried out to date have been reported, the final article being "The Performance of Thin Circular Saws in Several Dense Timbers".

Circular sawing studies will be continued in the laboratory sawmill which should be transferred and ready for operation on a new site by the end of 1963.

Stresses in saw teeth when subjected to lateral forces are being measured to provide a basis for designing stiffer teeth which may take their place in programmes aimed at lessening vibrations in circular saws and improving the accuracy of sawing in industry. Progress will be reported soon in Trade Journals. Brittle lacquers have been helpful in this work and studies are continuing with more accurate and informative photo-elastic equipment.

Saws used on small portable electric tools have been studied in detail at the manufacturer's request. Results to date indicate that cross-cut blades draw double the power of "combination" blades and sawn surfaces are not always smooth because blades sometimes vibrate. The performance of factory finished "combination" blades can be erratic because of poor preparation. Blade vibrations have much greater influence on performance than tooth design. As tooth penetration is small the effectiveness of edge angles is dependent more on the curvature of the blunted edge than on hook, clearance and bevel angles. Dish in the blades and lateral run-out significantly influence the performance of saws and suggest consideration of hammering, which as yet has not been applied to commercial blades. A cathode ray oscilloscope is currently being used for measurement of saw blade vibrations. Suggestions for improving the preparation of the saws have been submitted to the manufacturer.

The reasons for failures in welds in wide bandsaws are being studied in collaboration with the Metallurgy School, University of Melbourne. Further investigation of current use of bandsaws in Australia is under consideration.

Facilities for studying the fundamental aspects of wood cutting have been expanded and will be discussed later.

(d) Grading

Collaboration with the Standards Association of Australia is continuing, although no original field work has been undertaken for some years; knowledge and experience that has accumulated is being applied in pre-committee and committee phases of the advancement of specifications. Attention has recently been given to sleepers, structural timbers, decking, sawn and milled hardwoods generally, timber for boatbuilding, flush doors, wooden containers for bulk fruit, tray packed fruit and rindless cheese, and the sanding of floors. Assistance has been rendered in revising terms and definitions used in timber grading rules.

(e) Waste Utilization

As opportunities arise the utilization of wood residues is encouraged.

Finger jointing investigations have continued. Development of a technique for finger jointing timber at moisture contents well above fibre saturation point have resulted in a patent application being lodged with the patent examiners while a local engineering firm is at present being assisted to develop equipment for applying this technique industrially.

A detailed study has been made of cutter design and maintenance, particularly in relation to the production of finger joints having a minimum of end grain. Other methods of producing this effect are also being investigated.

Investigations have been commenced on the movement of the external fingers of a joint during glue cure, weatherometer tests on joints made with various adhesives have been continued and scout tests on the jointing of chip board have been carried out. A paper covering research activities in the finger jointing field was prepared for the 8th British Empire Forestry Conference.

II. New Zealand*

(a) Structural Grades

Some progress has been made with New Zealand sawmill industry in acceptance of the need to produce a standard structural grade in radiata pine based on visual grading. In sawing procedure

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*Prepared by J. S. Reid.

with radiata pine it is necessary to have an appreciation of admissible defects before cutting to sizes suitable only for structural purposes - hence visual grading is necessary to a degree before machine grading could be operated commercially. Provisional rules for visual grading are in draft for the principal New Zealand timbers likely to be available for designed timber construction.

(b) Grading Rules

Provisional grading rules for glued lamination stock have been developed for radiata and Corsican pines, Douglas fir and larch.

(c) Scaffold Planks

In the course of preparing a standard specification for scaffold planks, attention was given to acceptance test methods replacing the static loading test previously provided. Drafting of the specification is completed but grade requirements for single long span planks have been made more restrictive than Forest Service recommendations and only imported Douglas fir following Pacific Coast rules for scaffold planks and local kahikatea are currently admitted. For heavy duty, short span, platform scaffold the specification admits various local timbers but grade requirements are above Forest Service recommendations.

(d) Standards

Other New Zealand Standards currently receiving attention are: plywood (interior and exterior), glues, furniture, joinery, ladders, tool handles, and pallets.

(e) Study of Origin and Development of Principal Defects in Planted Conifers

As an offshoot of timber grading, much attention is still being focussed on the above matter in mill studies, node studies and extensive investigations. Particular attention is being paid to the incidence and causes of tangential resin pockets in radiata pine: evidence points to cambial damage from high winds. One mill study currently being planned is to assess sweep and malformation in radiata on a poor site.

Discussion

Bryant: Our work is largely confined to the many enquiries which our Utilization Section handles. After years of trying, we now have an architect on staff. His first job was the preparation of a report on fire regulations in relation to timber in New South Wales, and other States may find this useful. Research work is under two headings, our examination of surface finishes, which is now being brought to a close after much work, and utilization studies on species such as brush box and flooded gum. Our advice has been greatly appreciated by the public and State Departments who have saved large sums of money, particularly the Education Department. The Division is represented on a State committee set up to determine whether or not New South Wales should join the Commonwealth paint committee. The Division has fostered the use of bull oak for parquet flooring, one firm in Sydney being interested in export. We have some 60 million feet of this timber on the North West. Johnstone river hardwood is the favoured species for parquet flooring, but bull oak is superior from the point of view of hardness.

We have also started a project to log grade flooded gum and also attempt to correlate the life history of regrowth flooded gum with defects obtained in the mill. This work, together with studies on brush box and other important N.S.W. species will occupy more of the Section's time in the future.

Ryley: We appreciate the work done in North Queensland by D.F.P. and feel that results have justified the effort put into it. We are currently doing a study on plantation hoop pine at six mills. Our experimental sawmill located at Rocklea near Brisbane has now been completed and is ready to start, and we look forward to co-operating with other Government departments, also with D.F.P., in research.

McConochie: The machine developed in Queensland for finger jointing is now working with reasonable success. With modification to the feed method, it will be competitive with machines imported from overseas.

Willington: We are investigating the problems associated with the marketing of radiata pine scantlings in low e.m.c. areas and felt we should look at problems of production and marketing. The investigations are starting in the bush, and will follow the log

right through the process of sawing and drying. We will pay particular attention to rate of moisture movement through scantlings during drying.

McConochie: In Queensland, some of the coastal mills are kiln drying down as low as 8 per cent. for use in western areas where humidities are low.

Elsey: We are actively engaged on extension work and, in addition, have made some investigation on the milling of the uneconomic log, and the extraction of veneer logs from a pulp wood operation.

Noar: We are doing some work on integrated operations in the southern regrowth forests to get maximum volume of saw logs. One big problem is that of occluded branches of which there would be no evidence on the surface of the log, but which cause serious degrade in timber converted from it.

Wickett: Our efforts have been concentrated on the re-design and re-building of the Department's mill destroyed in the Dwellingup fire. The mill will be used for experiments in the economics of sawing logs of different size and quality. Mr. Page's work on sawing of jarrah and karri has been most helpful to us.

Huddleston: The Division of Economics and Marketing in New South Wales has carried out the same sort of work as Mr. Turnbull did in North Queensland in the sawmill studies and I regret that D.F.P.'s programme was too full to enable them to do similar work in New South Wales.

Item 7(b)

Investigation of the Sawing of Siliceous Timbers with Hardfaced Saws*

The purpose of the investigation was to develop techniques for the application of hardfacing material to circular saw teeth and to assess the economics of the operation by comparing them with the performance of an ordinary steel saw.

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*Prepared by G. Canaway.

The work was prompted by the need to utilize large quantities of turpentine (Syncarpia laurifolia) that exist in the coastal forests of New South Wales and the depletion of supplies of easier to cut species, which forced the sawmillers to exploit the turpentine for girders, flooring, etc.

Turpentine is high in silica and dulls ordinary saws in under 1 hr necessitating a saw change during which four men are idle for from 10 - 15 min.

The hardfaced saw used was prepared by the Division of Wood Technology and the sawdoctor at the mill concerned in the test prepared the ordinary saw.

Techniques were developed for the application, grinding and sharpening of the hardfacing material.

The hardfacing (Cobalide 3) was applied by oxy welding to a recess 3/32 in. deep by ½ depth of the tooth filed in the tooth face.

To do this the saw was mounted in a jig containing two movable chill plates to dissipate the heat. Next a low pressure oxy acetylene flame was played on the tooth face until sweating occurred, after which the heated ⅛ in. diameter welding rod was melted and run into the recess. Each tooth must be cooled slowly by gradually withdrawing the flame. Care should be taken to ensure that only enough metal to fill the recess is applied.

The shaping of the "hog" and the sharpening of the tooth was done by means of a specially designed jig into which was fitted an electric drill and a silicon grinding wheel. A normal set of 0,020 in. was given to each tooth.

On the day of test the ordinary saw ran 50 min in turpentine and the hardfaced saw for 4 hr.

Calculations based on the production figures of the mill, with generous allowances for rest periods, would give an increase in production of 900 super ft per day.

Cost figures were taken out on the respective saws on the basis of -

(i) Cost of saws

1. Saw life
2. Saw maintenance

(ii) Cost of saw changing

(iii) Running costs

On comparison of unit costs per super ft worked out on the above, the hardfaced saw showed a saving of 0.703 pence per super ft or on an average daily No. 1 bench output of 6,650 super ft, £19.

Discussion

Huddleston: Mr. Canaway has been working on problems of hardfacing of saw teeth by various techniques using cobalide and applying it as a facing to the teeth in two ways, one on the top of the teeth and the other on the face of the teeth. He has been able to condition saws and use them in the cutting of turpentine with great economies. The technique of hardfacing involves very careful application of heat to the saw teeth, the surface metal being taken to the point where it is almost flowing and then the cobalide is applied to it. After application of the hardfacing, difficulty arises in the grinding of the tooth and a jig was developed for use with a silicon carbide grinding wheel. This was successful in conditioning the teeth. This work has an important application in the sawing of bull oak for parquetry flooring. The timber is so hard that in one mill it knocked off the tips of a tungsten carbide tipped saw and we are of the opinion that hardfacing will materially effect the economics of using this timber.

McKenzie: Was facing the top or the front of the tooth more effective, and will Mr. Canaway be doing any work with a carbide impregnator? We have one of these machines which applies a thin layer of carbide on the surface of the tooth.

Huddleston: We do not plan to do any work with the carbide impregnator, and propose to continue with the cobalide. We only aim to solve a utilization problem and are not undertaking basic research into this problem.

McConochie: There has not been general success with hardfaced circular saws in Queensland, but one firm cutting brush box has found a satisfactory technique using a high speed gang saw. They use a 14-gauge blade - hardfaced with cobalide - and they get approximately 3 weeks of continuous cutting.

Item 7(c)

Results of a Theoretical and Practical Approach to the Breakdown of and Recovery from Brush Box Logs for Backsawn Flooring

Huddleston: The average sawyer in New South Wales takes no notice of what effect his action will have on the ultimate recovery from the log that he first cuts. We have been trying to persuade sawmillers to plan a breakdown pattern on each log, without great success, but recently we organized a symposium on breakdown patterns in Coff's Harbour attended by approximately forty sawmill managers. We presented two papers, one setting out the effect of cutting to pattern, and the other giving a number of theoretical patterns showing lineal cut and theoretical recovery. This meeting proved how inconsistent so-called expert sawyers were. Logs were considered on the basis of producing 4 x 1 flooring backsawn. In a 4 ft 9 in. girth log, it is possible to get from 57 to 67 per cent. recovery on a theoretical basis, according to the way you break down the log. Following the symposium, one of the sawmills set up an experiment to prove these figures wrong. Although they did not get the theoretical recovery due to several factors at variance with the theoretical basis, their actual recovery was 20 per cent. higher than normal recovery from similar logs. As recovery goes up, the total amount of work done by the sawmill comes down. With a 4 ft 9 in. log, the total length of cut varies from 1,340 lineal ft to 1,580 lineal ft, with a variation in recovery from 57 to 70 per cent. We will be doing a lot more of this work, as the Country Sawmillers' Association has asked for a similar symposium in other centres. We feel that the possibility of improving sawmill techniques by this method is so great that everybody should be participating in it.

McConochie: In Queensland, the sawyers do endeavour to get maximum recovery by producing backsawn boards where possible.

Turnbull: The range of recovery that I observed in Queensland was very considerable, and was influenced by a great number of factors. I am most impressed with Mr. Huddleston's report and feel that there should be a great deal more activity in this field.

Item 7(d)

The Need for Better Publicity for the Utilization of Local Native Grown Timbers as Against Imported Timbers

Ryley: The fact that interstate and overseas contractors are working in Queensland has created a problem in that they are only familiar with southern or imported timbers, and are not aware of the merits of local Queensland timbers which, in some cases, are better than the timber imported. We have always pressed the use of local Queensland timbers and I think there is an urgent need to give advice to architects and contractors working in Queensland who do not have knowledge of local timbers.

McConochie: On a recent job in Brisbane, much of the oregon specified failed to pass a grading specification and advice was sought from the Department as to what other timbers might be suitable. We found that the requirements could be supplied in large size defect free hoop pine.

Huddleston: This is quite a difficult problem, as the architect always has a reason why some timber is not suitable for a particular job. In a recent case, roof timbers for a building in Coff's Harbour were specified to be in oregon, the matter was taken up with the Department of Public Works, who said that aluminium roofing corroded in contact with hardwood and therefore hardwood was not acceptable. We immediately investigated this and have disproved it, but oregon was used in the meantime. It is common to get public departments with definite opinions, refusing to take advice or notice of publicity, and it is necessary to demonstrate to them that timbers proposed are, in fact, satisfactory. In eastern Australia there are three main research organizations advising on the suitability of timbers and we are not always consistent. We should make an effort to see that our advice is always the same. This will help to utilize native timbers.

Chairman: I agree that we should keep each other informed on the use of native timbers, but when approached for advice it is unknown whether the enquirer has already approached other organizations.

Turnbull: We try not to overlap, and where enquiries originate from New South Wales or regarding New South Wales timbers, we refer them to D.W.T. It is not possible to circulate the questions amongst all research bodies and keep the enquirer waiting for an answer.

Cromer: The Commonwealth Department of Works refuses to use cypress pine in the Northern Territory, in spite of the fact of its high termite resistance. At the same time, we have been running a forestry programme trying to promote the use of cypress pine. In one case where concrete brick houses would have cost £10,000, we persuaded the Department to use cypress pine resulting in a saving of £5,000 each.

Turnbull: We are extending the range and number of species descriptions, but the importance of contact work must not be overlooked and we hope that the forestry departments will undertake more of it.

Item 7(e)

Trends in the Sawmilling Industry*

With the increase in cost of raw materials today most industries are forced to find ways to increase the amount of usable material from the raw material. This applies particularly to the timber industry and in Queensland several mills have rebuilt or are redesigning with this object in mind.

(a) Plantation Species

Most of the sawn product from plantation logs in Queensland is utilized for cases for the fruit and vegetable industry or small dimension products. This type of cutting involves many passes of each flitch over a conventional bench. The loss of timber due to the gauge of the circular saws prompted four of the millers to consider band resaws and three to couple with them an automatic flitch return. The recovery was increased and they were able to save one man's wages in the mill.

All but one of the mills retained the original breaking down machinery. This mill imported a Canali hydraulic log bandsaw and resaw and retained the tailer out on this resaw who also sorts for size and grade. The blades used by this mill are 19 gauge on breakdown and 21 gauge on resaw, while at the other mills 19 gauge are used.

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*Prepared by J. McConochie.

Another new mill has been built and is designed to have a log intake of 10,000 super ft/day and produce 1 in. and 5/8 in. boards for the manufacture of laminated and jointed material. This mill uses a twin edger with roundabout and a radial arm circular resaw and roundabout. The remaining thinning mills are still operating unaltered.

(b) Hardwood

At the end of 1953 there were very few, if any, accurate sizing log carriages in operation in Queensland. In the last 10 years some very notable advances have been made by a few hardwood and brushwood sawmillers. All told, ten sizing carriages have been installed to date and two are in the process of manufacture. Only one of these machines is an imported one. This machine and one Australian made machine are being used with log bandsaws. The remainder are working with twin saw Canadian head rigs.

It is interesting to note that in 1953 two of the mills which were rebuilt were in a group of thirteen in which mill studies were carried out. These mills were again studied in 1960 and the production rates had increased, in one case from 49.3 to 102.92 super ft/man hour and in the other from 55.8 to 78.9 super ft/man hour.

Another machine that has been installed is a Linck gangsaw. This machine is used for the cutting of ironbark, brush box and hoop pine. The blades are 14 gauge with cobalite tips. When cutting brush box, the machine is used to produce flitches which are then stored and returned to the machine to be cut into 1 in. boards.

(c) Cypress

A small sizing carriage has been installed recently to cut cypress pine logs. At the present time the mill has not been operating long enough to observe any increase in recovery or production rate. This type of carriage appears as though it would be satisfactory for mills handling plantation grown species.

(d) Experimental Mill

The experimental sawmill operated by the Department of Forestry has been rebuilt with modern machinery. The log bandsaw has been equipped with a small electro pneumatic sizing carriage. A breast bench fitted with infinitely variable speed

drive and radial arm type feed has been installed. The fence is hydraulically operated and the saw spindle is driven by means of an hydraulic motor to give the speed variation and still maintain sufficient power to operate the saw.

Discussion

Turnbull: Sizing carriages are increasing in number in most parts of Australia.

Bryant: The trend in New South Wales is for the small sawmiller to go out of business and the big sawmill to take over.

Ryley: The smaller mills in Queensland are relatively inefficient and many are going out of business.

Item 7(f)

Probable Limits of Sawing Accuracy Attainable with Current Australian Precision Log Carriages*

The accuracy with which a carriage and saw can produce dimensioned timber is influenced by -

(i) the accuracy to which the carriage setworks can repeatedly index the leading end of the sawn face of the log at a desired distance from the saw line;

(ii) the accuracy to which this given relationship between carriage and saw can be maintained as the carriage moves along the track and as the saw cuts;

(iii) the tendency of the log to spring and the degree to which the carriage restrains this tendency.

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*Prepared by M. W. Page.

The following table in units of 1/32 in. shows, in the top row, the range about the intended dimension within which 90 per cent. of all gaugings or settings could be expected to fall, and in the second row, the accuracy limits within which it could be expected that the gauged dimension would be produced along the length of the log in 90 out of every 100 observations. The bottom row shows the limits about the intended dimension within which it should be possible to produce 90 per cent. of sawn pieces.

The first column shows the figures obtained for a riderless carriage cutting jarrah in Western Australia, the second column those for a riderless carriage cutting brush box in New South Wales, the third column those for a highly regarded 4-man breast bench producing "ash" boards in Victoria, and the fourth column the figures for a 2-man recovery bench cutting jarrah in Western Australia.

Both the breast bench and the recovery bench are regarded by the companies operating them as producing well-sawn timber. From the figures for the first two columns, it would appear that carriages can also produce to this desired accuracy.

LIMITS EMBRACING APPROXIMATELY 90 PER CENT. OF OBSERVATIONS

(1/32 in.)

	Western Australian Carriage	New South Wales Carriage	Victorian Breast Bench	Western Australian Recovery Bench
Gauging or setting	+3 to -2	+3 to -3	+2 to -3	+3 to -4
Sawing	+4 to -2	+6 to -3	+4 to -2	+5 to -4
Actual dimension	+5 to -2	+4 to -3	+3 to -2	+5 to -4

Discussion

McConochie: The comments about mills' acceptance of these limits would also apply in Queensland. The concern is to produce a certain size, whether a little bit full or a little bit small does not really matter.

Wickett: Do these figures take into account the dimension along the whole of the flitch?

Page: The measurements were at the nose, centre and tail of each piece, and do not take into account straightness, only variation of dimension along the length. Those figures related to results obtained in 1962 in the mill at Dwellingup where flitches were in fact much fuller at the centre than at the ends. On studies done this year, this position has improved, and they are getting a much more uniform dimensioned flitch.

Huddleston: The important point is that the accuracy you get from a carriage depends on how you use the carriage and how you set the log up.

Item 7(g)

Utilization of Heads of Radiata Pine*

We became interested in this problem for two basic reasons. Firstly these heads constitute a fire hazard until they are rotted; this period can be for 2 or 3 years. Secondly these heads can constitute a disease hazard, for example, there is evidence to suggest that Sirex is attracted to the heads of freshly fallen trees and that this insect can complete its life cycle in such a head. A further advantage which results if heads can be got rid of is that the forest is improved for recreational uses.

It seems to us that there are three things that can be done with these heads. They can be burnt or macerated more or less in situ, or they can be removed from the site. South Australian Woods and Forests Department is understood to be working on the first two methods so we decided to look into the third.

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*Prepared by A. G. Hanson.

The cheapest way of removing them from the site is to put them into chip form as soon as possible. Having got the material into this form we would like to find a market for it so as to recover some of our costs.

The use of the chips for fuel is a possibility but it is difficult to compete against either coal or oil both on price per Btu and availability of burning equipment. Briquetting has been investigated and satisfactory briquettes have been made. We are still investigating this line.

The use of the chips as a source for turpentine, pine oil and rosin was considered. Previous work by the N.S.W. Forestry Commission and the Government Chemical Laboratories, Western Australia, indicates that this line of investigation is not likely to yield successful results.

The chips would probably be suitable for manufacture into softboard if we could get rid of the bark. We are currently investigating methods of separating bark from wood.

The chips could be made into compost. Previous work by W. McKenzie holds out some hope for this, provided a cheap source of nitrogen is found. Fortunately in the A.C.T. we have sewerage sludge which could be used. We are pursuing this line but there are a few unresolved problems. The chips may also be used in combination with Portland cement or gypsum to make building boards. We intend to make a couple of boards for testing but are not over hopeful that this line will be fruitful.

We placed this item on the agenda for the information of delegates and to seek any further ideas.

Discussion

Thomas: As regards disposal of top *in situ*, this has been done adjacent to the mills for fire protection purposes only - the economics have prevented any large scale work. Regarding mechanical disposal of these tops, we have endeavoured to develop a machine that would thrash the tops to pieces but with limited success. It is based on the principle of a rotary hammer, and we are trying to develop it further as we think it has a definite application. Nevertheless, we feel it would be better if some economic use could be made of the tops. We have an outlet at

the moment in that the south-east electricity authority does use pine residue for fuel. If a simple method of separating bark from the wood is discovered, there certainly would be a ready market for particle board chips.

Turnbull: Is this operation beyond the limits of the Cambio barker?

Hanson: The problem of the Cambio as we see it is that we cannot spend much time and effort on this material, which would need to be de-limbed before barking. In addition, with a portable barker and chipper, this is all adding to the plant you have to take into the bush.

Thomas: I think it will be possible to get utilization in particle board plants down to material less than 3 in. diameter.

McKenzie: I assume Mr. Hanson is aware of the possibility of taking too much off the site and not leaving enough organic matter for the soil - it may show some long term deleterious effect.

Item 7(h)

Forest Products Industry and Research Activities in the Territory of Papua and New Guinea*

Under the above heading, I wish to bring out four main points, namely -

(a) the present state of the forest products industry;

(b) the problems facing the industry;

(c) the aims of the Division of Utilization;

(d) the present state of forest products investigations.

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*Prepared by S. J. Colwell.

(a) The Present State of the Forest Products Industry

The timber industry has shown a speedy growth in the period since the end of the 1939-1945 war, gradually changing from the position where it was unable to supply local requirements to the position at present where substantial volumes of timber are becoming available for export. It is confidently expected that within 2 to 3 years the export figure will increase to 100 million super ft, far outweighing the present log production figure. Almost all this increased export will go to Japan.

This increase in production, although energetically supported by the Forest Department, has been in the main outside our control. The political and economic changes in the Pacific area have drawn increasing attention to the forest resources available in Papua and New Guinea. The increasing Japanese demand for timber, the increasing establishment of local conversion plants in the Philippines, the political uncertainty in North Borneo, the retirement of the Dutch from West New Guinea have led the Japanese timber buyers to seek added supplies in this country.

Most of the increased export will initially be in the round, but by judicious control some converted material, including sawn timber, plywood, veneer, and chipped hardwoods, and softwoods, will be included in increasing amounts.

As important as the volume increase in production and export of timber, is the increasing utilization of available species. When I arrived in the Territory some 10 years ago, the timber industry was based on five main hardwood species and two softwood, namely, taun (Pometia spp.), kamarare (Eucalyptus deglupta), kwila (Intsia bijuga), erima (Octomeles sumatrana), New Guinea walnut (Dracontomelum spp.) and the Araucaria spp. - hoop and klinki pines. At the present time some forty odd hardwood species are in use, running down to the light coloured, light density species, with a high proportion of these forty species being also exported. This increased utilization has been due to increasing knowledge of the properties of these species, being able to place them in their optimum end use, the increasing ability to handle them without degrade, but also due to increasing demand. This increasing demand has the effect, of course, of increasing the efforts to answer the day to day problems.

Table 1 would indicate that at present the production outweighs local demand, thus allowing a surplus for export. This surplus is presently being exported, and an increase in log production will result in direct increase in exportable material.

(b) The Problems Facing the Industry

The basic problems facing the industry and the Forest Department in its efforts to assist industry, are common to all developing tropical countries:

(i) Multiplicity of forest species, most of which are relatively unknown to world markets, and a large number of which remain undescribed.

(ii) Distance from world markets and high shipping freights to the Territory's natural market in Australia.

Other problems are not, we consider, so common in other tropical countries.

(iii) Undeveloped road access, tied to severe terrain, resulting in high cost of log at shipping points.

(iv) Insufficient wharf facilities.

(v) The lack of good sheltered anchorage which prohibits the shipping of logs from large stretches of coastline.

(vi) The necessity to purchase timber rights from the indigenous inhabitants before timber sales can be made. All timber is primarily owned by the local inhabitants.

(vii) Inability in the past to attract capital at a level which would ensure efficiency.

(c) The Aims of the Division of Utilization

The Division is responsible for instigating and carrying out a forest products research programme and also controls all timber sales. Its basic aims in regard to forest products research can be clearly stated as follows:

TABLE 1

RECENT FOREST PRODUCTS STATISTICS

Commodity	1957/58	1958/59	1959/60	1960/61	1961/62	Estimated 1962/63
Total log production super ft true volume	50,934,251	50,530,867	53,684,353	64,578,132	66,629,383	76,000,000
Exports Total log, super ft true volume (sawn included as log equivalent)	6,855,593	9,452,585	11,610,147	8,379,150	8,035,321	17,000,000
Export Plywood sq. ft. 3/16 in. basis	26,492,054	25,497,404	30,511,490	21,861,804	26,358,201	22,000,000
Export veneer sq. ft. 1/16 in.	825,810	297,724	6,841,801	4,559,165	5,051,675	6,300,000
Imports Sawn super ft	252,691	149,630	200,157	221,259	87,332	340,000
Imports Plywood sq. ft. 3/16 in. basis	37,445	41,687	9,062	43,286	N.A.	N.A.

(i) To advise local timber using authorities on the optimum end use for local species, and the best methods of handling these species.

(ii) To increase the overall utilization of forest species, increasing yields per acre and in consequence reducing costs.

(iii) To investigate future trends in forest products in order to advise on which species should be encouraged silviculturally.

(iv) To increase the efficiency of the industry in general.

(v) To determine the-feasibility of utilizing increasing volumes of thinnings, including both hardwoods and softwoods, from local plantations.

(d) The Present State of Forest Products Investigations

Before briefly listing the present state of investigations in the Territory, I would like to point out several of the problems associated with this work:

(i) Lack of appreciation in general by those outside the Forest Department of the potential of the Territory's timber resources.

(ii) Lack of appreciation of the present need for research, which results in lack of both funds and staff.

(iii) The almost complete lack of basic "know how" within the industry. This is a problem which I had not fully appreciated until quite recently and is quite real, as it means that you have no one to talk to.

Preservation.- Practically we consider that the answers to most of the problems are sufficiently known to allow of action being taken. However, with our prime objective - the compulsory treatment of all building timbers - we have as yet had no final success. Technically the time is ripe, but due to lack of legal draftsmen, pressure of business in the Legislative Council, and our own inability to completely sell the idea, this matter is still classed as unfinished business.

We have been experimenting with bandage treatment of poles and posts, using Tanalith "C" with some success.

Basic Timber Properties. - As you are aware, this work is being carried out by the Division of Forest Products, and our only job is to keep up the flow of authenticated wood material. This project progresses satisfactorily. However, we intend almost immediately to request the Division to investigate urgently two or three species from Bougainville of which we know very little. (An area in Bougainville containing upwards of 500 million super ft will be offered for tender in the very near future, which places some urgency on some species which commonly occur in this area.)

Log Grading. - We are presently investigating this problem with the object of introducing rules to cover quality and species of logs exported. To the present we have been satisfied to allow buyer specifications to establish export grade. However, with the increased export, we consider that we need to go further. We are at present experiencing difficulty in establishing grades which are both satisfactory to the buyer and which cover "run of the bush".

Workability and Sawing Studies. - These are continuing projects and progress slowly, although we have had successes in the sawing of some species, particularly Anisoptera species. With the closure of the Department's commercial sawmilling operations in Lae and Rabaul, we have experienced difficulty in carrying out other studies. However, we have re-established the Rabaul mill on an experimental basis and will, in the coming financial year, erect a further experimental mill in the Brown River area, in close proximity to Port Moresby.

Seasoning. - We have reached the stage where air seasoning is being more widely practised, and investigations on drying notes are proceeding. The first Territory kiln is presently being installed in Port Moresby by Intertherm, Brisbane.

Species Identification. - This is a major problem which we are answering in two ways:

(i) by the establishment of authenticated plots in the areas of exploitation in which the species are labelled; and

(ii) by the introduction of a card key based on macroscopic wood, bark, and botanical characteristics which can be recognized by the trained layman.

Thinnings Utilization. - As mentioned above, we are faced with increasing supplies of thinnings of teak, kamarare, hoop and klinki pine, and final crop balsa. We are presently investigating possible uses and will commence conversion studies in this year if necessary equipment becomes available.

Veneer Handling Investigations. - I consider, as mentioned above, that Australia is the natural outlet for our forest products. I further consider that, with the changing pattern of utilization, the demand for fine finish plywoods will increase, with a decrease in the demand for plain finish ply. This could bring to the forefront tropical species which, although low in volume, are satisfactory in character. With the above in mind I have endeavoured to encourage veneer production and intend to embark in this coming year on a project designed to determine the best methods of handling veneer for export.

Chip Handling. - With increasing demand for pulp and particle board raw material we are considering the possibility of the export of chip material. It would at present appear to be economically feasible.

Laboratory. - It is worth noting that a laboratory for this Department has been designed and should be erected in the coming year. It is designed to provide facilities for wood anatomy, seasoning, preservation, and entomological activities.

Finger Jointing. - The first plant of this nature has just come into operation in the Bulolo area, in an attempt to upgrade previously unsalable low grade softwoods.

Marine Borer Investigations. - These investigations are continuing.

Durability. - A project is in train to determine the life expectation of Australian timbers throughout the range of durability classes, and to compare these with local timbers.

In conclusion, I would like to add that we appreciate our problems, realize our shortcomings, but are endeavouring to overcome them. We would welcome visitors from the forest services and the forest products research centres, and any such visitors may rest assured that every opportunity will be taken to discuss our problems with them, and to seek their assistance.

Discussion

Bryant: We are amazed at the amount of work they manage to get through in New Guinea.

Bamber: Quite a considerable amount of New Guinea timber comes into Sydney for cabinet work, joinery and plywood. I wonder if the development in New Guinea is progressing at too fast a rate for the adequate utilization of these species, particularly the white or pale coloured ones which often arrive badly infected with blue stain. We feel also that many of these are susceptible to powder post beetle, and without proper information to the contrary we invariably say that they should be treated where the vessel size is large enough. I feel that more extensive work in regard to these particular problems is warranted.

Tamblyn: We have just put out a list of about seventy New Guinea species which are graded for Lyctus susceptibility.

Bamber: On numerous occasions we have tried to identify samples which we do not know, and which D. F. P. also does not know. We feel that the New Guinea people could help by sending us authenticated samples for our own collection.

Chairman: The difficulty is getting the authenticated samples. It is necessary to follow publications from the various areas of the world to find out when these species have been properly authenticated.

Item 7(i)

Fundamental Aspects of Cutting *

The main project on blunting effects is still being developed. Equipment, including a dust-proofed sharpening laboratory and metallographic microscope is substantially complete. Much has been learned of the science and art of producing very sharp edges.

(a) Corrosion as a Factor in Cutter Wear

This came to our attention during preliminary tests of cutters highly polished to produce sharp edges. Bands of blue stain appeared along edges after very little cutting in green Pinus radiata - more pronounced in eucalypt. Cleaning with dilute alkali revealed pitting similar to metallurgical acid etching.

It is known that damp wood, especially hardwood, may cause corrosion, but the rate required in the present instance would be high, and there are other possibilities besides acid corrosion. Therefore, a brief investigation was undertaken in consultation with the Wood and Fibre Structure Section.

To investigate nature and rate of attack, drops of solutions of water-soluble extractives at concentrations occurring in some woods were placed on cutters. Both acetic acid and tannic acid solutions at pH_3 caused rapid etching, more rapid than hydrochloric acid at the same pH. Oxygen appeared to be involved.

Using the cutter as negative electrode at about 10 V, with these solutions as electrolytes, attack was suppressed. Using it as a positive electrode, attack was accelerated.

These results are typical of acid corrosion, which, in the case of acetic acid is clearly the mechanism. However, the possibility of chelation by polyphenols, where abundant, has not been ruled out.

Kivimaa observed marked suppression of cutter wear due to an imposed negative potential on steel and tungsten carbide cutters working in green wood. If this is taken to be a corrosion phenomenon, the latter appears to be possibly quite an important factor in the wear of cutters working green wood.

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* Prepared by W. McKenzie.

(b) Friction Between Cutter Steels and Wood

The possible importance of friction phenomena in cutting was established in earlier work. Therefore, an apparatus was developed with the assistance of Timber Physics Section, to measure friction of wood sliding on steel. Very little satisfactory work had been done on this, so that some of the factors involved have been investigated.

Sliding speed, and contact pressure up into crushing ranges, had little effect.

For smooth surfaces (600-grit) there was little difference between species; coefficients varied between 0.1 and 0.26 for dry wood, and between 0.36 and 0.58 for green. Thus, moisture content is seen to be important. Extraction of lipoids raised the friction coefficient of dry wood to about 0.5, confirming Atack's findings and suggestion that hydrogen bonding is one important mechanism, especially as oven-drying, even at low temperatures, reduced the coefficient to about 0.2.

A mechanical mechanism is also suggested by the interactions of species, surface roughness and direction of abrasion scratches. The coefficient increased more with surface roughness for less dense species. For ironbark the value for 60-grit abrasion was roughly twice that for 600-grit, whereas for radiata pine it was about three times. Direction of abrasion scratches relative to sliding direction was important for coarser abrasion, especially with the denser species. In radiata pine the increase from 600- to 60-grit was only about 12 per cent. whereas for mountain ash and ironbark it was about 100 per cent.

These effects are of interest in interpreting the so-called friction values obtained from a theoretical relationship of the cutting force components, especially in regard to bluntness effects.

(c) Oblique Cutting

Some light has been thrown on bluntness effects by a project undertaken in association with Professor Norman C. Franz, on sabbatical leave from the University of Michigan. Inclination angles from zero to very nearly 90° have been achieved by varying the speed of a sharp-edged disc with respect to the speed of a work-piece fed to it.

Preliminary experiments were carried out to investigate the effects at fixed inclination of varying rim speed over a range of 4.6 to 46,000 in./min. Using an edge about 30 μ in width, at about 600 ft/min, the effects of heat generation became plainly evident. At speeds up to 12 ft/min there was negligible effect.

It has been established that two factors, edge bluntness and wood density, are highly important in determining the inclination required to produce a high quality chip and surface.

It appears that the important problem is the interaction between the cutter face and its edge, and we are proceeding to investigate this by varying inclination, edge width, rake angle and chip thickness.

(d) Standardization of Cutting Terminology

A background paper has been submitted to the F.A.O. Committee on Sawing and Machining for the September meeting, advocating international uniformity in naming the basic features of the various cutting processes, and proposing certain English terms, referred to diagrams. It is expected that the proposed terms will be circulated to interested people for comment.

Discussion

Cokley: We are very interested in the corrosion aspects. Over the years we have had problems with yellow walnut where corrosion appeared to be a factor. In the case of immunizing, the salts do appear to cause corrosion. Are you looking at any of the problems associated with the multi-salt preservatives?

McKenzie: It does appear possible that the blunting nature of some timbers such as brush box is not solely related to their silica content. We have not extended yet into applied problems and have much other work to do before this would be possible.

Bryant: We regard this type of fundamental research as of very great importance to the industry, and would like to see more of it.

Booth: Have you had any opportunity to do any work with steels of varying composition?

McKenzie: Yes, we found corrosion was high in low chrome steels, say up to 2 per cent. chromium, but there was still slight corrosion at 12 per cent. chromium. With our friction work we used stainless steel which showed no evidence of corrosion.

ITEM 8. VENEER, PLYWOOD, GLUING

Item 8(a)

Review of Research Activities

1. D.F.P.*

(a) Peeling

Peeling trials have been carried out with several dense species to investigate the possibility of obtaining veneer quality acceptable for structural grade plywood.

In limited tests optimum pretreatment conditions and lathe settings have been established for peeling blush tulip oak and negrohead beech. Nosebar pressure and profile were found to be critical for good quality veneer.

Preliminary peeling trials of eleven Fijian species have been completed. Four species show definite promise, viz. Myristica castanaefolia, Gonystylus megacarpus, Agathis vitiensis and Endospermum macrophylla.

Studies on the effect of knife sharpness and knife wear have been continued.

In one experiment knife edge recession of 0.008 in. was observed in peeling 50,000 ft of 1/16 in. Pinus radiata veneer. The effect of wear on peeling tightness was found to be slight. Some increase in roughness was observed but at the completion

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*Prepared by J. W. Gottstein.

of the experiment the veneer was still of high quality by commercial standards. The increase in roughness occurred mainly during the early stages of wearing and after that there was little change.

The formation of wear strips on the face and back of the knife appears to have a sharpening effect which retards edge blunting. Changes of peeling quality as the knife wears appear to be mainly the result of a slight increase in effective wedge angle.

When peeling 17,000 linear ft of knotty Pinus radiata veneer edge damage occurred mainly in the early stages and subsequent wear produced an edge relatively smooth and resistant to damage. Edge recession was almost twice that resulting from peeling a similar length of knot-free veneer.

The beneficial effect of increased knife wedge angle on resistance of a veneer knife to gapping was shown when peeling brush mahogany (Geissois benthamii). In this test a knife with a standard 19° wedge angle was extensively gapped, while in knives with 23°, 26° and 30° wedge angle, damage was limited to a few minor gaps.

Studies of the causes of delay in reaching full veneer thickness in initial peeling revolutions and of the effect of knife clearance on veneer thickness and lathe power requirements have been completed.

(b) Gluing

We have continued our work with tannin adhesives and also have given special attention to bonding high density species with phenol and urea formaldehyde glues. Dr. Cohen has undertaken a special study of wood-glue interface on the glued joint, the results of which he will discuss later.

Several factory trials of wattle tannin adhesives have been carried out and wattle tannin adhesives are now being used commercially in appreciable quantities in Australia.

Studies have been made of the effect of solids content and pH on viscosity of tannin solutions, the effect of pH on gelation time and pot life and on adhesion. Control of pH is critical when using wattle tannin adhesives.

Several new tannins have been investigated, viz., quebracho and extract of Phyllanthus emblica bark.

The effects of adding toxic chemicals to the glue line to control insect attack were studied. This work, which is being carried out in collaboration with the Preservation Section and the Division of Entomology, Canberra, has been mainly concerned with protection against termite attack. The effect of arsenic, dieldrin and chlordane at protective levels on adhesion with phenol and urea formaldehydes was examined.

Loss of chlordane and dieldrin from resorcinol formaldehyde was studied under cold- and hot-setting conditions. Under cold-setting conditions loss of both insecticides was negligible, but under hot-setting conditions losses were considerable, with three to eight times as much of the more volatile chlordane being lost when pressing at 130°C.

The effect of instantaneous dip-diffusion treatment of green Pinus radiata veneers with metal-chrome-arsenic preservatives on phenolic bonding was investigated. Four different commercial preservatives (Celcure A, Boliden S25, Boliden K33 and Tanalith C) and two commercial phenol formaldehydes were used. Pick-up of preservative was high at a little over 1 lb/cu.ft.

Dry shear strength was lower in treated material than in the controls, but wood failure was high. The wet strength was generally well maintained. There were small differences between the adhesives.

Very recently, using the electrical resistance control technique, excellent adhesion was obtained with coachwood veneers commercially pressure treated with Tanalith C to a loading of 0.5 lb/cu.ft. and prepressed.

A study was made of the effect of filler and age of mix on the viscosity of two commercial phenol formaldehydes. When 20 per cent. shell filler was added they showed a marked difference in viscous behaviour at 25°C. Both glues under conditions of slight evaporative loss showed substantial changes in viscosity.

Small additions of water (2 or 5 per cent.) to the resin alone resulted in quite large decreases in viscosity, but in the presence of filler the changes were not very significant.

Fillers differing in particle size had the same general effect, but the rate of increase in viscosity with the finest filler was higher than with the coarser fillers.

A control technique has been developed for gluing veneers of high density species with liquid phenolic resins. The importance of being able to obtain a reliable phenolic bond with high density species is clear, but previously the best we have been able to achieve in this problem has been very considerable variability of results. A control technique, which appears to overcome this difficulty, has been developed.

In this technique the electrical resistance of the glue line is used to indicate the time at which the hot pressing of liquid phenolic resins should take place. Using this method the bond qualities obtained with several high density species, including silvertop ash, negrohead beech, karri and blush tulip oak, are better than we have been able to obtain before.

Tests have been limited so far, but the results have shown the desirability of prepressing or double spreading when high bond qualities are required in some dense species.

(c) Compression of Plywood During Hot Pressing

In a study of compression of plywood during hot pressing, hoop plywood was bonded with a urea formaldehyde glue at an initial glue line pressure of 150 lb/sq.in. During pressing the pressure was reduced to 50 lb/sq.in. for varying periods.

Under the conditions there was in all cases a slight temporary increase in panel thickness as a result of pressure reduction, but afterwards further compression took place.

Compression increased more than proportionally with increasing panel thickness.

(d) Control of Veneer Staining in Commercial Driers

Studies under factory conditions have shown that iron staining during drying can be controlled by removal of excess water before the veneer comes in contact with the iron parts of the conveyor.

(e) Fire Resistance of Plywood

In co-operative work with the Commonwealth Experimental Building Station, 5-ply panels of 1/16 in. coachwood bonded with different adhesives were submitted to the early fire hazard test.

In this test, panels bonded with unextended urea formaldehyde were much superior to those with phenolic or casein bonds, and also to those with flour extended urea formaldehyde bonds.

Vermiculite film bonded to the plywood surface with unextended urea formaldehyde gave a considerably improved rating in this test.

(f) Distortion Studies of Plywood in Glued Composite Assemblies

When the squeeze-out of an aqueous glue, such as cold-setting urea formaldehyde or casein, occurs during the construction of hollow doors or partition walls, a distortion occurs which outlines the framing members.

The profile of the gluing surface of the solid wooden block used in the joint assembly was found to be an important factor in this kind of distortion and particular designs have been successful in almost eliminating squeeze-out and distortion under heavy spreads and high pressures.

(g) Forming Manufactured Plywood Into Simple Curved Shapes

A cold bending technique has been developed based on moisture plasticization and the effect of moisture change in inducing permanent set which was reported to the last Conference.

Using simple rollers and clamping bars, sets at 3¼ in. and 2¼ in. radii along and across the grain respectively were produced in 3/16 in. coachwood plywood.

(h) Punch Resistance of Plywood

The relation between veneer thickness and punch resistance in assemblies of hoop pine and karri up to 5/16 in. thick has been investigated.

In tests of 4-ply mixed species assemblies of 1/16 in. hoop pine and karri veneers using 2 x 1/16 in. veneers as a core, dense faces with soft cores gave greater punch resistance than soft faces with dense cores.

(i) Colour Finish for Yellow Walnut Veneers

In yellow walnut veneers a colour more acceptable than the natural one has been obtained by instantaneous dip diffusion using dilute potassium or sodium dichromate solutions.

(j) Exposure Tests

Unpainted panels overlaid with aluminium foil and Crezon are still in good condition after 6 years' exposure, although the unpainted Crezon surface is now powdering appreciably. Chalking in cream oil painted panels is now extensive, but aluminium filled films appear to be superior in this respect. Surface veneer checking has extended in one panel finished with an aluminium alkyd paint. Slight flaking has also occurred in a cream oil paint on one aluminium overlaid panel, while a cream epoxy paint has behaved similarly on a kraft paper overlaid panel.

Borax treated veneers bonded with phenolic resins remained inferior to untreated veneers using phenolic bonds after nearly 6 years' exposure.

Tannin bonded panels are still as good as the phenol formaldehyde bonded controls after 5 years' exposure.

(k) Veneer Reeling Equipment

A veneer reeling device based on a car differential has been developed and is installed in the Laboratory. The design has been made available to plywood manufacturers.

II. New Zealand

Kininmonth: Our gluing activities have been mainly in the glued lamination field. Exposure tests have been assembled and we are continuing to study the durability of treated and untreated radiata with a full range of urea phenolic and water soluble glues used under interior and exterior conditions. Some work has also been done on the exposure of laminated crossarms. The effects of moisture content on immediate bond strength have been studied on four species, including radiata, using five glues, and these results will be reported shortly. Other items are in the lamination field, one being the testing, using strain gauges, of beams with artificial discontinuities to study the effect of defects and their relation to the neutral axis, the other being the testing of structural sized laminated beams.

III. New South Wales

Booth: Most of our Section's time is taken up with contact and advisory work to plywood plants and we endeavour to get around to all of them to see their problems and advise on layout and production methods. We do a great deal of quality testing work on plywood, also investigations connected with veneer production. We have carried out applied research in an endeavour to stimulate use of hardwoods in production of plywood because this is an excellent way of using logs with faulty hearts, and some of our species have shown promise in this direction. We have worked on spotted gum, Angophora, E. grandis and E. pilularis and have had fair results in improving the quality of spotted gum plywood, a lot of which is produced by cold-pressing using urea glues; there is also commercial production using urea and some phenolic glues. E. grandis seems to hold great promise as general plywood species. We find that it glues excellently and exposure tests of panels of it are very satisfactory. It is a fairly easy species to handle in the mill, as it peels well and dries without substantial degrade. Blackbutt peels fairly well, dries with a lot less degrade than we though it would, and holds promise as an auxiliary species. We have done a lot of work on negrohead beech and would like to acknowledge assistance from the Division in work they have done on peeling this species. We have found that steaming of logs in mills is most important, and where steaming equipment has been installed it has been in full log length, so eliminating checking at the ends of billets. Production of the veneer is then made very easy and the quality is improved. We have also found that steaming makes the veneer easier to glue with phenolics and it is now on the market as a phenolic-glued species. We have found it to be acceptable as a low-priced clear finishing plywood.

We have had some success in the development of brushwood veneers for decorative purposes - here, we believe, is a great opportunity for increasing the return from brushwood species. Species we have worked with in collaboration with producers are coachwood, white birch and tulip oak. By paying great attention to detail, we have been able to market successful lines in those three species.

We have carried out exploratory work on eucalypts, including some of our New South Wales ash-type eucalypts. Tallowwood has been used as a decorative veneer and, although it is a very strong timber, it slices well and has an appearance somewhat similar to teak.

Studies on waterproof plywoods have continued, this work being based on the premise that since New South Wales is a very important producer of marine plywoods, we wish to improve the durability of N.S.W. species. We have three sites for testing durability, one in the coastal region of Sydney, one in the arid far west, and one in Sydney Harbour in the inter-tidal zone. We are continuing to expose established species, also promising new species, with various glues in these three areas, to establish their actual performance in practice. We find the most rapid breakdown in the arid area, and the slowest in the inter-tidal zone. We have also found that plywood from spotted gum, which passes the standard tests, does not seem to last any time with conventional phenolic glues.

Regarding work on adhesives, Mr. Hertzberg, who did the work in our Division on radiata tannin glue, has taken up a scholarship at the University of California. He is working principally on urea resins, and will be away for another couple of years. We have done some work with particle board to determine comparative strengths of various types of urea glues and have carried out a certain amount of work on fortified ureas for use in formwork plywood. They are not very durable but could possibly have some application for species which are not readily bonded by phenolics.

Radiata tannin work has been limited to inspection of the exposure tests, and so far the durability is very good; there has been no breakdown of any panels at any of the sites and their performance alongside conventional phenolics has been very good. Some of our earlier tests on mimosa tannins are now very old and are also performing very well. Reduction in pressing loss due to compression during pressing was investigated on a commercial press which has a programme control for glue line pressure. Using film glues, we found no improvement. The change of pressure during the cycle was not worth-while, because the panels are sprayed with water on leaving the press and the long-term recovery of all thicknesses was the same, i.e. the wetting enables plastic recovery of the wet wood.

We have worked on the effect of flours on viscosity of urea resins, and have found that the same flour would behave in quite a different way in a mix with different types of both powdered and liquid urea resins. We have no explanation for that, except the varying free formalin content of these resins. Flours from

different areas of the State have also been tested, complementary to the work we did some years ago. We have looked at starch as an extender for urea resins, with the object of developing a complete hardener system for use with automatic glue mixing plants. Tests of wheat proteins as substitute for casein in casein glues have been carried out and it appears that highly modified glutins are suitable.

The remainder of our work has been to do with recommendations concerning the use of various adhesives for specific purposes, particularly in the boat building field.

Discussion

Cokley: Apart from a testing service, our main investigations on the adhesive side have been lamination work in relation to pine. There have also been some problems with production of wide flooring from our hardwood species. We investigated the peeling properties of tulip oak from Mackay, with a view to its use as a plywood species. Our results under mill conditions were not good but one of the problems was log quality used.

Plomley: Concerning Mr. Booth's comment on the phenol formaldehyde bonding of negrohead beech after steaming, we had some hopes for a similar treatment with karri but found no improvement with steaming. We are interested to hear the results of exposure of tannin bonded panels, both radiata and wattle tannin. It is encouraging from the point of view of tannin utilization in the adhesives field.

Chairman: Is tannin formaldehyde adhesive being used commercially?

Booth: It is not very popular now, due to a change in the type of plywood produced. The phenolics are suited principally for intermediate quality plywood. For high quality plywoods, the cost of the product is so high that you cannot afford reject sheets, hence the ultimate quality adhesives must be used.

Item 8(b)

The Nature of the Bond in Gluing of Wood with Phenolic Resins*

Basic work has continued along the following lines, and has provided extremely interesting results.

(i) Preparation of standardized resins of varying functionality to determine at what point functionality becomes critical. A resin of 2.25 functionality is critical and we now use such a resin to determine the gluability of new timbers.

(ii) Chemical examination of wood extractives. Attempts to achieve some results with model substances. This has been fairly successful and has confirmed our general theory on gluing with phenolics.

(iii) Development of a new type of test piece using thin shaving technique.

(iv) Proving that lignin plays a decisive role in phenolic gluing and that cellulose is inert. Phenolic resins form covalent links with lignin. Some lignins appear to be very reactive and others less so.

(v) Some natural extractives can be impregnated into refractory woods to improve glue performance.

The Wood-Glue Joint‡

This investigation was proposed at the Tenth Forest Products Research Conference. As a first approach to the problem, it was considered that some useful information might be forthcoming if the adhesive film could be separated intact from a bonded assembly and its various physical and optical characteristics observed. At the U.S.F.P.L., Tarkow was thus able to demonstrate

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*Prepared by H. Booth.

‡Prepared by W. E. Cohen.

some of the defects present in adhesive layers (J. Polymer Science 4(12): 343-348, November-December, 1960). However, for his work, he used aluminium for both adherends and, therefore, did not throw any light on the circumstances which might prevail when wood constituted one or both of these.

Therefore, it was decided to use an assembly in which coachwood veneer was bonded to aluminium by means of a cold-setting epoxy resin. By so doing, advantage could be taken of Tarkow's method for removing the aluminium adherend after this had served as a support for the adhesive film while the wood was being removed.

Of the various methods considered for the latter, it was finally decided to use a chemical treatment. After several had been evaluated with respect to their efficacy in removing the wood and to the resistance of epoxy resin to them, the final choice was one in which the wood was treated in rotation at room temperature with 38 to 40 per cent. formalin, 72 per cent. sulphuric acid and a water jet wash, the latter to remove hydrolysed wood and soluble lignin. This cycle of treatments was repeated until no further reaction was indicated, a week generally elapsing before this stage was reached. However, not all the wood could thus be removed apparently because some of it was protected from reaction through being enveloped by resistant and impervious epoxy resin. This woody layer, which did not appear to be any thicker than a single wood fibre, has provided tangible evidence of the "penetrated wood" zone in the 7-zone joint postulated by Horioki. Apart from these fibres, there appeared to be replicas of others on the surface of the adhesive film, i.e., of fibres which had been only partially embedded in the film and therefore still vulnerable to the chemical treatment.

Thus we had an adhesive film which, although not as ideal for various physical measurements and optical studies as was that obtained by Tarkow, nevertheless offered some prospects of revealing the physical state of the wood-adhesive junction.

However, separation of the film from the aluminium has not proved to be as simple as we had been led to believe from Tarkow's paper. He used cupric chloride to dissolve it but copper is deposited copiously during this reaction and the agitation and/or washing necessary to disperse this have caused disintegration of the adhesive film in most samples to which the treatment was applied. After trying various modifications of the treatment, we have more

recently been using dilute sodium hydroxide at 40°C instead of cupric chloride. When first suggested by Dr. Wardrop, this treatment appeared to be speedy and effective but it has since transpired that, in the sample on which it had been tried, there was a predisposition for the adhesive and aluminium to part because of the sample's location in the assembly panel. Because of a side slip during pressing, samples located at each side of the panel have shown a disposition to parting on either side of the adhesive film. More recent trials on other samples have demonstrated that, although as slow as that applied to the wood adherend, treatment with sodium hydroxide does eventually yield an intact film free of aluminium.

The assembly panel was cut up into 64 squares each representative of a different station. The woody adherend has been removed from all of these and disposal of the aluminium is in hand. When the adhesive layers have been isolated from sufficient squares such that all stations may be represented, they will be studied along the lines followed by Tarkow except that the presence of wood fibres will virtually complicate some of the determinations envisaged.

Discussion

Booth: Some years ago we noticed reference in the literature to a method of dissolving away the wood on each side of the phenolic glue line using chromic acid. We tried this technique and did succeed in isolating an intact glue line, but with our equipment we could make nothing of it.

Item 8(c)

Preservative Treatment of Veneer and Plywood Including Marine Plywood

I. Queensland*

The initiation of commercial pressure treatment using copper-chrome-arsenic formulations enabled studies to be made, both experimentally and commercially, of aspects involved in the treatment of veneers and plywood using Tanalith and Celcure.

*Prepared by K. Cokley.

In the treatment of veneers it is desirable for such to be based on green or semi-green material. In the case of hoop pine it was found that there was no problem in treatment, either green or dry.

In the case of imported veneers - meranti and serayah - it was found that fresh veneers had a tendency to stick and impede solution penetration. Reduction of the weight factor by a supporting frame assisted penetration, however it was found necessary for satisfactory treatment for the veneers to be separated from the block stack - a few hours was sufficient - and then block stacked for treatment. Penetration was adequate.

In summary it was found:-

(i) In general "red" veneers gave significantly higher sludge than pale veneers,

(ii) The ratio of components was affected by veneer thickness; in general thin veneers, e.g. 1/20 in., gave a higher ratio of chromium than thick veneers such as 3/20 in.

(iii) Gluing difficulties were experienced at approximately 0.5 lb/cu. ft.

In comparison, treatment of veneer by the momentary dip process produces a clean veneer with no gluing difficulties. On present evidence it would appear desirable that treatment of veneer be carried out by the momentary dip process rather than by pressure processes.

The treatment of plywood was found to present problems in relation to distribution of preservatives. In general, for a loading of 0.7 lb, it will be found that the inner plies will have loadings much less, i.e. the primary concentration is in the face and back veneers. When used as a full sheet, this condition does not present problems, but when utilization involves cutting, i.e. exposure of low concentrations to hazard, failure may occur.

In the case of marine plywood, it is the considered opinion of this Department that all such material should be treated with a general purpose fixed preservative. Examples are known of severe marine borer attack on untreated material. In anti-Lyctus treatment, commercial trials were initiated in February, 1962

at an Ipswich plymill, into the use of Dieldrin emulsions applied to veneers by the momentary dip process. Initially a solution concentration of 0.5 per cent. was used. Loadings of approximately 0.1 per cent. were obtained with short block stack times. Subsequently the material was dried and glued with excellent results. Based on the results obtained, commercial operation using a concentration of 0.05 per cent. began. After approximately 1 year's operation at two plymills, no difficulties have been encountered. Adhesion of such treated veneers has been excellent, particularly in the case of phenolic adhesives. Veneer so treated is clean and the treatment is definitely non-staining. The general impression is that the emulsifying agents used result in a more even wetting by the adhesive and resultant increase in the quality of the bond.

For interior plywood, approval was given under "The Timber Users' Protection Acts" in July, 1962 for the use of sodium fluoride and to date eight mills have applied for approval of its use for treatment of veneer. Three mills have reported difficulty in solution, formation of gelatinous precipitates causing blockage of pipes and, in one case, unconfirmed reports have been received of gluing difficulties. A source of concern lies in the great variation in the quality of fluorides available.

Discussion

Tamblyn: We feel that for marine borer control pressure treatment of plywood is probably the best solution. Compared to momentary dipping, pressure treatment of veneers gives a reduced concentration of preservative on the surface, because of the weaker solution. This may have some benefit with preservative causing gluing trouble, but for practical reasons we would prefer the momentary dip where applicable.

Plomley: We have not compared the gluability of veneers treated by the two methods, but in recent tests with radiata and several commercial preservatives we have had no difficulty in gluing with diffusion treated veneer.

Edwards: Treated plywood is a comparatively recent development in Australia. At the last Conference we reported the use in New South Wales of copper and zinc pentachlorphenate and only since that time have commercial interests shown any

II. New South Wales*

CURRENT REQUIREMENTS FOR APPROVAL OF COPPER-CHROME-ARSENIC TREATMENT OF PLYWOOD UNDER N.S.W. TIMBER MARKETING ACT 1945-52

Hazard	Required Overall Retentions of Boliden K33, Celcure A and Tanalith C in lb/cu.ft.					
	On a Charge Basis (Provided the Individual Veneer Retention is Also Obtained)			On Individual Veneer Basis		
	Boliden K33	Celcure A	Tanalith C	Boliden K33	Celcure A	Tanalith C
Plywood for inside use - not in ground contact	0.22	0.33	0.35	0.14	0.22	0.23
Waterproof plywood for outside use - not in ground contact - painted siding only	0.22	0.33	0.35	0.14	0.22	0.23
Waterproof plywood for outside use - not in ground contact - no marine borer hazard	0.40	0.50	0.50	0.27	0.33	0.33
As above but for higher hazard situations such as silos and irrigation weirs	0.60‡	0.75‡	0.75‡	0.40‡	0.50‡	0.50‡

‡ Where these high retentions produce gluing problems, a retention of 0.14 lb in the inner veneer and 0.60 lb in face veneers for Boliden K33 or 0.23 lb and 0.75 lb respectively for Celcure A and Tanalith C, might be considered, although this would presumably involve a second treatment after the plywood has been glued.

*Prepared by D. W. Edwards.

interest in marketing rot-proof plywood impregnated with C.C.A. salts. This interest has increased quite markedly in the last 18 months and has been spurred by a Department of Supply contract which called for this sort of plywood.

Types of approval issued under the N.S.W. Timber Marketing Act may be of interest. To take Tanalith C as an example, we have issued four types of approval: one for plywood for inside use, but not in ground contact - a retention of 0.35 lb; one for waterproof plywood for outside use not in ground contact, but for painted siding only - 0.35 lb; waterproof plywood for outside use, not in ground contact and without marine borer harzard - 0.50 lb; higher hazard situations, such as silos, irrigation weirs, etc. - 0.75 lb. We have not issued one for protection against marine borers as we feel it would have to be prohibitively high, somewhere about 1.5 to 2.0 lb. With the 0.75 lb retention, we have offered the alternative of lower concentration on the inside and 0.75 on the outside veneer.

A test of copper and zinc pentachlorphenate treated plywood has been in operation for some months. When results are available a report will be published.

Are there any reports concerning the problem of disposal of sander dust from C.C.A. treated material, and are any figures available on the percentage loss of chlordane and dieldrin in pressing operations, or alternatively, what is recommended concentration of chlordane and dieldrin when hot pressing is to be carried out? What is the hazard to operators as regards these contact insecticides?

Plomley: We have some figures for losses of chlordane from hot-pressed material. When pressing at 130°C losses varied from 5 to 20 per cent. for dieldrin and 30 to 57 per cent. for chlordane. The percentage loss seems to be higher at lower concentrations.

Tamblyn: The problem of disposal of sander dust containing arsenic was referred by us to Hicksons. They have stated that in at least one New Zealand factory, many tons of shavings have been burnt in a residential area, and there has been no trouble over a period of some 10 or 12 years. Concerning the hazard to the operator in handling organic inseciticides, New Zealand has had considerable experience as they have been adding dieldrin to the glueline for many years and I understand that they have had no trouble.

Kininmonth: We have had to dispose of large quantities of multi-salt treated shavings and I know of no particular trouble. I can supply information to those interested if desired. There has been some trouble in domestic burning of treated wood due to killing of vegetation in gardens.

Cokley: Disposal of the ash from C.C.A. treated material is concerning us, where the arsenic is in a more concentrated form. As regards the use of dieldrin, the operators are wearing protection and over the last 12 months there has been no trouble. With regard to loss of dieldrin, the loss through a mechanical drier was not as bad as expected. We are chiefly interested in the end loading after all operations are completed and we have in progress a co-operative experiment on the use of dieldrin in glue lines. We have given tentative approval for the use of arsenic trioxide in the glue line of plywood made of 1/16 in. veneer and final approval will be subject to our own tests, but there is no commercial production on this basis as yet.

Kininmonth: There is considerable interest in the treatment of veneers in New Zealand for plywood for both structural and marine use. The first trials have been on assembled plywood, mostly on radiata but using rimu as well.

III. D.F.P.*

At the last Conference I presented a statement on the relative merits of boron compounds, sodium fluoride, arsenic and metal-chrome-arsenic salts for treatment of veneers or plywood. In this statement it was contended that use of leachable preservatives for exterior plywood was not good practice and that a fixed metal-chrome-arsenic salt, or some modified formulation was desirable for all waterproof plywood. I attempted to make the point that a boil test implied satisfactory service under wet conditions and that the purchaser had a right to expect that this service would not be terminated prematurely by development of decay or insect attack. He could justifiably claim that a material purporting to be waterproof or marine grade which decayed in 12 months or so had, in fact, been marketed under false pretences.

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*Prepared by N. Tamblyn.

At the last Conference, copper-chrome-arsenic preservatives were considered to have defects for plywood treatment and we offered to try to develop a fixed colourless general purpose preservative with good gluing properties for dip treatment of green veneer and sought an opinion as to whether or not it could contain some arsenic to ensure effectiveness against insects.

The response to this offer was not encouraging. It was variously stated that sodium fluoride was satisfactory for treatment of exterior plywood, that copper or zinc pentachlorphenate treatments were coming into use, and that we were inclined to be over-anxious on behalf of the plywood user. It was further said that the industry was not ready for any mandatory treatment of exterior plywood, and also that use of arsenic in veneer treatments was more or less undesirable.

Under the circumstances, we have not tried to develop any new preservative, and in the draft revision of Australian Standards for Plywood, we have noted, without comment, that some of our most water-absorbent and decay-susceptible timbers are recommended for plywood for marine craft (Specification 0.59) provided any Lyctus susceptible sapwood is immunized. Under damp conditions many of these timbers are virtually "perishable" and can be expected to decay almost as fast as they could be attacked by Lyctus.

Since the last Conference we have made further observations and have confirmed our opinion that decay in marine plywood is common and that its frequent occurrence is doing a disservice to the industry. Recently we inspected a number of house boats at Eildon with serious decay in plywood hulls. We were informed by officials of the squadron that most of about 200 boats were variously affected - some very seriously. This had provoked considerable hostility to the use of wood.

We therefore put to you again our conclusions, which are -

(i) Unless durable species are used, treatment with a fixed preservative is highly desirable for all plywood bonded to pass a boil test.

(ii) If proprietary fixed preservatives are unsatisfactory or are not freely available because of patents, every effort should be made to develop a suitable fixed

preservative which can be applied to green veneer by momentary dipping, or possibly be incorporated in the glue.

(iii) As soon as suitable preservatives and methods are available, we should recommend, in the best interests of the industry and for the protection of the public, that their use should be made mandatory for all exterior plywood.

Discussion

Cokley: The earlier a colourless preservative is developed the better. Untreated plywood sugar boxes in North Queensland are giving very poor service, and although mechanical and poor handling factors come into it, decay is the most prominent cause of failure. Permission has been refused to use copper-chrome-arsenic in plywood for those purposes, so this plywood will be dependent entirely on painting systems and protective films. We have also had serious trouble with boats.

Huddleston: I agree that a clean preservative is desirable, but I do not think that all waterproof plywood should be preservative treated.

Tamblyn: The industry is suffering from the reputation which plywood has of not doing the job it is supposed to do.

Huddleston: Good quality waterproof plywood is often needed where the decay hazard is not high, giving satisfactory performance without preservative treatment. Manufacturers should advise resellers that certain applications may require preservative treatment and to warn customers accordingly. I agree that the cost of treatment is not high where plant is available, but a number of factories in New South Wales do not have ready access to treatment facilities. In addition, there are several species accepted for waterproof plywood which will not take preservatives readily. Therefore, by prescribing that they shall be treated, they would be excluded from waterproof applications.

Bryant: I support that statement. If a manufacturer wants to put a premium product on the market, he should reap the benefit. I feel it is a matter for the industry.

Ryley: I feel that if waterproof plywood is going to be used in water it should be treated.

Tamblyn: What is the good of the waterproof bond if the ply is going to rot? Plywood used under conditions for which it is specifically made may decay within 6 months.

McConochie: The retailer has no control over the uses to which the customer puts the plywood, similarly the manufacturer does not know where his ply goes.

Booth: Whilst I feel there is a need for a fool-proof colourless preservative, I certainly do not think it will be easy to develop. To manufacture a preserved plywood which hangs together and also gives the customer what he needs would be a big problem. Although the price difference between ordinary marine plywood and rot-proof plywood is about 5 per cent., experience has shown that only about 25 per cent. of customers buy the rot-proof ply. The uses of waterproof ply are so wide that it is wrong to say that all waterproof ply should be preservative treated, because there are many structural applications where the hazards are very small. We should, however, publicize the benefits of preservative treated plywood.

Chairman: It is apparent that it would be advantageous if we could develop a colourless non-leaching preservative for treatment of marine plywood, but this should not be intended as a means of compulsion for use in marine plywood.

Item 8(d)

Dimensional Stabilization of Veneer*

With the aim of reducing the craze-susceptibility of wood veneers, two types of dimensional stabilization treatments have been undergoing evaluation by application to hoop pine and coachwood veneers, viz., cross-linking with formaldehyde and acetylation. Apart from relating dimensional stability to reduction in crazing or checking on weathering, it has been necessary to ensure that

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*Prepared by W. E. Cohen.

neither gluing performance nor the strength of the veneers are affected by the treatments, both of which have the advantage that the catalyst and excess reactant may be washed out of the veneers without adversely affecting the dimensional stability attained.

For some preliminary trials which might serve in giving useful leads for future work, both treatments were applied under arbitrarily chosen conditions to 1/16, 1/24 and 1/32 in. veneers of both woods and to 1/48 in. coachwood veneer. Results of the evaluations of these, which have not long come to hand, have revealed that:-

(i) pyridine-catalyzed acetylation is the preferred treatment because, while substantially reducing dimensional movement and, therefore, craze-susceptibility, it has the least adverse effect on veneer strength and gluing performance;

(ii) coachwood is more responsive than is hoop pine and its thinner veneers (1/48 and 1/32 in.) are the more amenable to treatment;

(iii) reaction in the wet state may not apply uniformly throughout a veneer unless the reactant (acetic anhydride) is available in excess (i.e. at least 100 per cent. based on dry wood weight);

(iv) a fairly high degree of reduction in dimensional movement may be necessary before craze-susceptibility is reduced; this may be attained only by means of acetylation.

While the above-mentioned evaluations were in progress, some of the variables of both forms of treatment were investigated by application to matched 1/48 in. coachwood veneers with the aim of resolving optimal conditions.

For cross-linking with formaldehyde in excess, the following conclusions have been drawn:-

(i) the effect of reaction time at 120°C on reduction in tangential movement is significant and it may be necessary to heat for 40 to 80 min in order to obtain a satisfactory stability level;

(ii) zinc chloride would be preferred to aluminium sulphate in the catalyst role because of the latter's disposition to embrittle the wood;

(iii) for both treated and untreated veneers, the regression coefficients of tangential movement on moisture content are equal;

(iv) therefore, any reduction in tangential movement from cross-linking with formaldehyde would have resulted from depression of the veneer's intersection point by restricting access to hydrophilic sites.

With regard to acetylation, the following conclusions have so far been drawn:-

(i) with zinc chloride as catalyst, the effect of reaction time at 120°C is not significant unless the availability of reactant should be limited (loc. cit);

(ii) the effect of acetic anhydride availability is highly significant and it has been necessary to have it available at the level of 100 per cent. of the dry wood weight in order to achieve a highly significant reduction in tangential movement;

(iii) however, even when made available to this extent, there is no guarantee of its uniform dispersion and, therefore, of uniform reaction;

(iv) pyridine is significantly effective as catalyst even at quite low concentrations, e.g. 0.5 per cent. pyridine to wood;

(v) the reaction time with pyridine as catalyst has a highly significant effect on reduction in dimensional movement: there is also an interaction between reaction time and pyridine availability when the latter is at a low level;

(vi) pyridine would be preferred to zinc chloride in the catalyst role because of the latter's disposition to embrittle the wood;

(vii) with either catalyst, the regression coefficients of tangential movement on moisture content for both acetylated and untreated veneers are equal;

(viii) therefore, any reduction in tangential movement from acetylation would have resulted from depression of the veneer's intersection point by substitution of hydrophilic groups;

(ix) no gluing problems have arisen with acetylated veneers, and weatherometer tests, although not yet complete, have given some encouraging results with respect to reduction of craze-susceptibility.

Because of the difficulty in ensuring uniformity of reaction with acetic anhydride in the wet state, consideration is presently being given to the feasibility of using it and pyridine in their vapour phases by increasing the reaction temperature or by treatment under reduced pressure or by a combination of both. If favourable results should be forthcoming, it would then be possible to use acetic anhydride in more economical dosages.

Finally, mention might be made of a method for cross-linking in the wet state with formaldehyde at room temperature, an important feature of which is the limitation of the water content of the reaction mixture, 7.5 to 10 per cent. being the preferred range (B. Marek, Holz als Roh- und Werkstoff 16 (10) : 457 - 62 (October, 1962)). When applied to paper with hydrochloric and acetic acids serving as catalyst and reaction medium respectively, very encouraging results have been obtained with respect to both dimensional stabilization and enhancement of dry and wet strengths. On the other hand, when applied to 1/48 in. coachwood veneer, the method has been found to be most ineffective.

No Discussion

ITEM 9. MISCELLANEOUS

Item 9(a)

Preservative Treatment, Grading, Mechanical Testing and Strength Requirements of P.M.G. Crossarms

Wickett: Most of the questions I had were answered at the pole conference and subsequently.

Huddleston: What steps have been taken to overcome the distortion of crossarms during the treatment process?

Tamblyn: Quartercut or backcut arms generally dry square, arms cut on the half-quarter often diamond before going into the cylinder. At 1,000 lb pressure the diamonding may become accentuated, but it is wrong to say that treatment is primarily responsible for the distortion, particularly under the somewhat reduced pressures at present being used.

Huddleston: In New South Wales, untreated tallowwood crossarms are required to be fully back or quartercut. Although we have disputed this, the P.M.G. have insisted on this specification as they cannot afford to have any distortion. Should not the Western Australian specification call for the same specification, so overcoming the distortion problem?

Wickett: That would overcome the difficulty, but although the senior P.M.G. instructors in linesman schools have said that out-of-true to the extent of ⅜ in. on each end of the arm has no effect whatever on the workability of the line and is purely an appearance defect, apparently their engineers are determined to have a perfect product. If we are forced to cut fully on the back or quarter, we must get a lower recovery, and as it is difficult to get the quality the P.M.G. demand in any case, this would be a backward step. I have also been interested in proof testing of crossarms, and a lot of work has been done by D.F.P. on the design of a proof testing machine. The P.M.G. have agreed in principle to accept arms graded by that machine, and Hawker Siddeley have agreed to install the machine.

Page: All crossarms in Western Australia, irrespective of orientation of growth rings, are cut 3¼ square and dressed to 2¾ square. Hawker Siddeley is producing crossarms at Shannon

River, Pemberton and Dean Mill. The quality of arms produced is very high; they contain virtually no defects.

At Pemberton, two men turned every arm over on the skids for the P.M.G. inspector, who said he had never seen a specification but had been told to check for various defects.

The quality of arms at Officer, Victoria, is just as high as in Western Australia, but as they are not dressed they do not look as good. They are all fully quarter or backcut. However, at Officer there are no skids for inspecting the arms, and it is claimed that the inspector passes them by the bundle.

Item 9(b)

Corrosion of Aluminium in Contact with Wood*

Because of severe corrosion which occurred to an aluminium roof at a N.S.W. north coast seaside town several years ago in positions where the metal was in contact with hardwood roof members, a degree of prejudice developed in the use of green hardwood in metal-clad roof constructions, though the reason for the rapid corrosion has been attributed to the poor quality of the roofing, which is said to have had a high copper content.

Tests have been carried out by the Sydney laboratory on both seasoned and green completely humidified samples of heartwood and sapwood of blackbutt, rose gum, spotted gum, radiata pine and Douglas fir. The samples were kept in contact with aluminium roofing alloy, supplied by courtesy of the Australian Aluminium Company, for 4½ months. No corrosion occurred on the metal in contact with the seasoned timber, but slight pitting did occur on all samples where the green timber was kept under conditions preventing any drying.

The difference in corrosiveness between sapwood and heartwood was not significant in the case of the eucalypts. Radiata pine sapwood was more corrosive than the heartwood, but this position was reversed with the Douglas fir.

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*Prepared by K. Bootle.

The unseasoned timbers could be listed in the following order of corrosiveness, with the greatest corrosiveness at the top:

rose gum
blackbutt
spotted gum
radiata pine)
Douglas fir)

Under building conditions where initially unseasoned structural members will soon lose their excess moisture to the atmosphere, it would seem that there is little danger of corrosion problems with good quality aluminium roofing.

Discussion

Kininmonth: Aluminium was included in our corrosion tests in which strips of shim metal were bolted between blocks of wet treated wood, the whole assembly being kept wet in polythene bags. Corrosion was measured by changes in relative resistance to an electrical current passed through the metal. Aluminium was not very satisfactory in this test because (i) it was very difficult to get a good, stable joint between the metal and the tapping wires, and (ii) where corrosion did occur it was in the nature of very localized pitting. Dry, untreated radiata caused no corrosion; untreated wet, and the treatments (Celcure A, Tanalith C, Boron, Boliden S.25 and K.33) all caused a pitting failure. Boliden S.25 appeared to be worse than the others. Pitting in the untreated, wet wood appeared possibly to be associated with resin streaks - the blocks were all wholly sapwood.

Huddleston: This work was carried out in conjunction with the Australian Aluminium Company, and they are going to publish the results.

Item 9(c)

Text Book on Timber

Bryant: The new edition of the Australian Timber Handbook does to some extent meet the requirement, and therefore there is less pressure for a new book, but I feel that the need is still there.

Chairman: Our biggest problem is to find the time to do the re-writing that is necessary. The same problem arises with the Trade Circulars.

Item 9(d)

The Need for Full Co-operation in Advice to Industry by Various Organizations

Ryley: Being a State Forestry Department, at times individuals or industry avoid coming to us for advice, but prefer to go, say, to D.F.P. At other times, enquirers approach both us and D.F.P. We have found that there may be slightly varying answers to queries, and the enquirer then asks "who is right and who is wrong"? I feel that with many of these queries, we should be able to keep in closer touch and avoid duplication and possible embarrassment.

Elliot: There are occasions when a firm approaches us because, for some reason, they do not want to contact the State Forestry Department.

Ryley: This may be so, but occasionally certain matters between Associations and the Department have reached political level, and we have had no indication of their approach to D.F.P.

Huddleston: This trouble can arise between States in a similar way. Some northern N.S.W. sawmillers regard Brisbane as their capital city and they obtain advice from the Queensland Forestry Department. Where we are working on slightly different lines, this can result in conflicting advice. A similar case is where we are giving advice to a mill and a D.F.P. officer who happens to be visiting may offer different advice, not knowing that we have already been there.

Elliot: At one stage we sent copies of nearly all Queensland and New South Wales correspondence to the State people concerned, but we stopped doing this as we were getting little reciprocation. We still try to keep States advised of anything important in the correspondence.

Wright: Very often, any officer from any of the laboratories is regarded as a general wood technology specialist, and when visiting a plant may be asked questions outside his own field, on which he may comment in a very general sense. This is done in good faith but would sometimes make reference to other laboratories difficult.

Chairman: Many people in the trade not only play off the States against the Commonwealth, they play off the United States Forest Products Laboratory against Australia. Madison always tells the enquirer to contact this Division, but I do not think they ever do.

Tamblyn: Another difficult situation concerns interstate visitors who come to us to discuss various matters on which we give advice. Notification of the States would be a most difficult matter, as the person concerned may consider his query to be confidential, and I feel we should respect the confidence.

Ryley: I feel that copies of relevant correspondence should go to the State concerned, but verbal discussions are not quite so important in that the enquirer has nothing in writing. One of our problems is that advice is sometimes sought outside our Department to be used against the Department.

Wickett: We have no worries on this matter in Western Australia.

Noar: Any information we give in Tasmania is based on information provided by C.S.I.R.O., as we have no technical advisory service.

Turnbull: The most important situation to deal with is the one where the contact tries to get information from several sources. Then it is desirable that each one of us who is approached should inform the others of information given.

Boyd: We have tended to regard contact notes as purely a Divisional record; perhaps they should be treated in the same way as correspondence and those contacts marked where a copy to the State is desirable.

Chairman: We would like the States to reciprocate on some items of correspondence.

Huddleston: We try to do that, but as we are mainly on contact work you would not want to see all our correspondence, and often there is no indication given in the original enquiry as to what might happen to a project at a later stage.

McConochie: We recently had a case where we were asked to design a kiln, which we did, but the enquirer later wrote to D.F.P. on the same problem, so that time was spent by both of us in preparing almost an identical design. This is waste time which none of us can afford.

Item 9(e)

Relationship Between State Forest Services, D.F.P. and Industry

Huddleston: We are concerned with the general questions of relationships, not only between D.F.P. and ourselves, but between other organizations and ourselves. In New South Wales, to meet the needs of our timber industry, we have established an organization to service the industry. Our laboratory is registered with NATA and is equipped to carry out tests on products and so provide NATA certificates. Because of this, we get enquiries from other States, a particular one being extensive testing of hardboard from Burnie. This export order required a Government certificate against specifications, and we found that we were the only registered laboratory that had the equipment for this type of work. This occupied Mr. Booth's staff for a considerable time, and as some tests resulted in failure, discussions and further tests occupied more time. We were prepared to do this, however, at cost, in order to assist an export order. However, Mr. Booth is particularly busy, with a very depleted staff, and the work was done at a considerable sacrifice.

We feel, therefore, that the timber industry should provide its own facilities for this sort of work. Tasmania may be too small to tackle work of this sort, as are perhaps other States, and D.F.P. could not do it because we look to them for the basic research work that we cannot do.

Further to the previous item, it is important that if we go into one another's territory we should try to keep one another informed. For example, if an officer from D.F.P. wants to visit New South Wales, we would be delighted to make available transport and provide an officer to accompany - it would be an advantage both ways. Our officer has knowledge not available to the officer from Forest Products, and our people welcome the contact with D.F.P. people, but we should do all we can to eliminate the possibility of conflict that exists at the moment, and so use our staffs to the best advantage.

Wickett: It would not be practicable for us to employ a sufficient number of specialists to answer all enquiries and in view of this, it is necessary for us to send enquiries to D.F.P.

Noar: As far as Tasmania is concerned, we will have to continue sending enquiries and testing out. I cannot see how an organization to handle this work could be set up by a small Department such as ours.

Elliot: There has been pressure on the Victorian Forests Commission for many years to take on more extension work, and over the last year we have discussed with them ways in which they could relieve us of tests, inspections and general contact work, and have now come to a satisfactory arrangement. There are certain enquiries we still wish to receive, as we wish to maintain contact with the industry. We do not wish to receive routine enquiries which waste the time of research staff, nor those involving legal action. Many enquiries are being re-directed by us to the Commission or are going directly to the Commission, and where an inspection is required we normally now refer this to the Commission. In the case of enquiries over the telephone which we can answer direct, we usually do to maintain public goodwill. The number of enquiries the Forests Commission are receiving are increasing quite considerably, to the extent that they intend to increase their staff. There is a nominal fee charged by the Commission in the case of inspections. There is a similar arrangement with the Forestry School at the University, and although it is not being publicized, they are prepared to do certain types of tests, again, for a fee.

Threader: The Commission will gradually undertake more of this work, as we can build up our staff and equipment. I would also like to point out that the job of supplying timber to D.F.P. falls more heavily on Victoria than any other State.

Bryant: How many people at what level of qualifications have you got for this work?

Threader: Three, but not full time, and they are all professionally qualified.

Elsey: We do not have a separate section dealing with enquiries, but as a result of this diversion our work is increasing. This is over and above the normal work of officers on other jobs. We have had many officers out on the Sirex problem recently and until this settles down we will have some difficulties.

Item 9(f)

Conferences

Chairman: The F.A.O. Consultation on Plywood is at present in progress in Rome, and Mr. Gottstein is attending this. He was responsible for preparing a number of background papers which will be presented. Industry is also well represented. At the end of August, there is a meeting sponsored by F.A.O. in Stockholm, Sweden, of IUFRO dealing with tree genetics, one session of which relates to the inheritance of wood properties. Mr. Fielding is to be an Australian representative.

On September 11th, 12th and 13th there will be another session of IUFRO meeting in Madison dealing with three aspects of forest products - Wood Quality, divided into two Sub-Groups, Macroscopic and Microscopic; Wood Machining and Fire Resistance. Commencing the following week, there will be the F.A.O. Wood Technology Conference in Madison, lasting 2 weeks, and attended by representatives from all Forest Products Institutes throughout the world, including myself and Mr. Pearson from this Division.

Huddleston: Arising from a proposal to establish an Institute of Wood Technology in New South Wales, a Wood Technology Study Group has been formed and at monthly meetings there are attendances in the order of 100 each night, representing a good cross-section of the industry. We seek speakers on the subjects concerned. I think the idea would be well worth following in other States. At the moment this is purely a study group but it could lead to an Institute.

Another group of interest, also formed in Sydney, is the Building Science Research Forum. Its first Conference, on plastics, was well attended and the Forum is now well established. We hope that timber will be one of their subjects of study later. Action has been taken to form State branches.

Chairman: In August of next year the Building Research Congress, organized this time by the C.E.B.S., will be held in Sydney.

Item 9(g)

Forest Products Research Conference

All delegates expressed satisfaction with the form of the Conference. It was agreed that the next one would be in 2 years' time. Mr. Kininmonth expressed thanks for New Zealand again being invited, and said they would also appreciate the opportunity of submitting items for the agenda.

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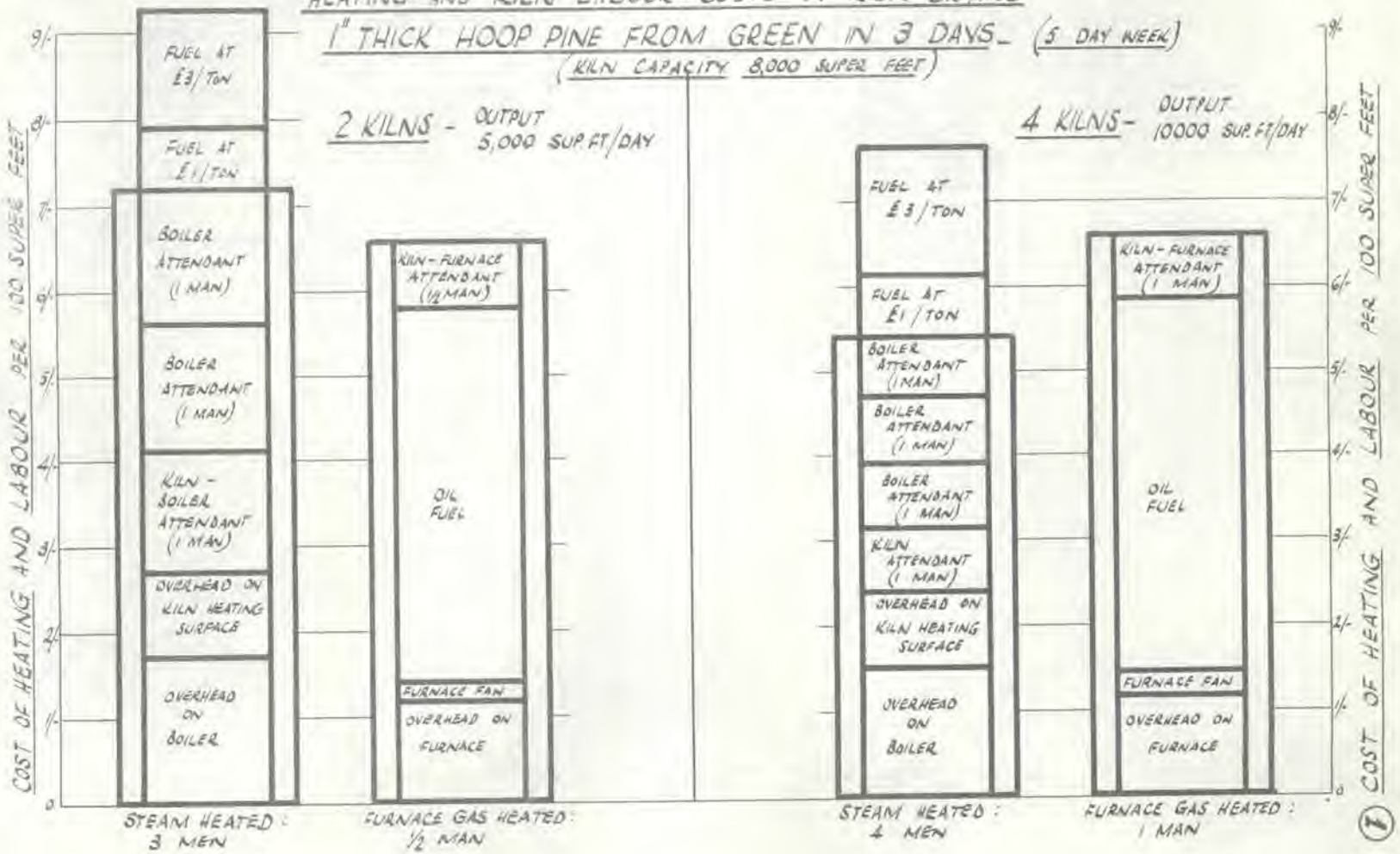
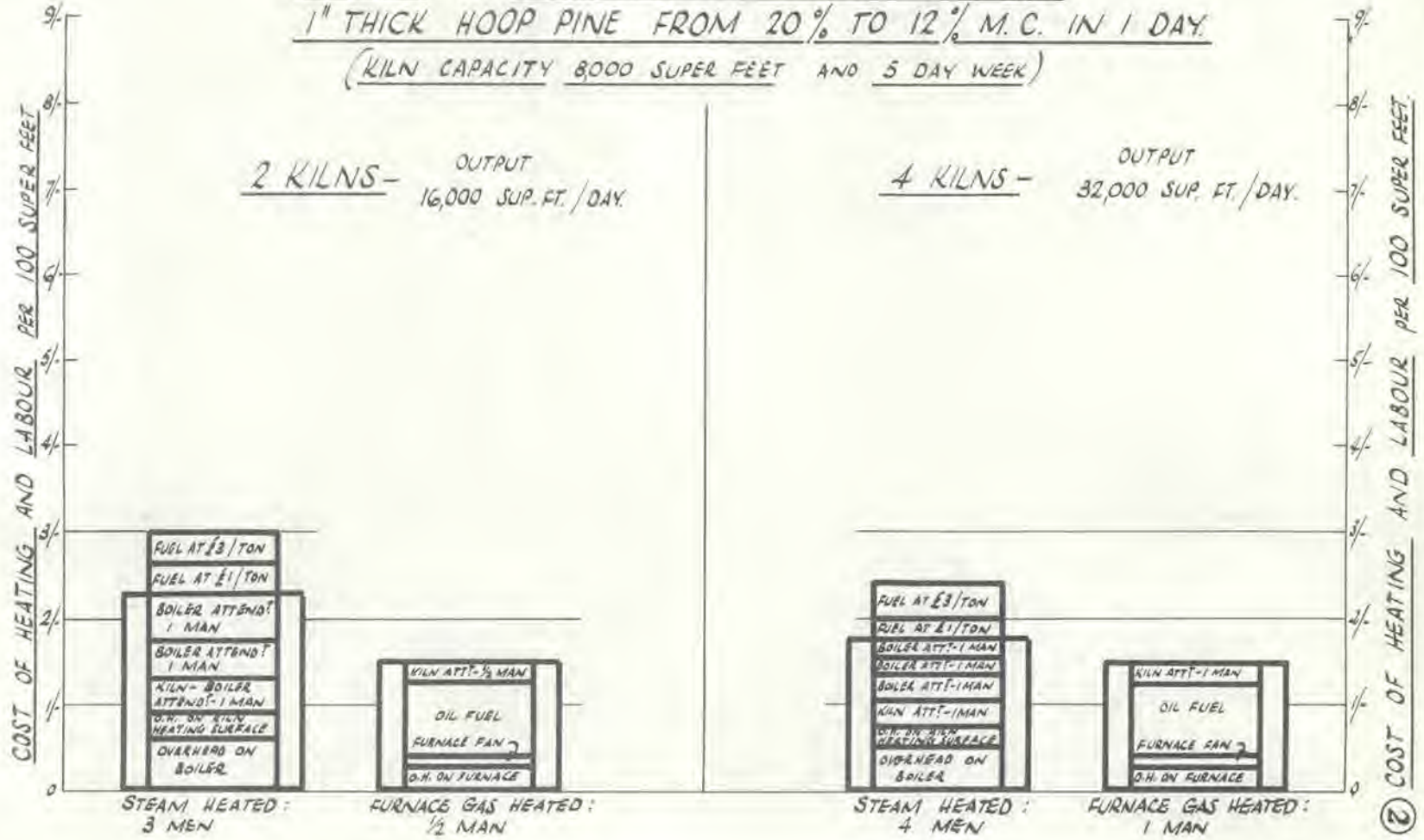
HEATING AND KILN LABOUR COSTS IN KILN DRYING

1" THICK HOOP PINE FROM GREEN IN 3 DAYS – (5 DAY WEEK)

(KILN CAPACITY 8,000 SUPER FEET)



HEATING AND LABOUR COSTS IN KILN DRYING
1" THICK HOOP PINE FROM 20% TO 12% M.C. IN 1 DAY.
(KILN CAPACITY 8000 SUPER FEET AND 5 DAY WEEK)



(2) COST OF HEATING AND LABOUR PER 100 SUPER FEET.

GREEN PINE (RADIATA PINE)

HEATING AND LABOUR COSTS ONLY

STEAM HEATING

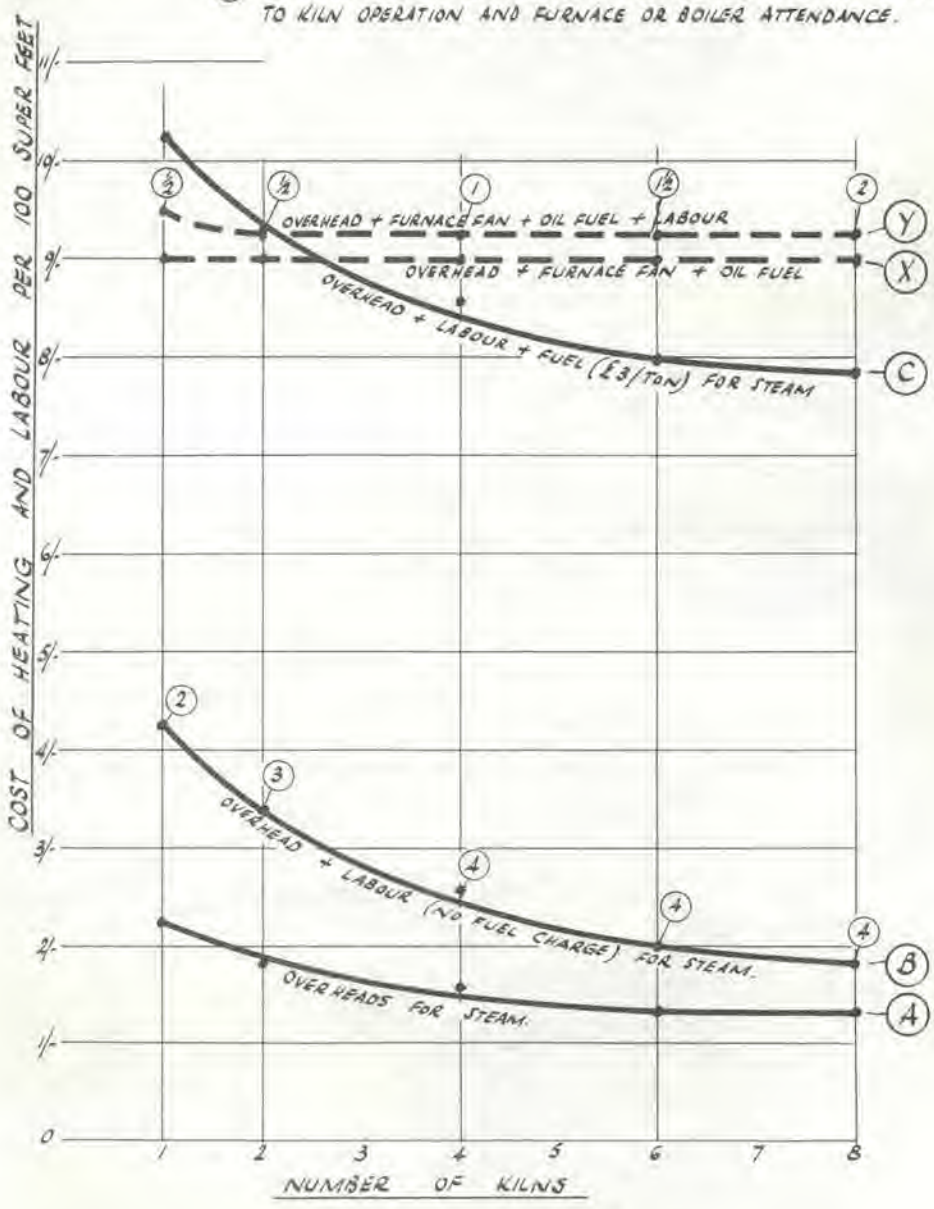
FURNACE GAS HEATING - OIL FIRED

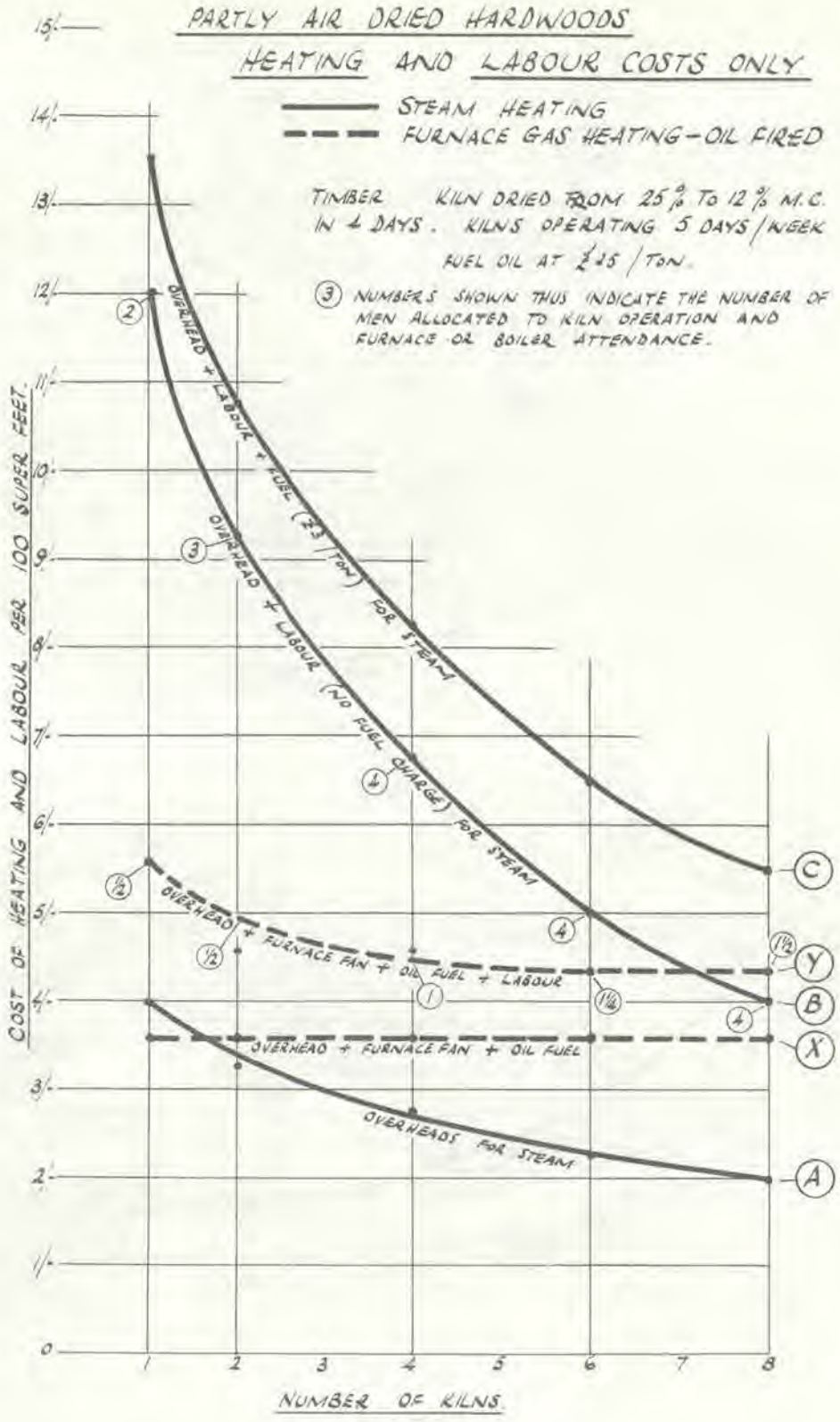
TIMBER KILN DRIED FROM THE GREEN CONDITION TO 12% M.C. IN 2 DAYS.

KILNS OPERATING 5 DAYS / WEEK

FUEL OIL AT £25 / TON.

(3) NUMBERS SHOWN THUS INDICATE THE NUMBER OF MEN ALLOCATED TO KILN OPERATION AND FURNACE OR BOILER ATTENDANCE.




PARTLY AIR DRIED HARDWOODS
HEATING AND LABOUR COSTS ONLY
STEAM HEATING
FURNACE GAS HEATING – OIL FIRED
TIMBER KILN DRIED FROM 25% TO 12% M.C. IN 4 DAYS. KILNS OPERATING 5 DAYS/WEEK
FUEL OIL AT £25/TON.
(3) NUMBERS SHOWN THUS INDICATE THE NUMBER OF MEN ALLOCATED TO KILN OPERATION AND FURNACE OR BOILER ATTENDANCE.
COST OF HEATING AND LABOUR PER 100 SUPER FEET.
15/-
14/-
13/-
12/-
11/-
10/-
9/-
8/-
7/-
6/-
5/-
4/-
3/-
2/-
1/-
0
OVERHEAD + LABOUR + FUEL (£3/TON) FOR STEAM
OVERHEAD + LABOUR (NO FUEL CHARGE) FOR STEAM
OVERHEAD + FURNACE FAN + OIL FUEL + LABOUR
OVERHEAD + FURNACE FAN + OIL FUEL
OVERHEADS FOR STEAM
C
Y
B
X
A
1 2 3 4 5 6 7 8
NUMBER OF KILNS