PROCEEDINGS

FOURTEENTH

FOREST PRODUCTS RESEARCH CONFERENCE

HELD AT

BASSER COLLEGE, UNIVERSITY OF NEW SOUTH WALES,

SYDNEY

MAY 26 - 30, 1969

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CONTENTS

		Page
ITEM 1	GENERAL	
(a)	Wood chips (NSW)	1
(b)	Debarking for pulp (DFP)	3
(c)	The need for reassessment of the effect of wood characteristics on wood quality (Q)	6
(d)	Exotics (NSW). Pinus pinaster (SA)	10
ITEM 2	ENGINEERING, MECHANICAL PROPERTIES	
(a)	Research reviews	14
(b)	Timber engineering (NSW)	23
(c)	Prototype testing (NSW)	28
ITEM 3	PLYWOOD ETC.	
(a)	Research reviews	30
(b)	Plywood exposure tests (DFP)	34
(c)	Developments in impregnated plywood and preservation of plywood by glueline additives (NSW)	36
(d)	Treatment of veneer and plywood by methods and chemicals not currently used (Q)	39
(e)	Difficulties experienced with waterproof glue in laminated members (SA)	not included in proceedings
(f)	Suitable glues for face glue structural members subject to short term exposure during erection (SA)	not included in proceedings
ITEM 4	PRESERVATION	
(a)	Research reviews	45
(b)	Treatment of radiata pine heartwood (DFP)	61
(c)	Boultonizing (i) sawn hardwoods (ii) round timbers (DFP)	64 65

ITEM 4 (cont'd)

		Page
(d)	Effect of timber species on preservative performance (DFP)	66
(e)	"Natural" finishes for external timbers (DFP)	69
(f)	Suitability of imported and Australian timbers for external joinery (DFP)	72
(g)	Forest diseases and their effect on timber utilization (NSW)	75
(h)	Protection of timber before and during conversion (NSW)	80
(i)	Report from the Preservation Committee	82
(j)	Report from the Fire Retardant Committee	87
(k)	The desirability of investigations into waterborne preservatives other than CCA salts (Q)	90
(l)	Treatment of poles and posts by sap replacement or sap displacement (DFP)	94
(m)	Arsenical creosote (DFP)	96
(n)	Treatments for marine piling (DFP) (Q)	98
(o)	New oil-borne preservatives (DFP)	107
(p)	Toxic levels of insecticides to Lyctus (DFP)	108
(q)	Pretreatment factors influencing treatability and performance of timbers (DFP)	111
(r)	Cryptotermes brevis position at Maryborough (Q)	113

ITEM 5 UTILIZATION

(a)	Research reviews (including report from Austis Research Committee)	114
(b)	What is the future of hardwood (NSW)	128
(c)	Rationalization of log grading in relation to industry integration (DFP)	135
(d)	Developments in sawmilling machinery (NSW)	136
(e)	Machining problems in wood of non uniform texture (Q)	137
(f)	Noise in woodworking plants (NSW)	142
(g)	Problems associated with timber use in regard to current building trends (Q)	146

ITEM 5 (cont'd) Page

(h) Problems of fast grown eucalypts (NSW) 153

(i) Compliance with clean air acts 155

(j) Minor forest products (NSW) 160

ITEM 6 SEASONING

(a) Research reviews 164

(b) Developments in timber seasoning (NSW) (DFP) 168

(c) High temperature drying of P. radiata (DFP) 172

(d) Reduction of distortion in sawn material particularly from small diameter stems (Q) 174

i drying of small plantation logs of hoop pine prior to sawing

ii elimination of twist from rejected scantling

(e) Control of surface checking in backsawn collapse susceptible eucalypts (DFP) 178

(f) Surface treatments to protect timber on the construction site (SA) 180

(g) Monitoring of drying in kilns (DFP) 180

(h) Moisture movement inhibitors to improve stability of joinery (SA) 181

(i) Prefreezing as an alternative to reconditioning (DFP) 181

(j) Surface treatment of P. radiata flooring boards to improve surface crushing strength and resistance to abrasion (SA) 182

(k) Control of end splitting in round timber (DFP) 183

ITEM 1. WOOD STRUCTURE

Item 1(a). Wood chips for pulping*

This subject was suggested as an agenda item by New South Wales before we knew that the Division of Forest Products would be speaking on the debarking of pulpwood. We believe that the problem of economically debarking both pulpwood logs, and saw logs whose off-cuts can then be chipped, is a most important one from the viewpoint of the pulp industry and especially of the hardwood timber industry.

Under Item 5 in the Utilization Section of this Conference, Mr Bootle will discuss the future of hardwoods as we see it in New South Wales. As you will hear, his assessment is pessimistic though I believe it to be realistic for this State, since we are the largest importer of softwoods and because our rapidly expanding exotic plantations are already producing these timbers in significant quantities. Mr Bootle has not dealt with the use of hardwood chips for pulping, and in my view this is the one bright spot on the horizon for the effective utilization of hardwood and it could well determine the future of hardwood forestry and sawmilling. I believe that, because of the increasing demand for our hardwoods by local and overseas groups and also because of the more realistic prices that the pulp and paper industry must pay for this material, the next decade will see increasing sales of pulpwood chips from mill waste and over-mature trees. The effect of removing useless trees from our hardwood areas will be of tremendous importance for the future economic production of hardwood and/or softwood from these areas.

Concerning prices I like to think that my own Commission played a significant role in establishing a price much closer to world parity prices than had previously been achieved in Australia.

A statement on "the availability of indigenous timbers in pulpwood and similar sizes in New South Wales" was prepared in October 1967, by the Commission's Division of Economics and Marketing. This was in response to many enquiries received during that year, largely by Japanese interests who wanted to export chips and who were therefore interested in deep water ports within economic reach of the raw material. Because there is only one suitable port close to the main pulp wood resource (Twofold Bay), the statement is not particularly optimistic about other areas. However, it is my belief that active attempts should be made to interest pulp makers to set up pulping

* Prepared by L H Bryant

facilities in one or more of these other areas because in the long run this makes economic sense and may mean that much less money need be spent on deepening existing ports such as, for example, Coffs Harbour.

Forest Departments are necessarily conservative in their estimates of raw materials available for pulping. Certainly that has been my experience with regard to the resource at Eden. I believe that we should be spending more time and money making accurate assessments of the raw material potential in the more significant areas so that we are in a position to encourage 100% utilization of the standing trees with the subsequent regeneration of a more valuable crop for future use.

In cooperation with our Division of Forest Management we have commenced experiments on chemical debarking in the Eden area using sodium arsenite and two recently developed organic arsenicals on two species of eucalypts (Eucalyptus sieberi and E. obliqua). The number of trees involved is 240 and the chemicals have been applied to frills cut low on the trees in September, December, May and June. This work is still in progress and was done because we could find no record of chemical debarking having been used on these species.

Mr Canaway has also carried out some work on E. obliqua and E. oreades using a Cambio debarker and it is clear that for small girth logs (up to 16" diameter) such a debarker could be modified to work effectively. Attempts to improve the efficiency of hand debarking using a vibrating spud bar have also been made but for various reasons do not appear promising. A number of other ideas have been considered, including the rumbling of split billets, but have not yet been tried. We are aware that APM is experimenting with a VK 16 Finnish debarker which was recently imported and we understand that Mr Hanson's group is considering the purchase of a Morbark debarker for trial. Finally, Harris-Daishowa is about to commission a debarker based on a number of existing machines. We shall therefore be most interested to hear the results of any work being carried out in this important field.

Discussion

Smith: Why is there a particular future for overmature timber as pulp, when younger material is generally considered more suitable?

Bryant: We could not sell overmature timber and as there will be a hardwood shortage it should be removed and a new crop grown.

Smith: Trials in Japan were promising for about a third of the Queensland hardwood species tested.

Colwell: TPNG have issued an exploratory licence to a Japanese pulp company.

Smith: What is the degree of species selection?

Colwell: Some is on density. Major species represent 100 million ft of 50+ lb/cu ft density out of 160 million total.

Jacobs: Pulp chips are the only means of putting our hardwood forests in order. Price varies from $25/unit downwards to as low as $15 for Tasmanian chips, depending on quality. This is serious and an answer must be found to this question of acceptable species.

Smith: In pilot trials we tested several species including two not yet used much for any other purpose. Scribbly gum and Angophora spp. were good and these are regarded as poor saw timbers.

Colwell: We are putting ourselves in the hands of the three biggest Japanese pulp companies and we cannot afford to let the buyer find all the answers as, if they do, they can dictate the price.

Muncey: DFP will find some technical answers but we are not economic experts and must keep out of price discussions.

Item 1(b) Debarking for Pulpwood*

Softwood pulpwood is entirely debarked by machine and this is not regarded as a problem.

Eucalypt pulpwood is a problem because of the type of bark, poor form and range of size of the trees. Eucalypts are barked by machine only in Tasmania, at two pulpmills by hydraulic means.

Reasons for bringing the subject up are to advise the Conference of the activity which has been initiated by the Division and of the progress that has been made.

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* Prepared by W D Woodhead

Background

1. Where manual debarking is carried out, debarking costs are increasing because of increased wages which are not balanced by increased productivity.

2. Current development of wood chip projects depends on machine debarking because of the large quantities involved; availability of labour is an important and sometimes limiting factor.

3. The trend for sawmills to convert offcuts and edgings into chips will continue, so prior bark removal is required.

4. Associated with the problem is the necessity to find uses for the bark or cheap means of disposal.

Present Status

(a) A study to determine debarking costs was conducted in Victoria with the help of APM, the Forestry and Timber Bureau, and the Forestry Department of the ANU. Fortuitously this covered the season of year when some trees were hard to debark and others were easy.

Some extremes of cost were observed and ranged from 10 cents to nearly $2 per ton of wood. Cost increased considerably for logs less than 14 in. diameter.
Details are currently being published by the Australian Timber Journal.

(b) An appraisal of factors affecting bark removal in WA and the Northern Territory has been made and reports issued to the Forest Authorities responsible for these areas. The information has been incorporated into an article and this is in the course of publication.

(c) An appraisal of a wide variety of barking machines operating in Australia has been made. For sawmills a rosserhead machine appears to be the most versatile. Ring barkers are best for pines. We now require a machine for eucalypts up to 30 in. diameter.

(d) Preliminary experiments on the use of steam to reduce bark adhesion have been made. This is effective but is unlikely to be commercially attractive if a machine is developed.

(e) An experiment on debarking pneumatically with air and sawdust was conducted but proved unsuccessful.

(f) Contact has been maintained with consulting engineers involved with the design of the wood chip plants and interested machinery manufacturers. Two prototype machines have been built and are now being developed.

(g) Current interest in the United States revolves around the separation of bark from chips but there has been no interest shown in this aspect by Australian companies. There are disadvantages, for it is difficult to get good chips as the knives are blunted by cutting bark. On the other hand if a successful method were to be developed a lot of forest waste, such as branchwood, would be made available for chipping. A very considerable research program would be required for such a project.

(h) The course of further development has not been decided. We are keen to see how successful are the machines under development, and what further moves in the wood chip field take place.

Discussion

Hanson: APM tried arsenic compounds for chemical debarking but abandoned it because of the hazard. The Forestry and Timber Bureau are getting a Morbark debarker for trials and ACT Forests have a ring type. Two methods are used in USA for bark/chip separation, the Hosma and the Vac-sink. Hosma is not commercially acceptable but the US Forest Service is doing more work on it.

Woodhead: Several methods will give as low as 4-5% bark in chips, but to get down to 1-2% would be too costly to justify. In chemical debarking arsenic may kill other trees via root grafts.

Bryant: Organic arsenicals have lower toxic threshold and are safer.

Vaile: What is bark/wood density difference?

Woodhead: 40 lb/cu ft for bark, 55-70 for chips. Two mechanical debarkers being developed for Eden are promising.

Gardner: Hydraulic debarkers will be used in Tasmania for all types of wood.

Hellawell: A German ultra high-pressure pump might work.

Woodhead: I have seen this used for derusting at Melbourne docks; it will cut Douglas fir; large hydraulic barkers are not so good for small crooked eucalypt logs.

Huddleston: Hand barking is probably still the cheapest for these.

Item 1(c) The need for reassessment of the effect of wood characteristics on wood quality*

It is not intended in this presentation to question the use or omission of any of the structural or physical characteristics employed in wood quality assessment, nor the methods by which they are determined by various workers.

The present purpose is to draw attention to the need to quantify the relative effect of each feature on specific properties of timber, plywood and pulp products.

The validity of using fibre length, diameter and wall thickness, cell wall organisation, spiral grain, percentage latewood, basic density and other characteristics as indicators of strength, stability and other properties has been clearly demonstrated in past studies.

However, many previous workers concentrated their efforts on establishing relationships between only one or two wood characteristics and the property or properties in which they were interested.

Inter-relationships exist between the characteristics used as indicators of wood quality. Also, individual wood or paper properties are relatable to more than one of these independent variables.

More comprehensive studies required to follow up the leads presented by the independent relationships established in earlier work have been fruitfully conducted by researchers in the field of pulp and paper technology, who have determined, for certain species and conditions, the relative influence of a wide range of wood characteristics on paper properties.

However, as far as is known, this has yet to be done for timber and plywood, and the information is urgently needed by wood quality improvement workers for use in the comparative evaluation of species, provenances, seed orchard candidate trees, and particularly the progenies of parental stock to be used in breeding programs. It is essential, if the weighting factors necessary for the framing of selection indices are to be provided, since the characteristics in a selection index should be given emphasis in proportion to their heritability times their importance, rather than in proportion to either of these alone.

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* Prepared by W J Smith

We are not concerned here with a consideration of any deficiencies in heritability information, but with those affecting reasonably reliable assessment of the relative emphasis to be placed on the various anatomical and physical characteristics as indicators of performance in the end use or uses envisaged.

At present, in comparative assessments, individual workers are forced to rely on the results of earlier studies providing incomplete information, and on their own subjective judgement as to how these can be applied to their own species, populations and requirements.

Multivariate analysis of the results of comprehensive studies would allow quantitative estimation of the degree of association between the various wood characteristics and desired wood and/or paper properties, both independently and in combination.

Relative weightings of these variables as determinants of timber strength and distortion rating, paper tear strength, etc. could be expected to vary with each of these properties and with species.

In addition, because of differences between characteristics in within-tree pattern of variation with age, the indicated influence of the independent variables can also be expected to vary with age.

For example, tracheid length, micellar angle, spiral grain, basic density, percent latewood, and cell wall thickness are all relatable to the strength of timber, but the relative importance of basic density might decrease with age while that of micellar angle might increase in hoop pine. Again, percent latewood could be relatively less important and fibre length more important as determinants of strength in Pinus caribaea than in P. elliottii. These are hypothetical illustrations, but feasible ones.

It is evident that the weighting factors to be used in different programmes may require separate determination, depending on species, objectives and rotation age. However, the results of any comprehensive study on any species should be capable of useful general application at the present time.

In an attempt to secure more reliable information here, studies have been initiated on hoop pine (Araucaria cunninghamii), Pinus caribaea and P. taeda. Material from P. patula, P. radiata and P. longifolia has also been stored for study as time permits.

Stress and distortion ratings are being determined for scantlings sawn from diametral flitches. Small clear specimens for standard mechanical tests will be cut from these when testing equipment

being installed is in operation. All anatomical and physical characteristics normally used in wood quality assessment are being determined on samples end-matched with the individual test pieces.

If at all possible, arrangements will be made for the pulping of residual material and the determination of handsheet properties.

It is hoped that multivariate analysis of the resultant data will provide the desired information on the weighted effect of each feature on mechanical properties measured in destructive testing, the distortion rating of the pieces the test specimens represented, and the paper properties. By including knot size as a further independent variable, it is hoped to use the mechanically determined stress ratings to shed some light on the relative influence of branch size and intrinsic wood properties on the strength of sawn timber.

Item 1(c) New Zealand*

(a) Beta-ray densitometer

Over the past two years the beta-ray densitometer has been used increasingly to study all aspects of wood density variation but particularly those related to the pulping characteristics of a wide range of species. The densitometer has also been used to examine localized resin concentrations in wood such as are found in the latewood zones of pine heartwood, and to estimate cell wall thickness from measurements of wood density and tracheid diameter made directly on the strips of wood used with the densitometer. A five part paper describing these developments is in press.

(b) Surveys of wood properties

A country-wide survey of Pinus contorta has been completed. Two "green" strains - probably of the coastal subspecies contorta - have shown up best on sites from central North Island to Southland. These strains are to be used for a program of tree improvement to be carried out against a background of intensified provenance research. Within each strain wood properties vary widely between sites. In general latewood is less strongly developed on colder high altitude sites and average wood density is therefore lower, though the timber would still be classified as a useful general purpose softwood.

(c) Provenance trials

Examination of increment cores from 12 year old provenance trials of Pinus taeda and P. elliottii growing on two sites indicated

* Prepared by J Maddern Harris

only minor differences in average wood density produced by different provenances. The densitometer, on the other hand, revealed distinctly different trends between provenances in the development of latewood with increasing age. As latewood is poorly developed in both species in New Zealand, any improvement would be welcome, but there remains the problem of predicting mature wood properties from the examination of young stands. There is no doubt that densitometric studies afford a better basis for prediction than conventional studies of average wood density, but a great deal of work remains to be done before long range predictions can be made with confidence.

(d) Spiral grain

A paper is in press describing three years' field experiments to examine the physiological basis of spiral grain development in corewood of P. radiata. It develops the hypothesis that spiral grain in this species can be explained in terms of spiral flow of metabolites (of which auxins are believed to be the most active constituents) induced by the phyllotaxy of the vascular supplies to short shoots. Experiments in which trees were disbudded, or from which second and third year needles were removed, with or without addition of synthetic auxins, have been added to the treatments described at the last conference.

Discussion

Hanson: In assessing wood for pulping, some thought should be given to the use of very young timber. In Pinus radiata, thinning at age 8–10 years might be economic if the thinnings could be used for pulp. Have the properties of this young timber been sufficiently studied?

In USA the addition of nitrogen fertilizers increases the rate of volume growth but not the dry weight of the wood produced to the same extent (i.e. fast grown timber has a low density).

Smith: Unless the application of fertilizer is repeated every few years, the effect is not likely to be detrimental to wood density of the crop. Its effect is a short term one. The long term effect of genetically influenced faster growth is more important and even this can be overcome by seed source selection.

Bamber: Experiments in New South Wales indicate that phosphorus and nitrogen have different effects. Nitrogen could affect fibre length.

Hellawell: Effects on wood quality and quantity must be viewed in relation to end use. New Zealand has experiments in progress on the use of fertilizers.

Tamblyn: Permeability is a very important character; treatment of this class of timber is very probable and this property should be examined.

Jacobs: The addition of artificial fertilizers appears to have only a passing effect which does not last long unless repeated. One application merely "tilts" the rate of growth.

Item 1(d) Exotics: Assessment of their wood properties*

Introduction

Exotics are being heavily relied upon in New South Wales for future wood supplies. Species either being planted or else under consideration for planting include: Pinus radiata, P. elliottii, P. taeda, Populus deltoides, Populus spp. and Pseudotsuga menziesii. The selection of species is essentially on forestry grounds.

Because of the large capital outlay involved in plantation establishment, the wood properties of the expected crop must be accurately known for the best utilization with maximum financial returns.

Published data on wood properties is usually inadequate to determine the properties of plantation grown wood as it is usually average values based on the wood from naturally grown forests. Plantation-grown wood, in most cases, is much different to the wood from natural forests.

Wood properties of interest

Fibre or tracheid length:	this has a relationship to paper strength and longitudinal shrinkage.
Density:	influences most of the working properties of wood, particularly strength.
Texture:	species with earlywood and latewood of contrasting hardness such as Psuedotsuga menziesii have uneven texture when the growth rings are wide and such wood is hard to plane and nail.

* Prepared by R K Bamber

Spiral and cross grain: results in seasoning distortion and loss of strength.

Permeability: all of the species listed above are of low durability and preservative treatment must be considered in situations of high decay risk. Permeability is influenced by the presence of sapwood and heartwood, extractives and anatomy.

Reaction wood: this leads to abnormal shrinkage in hardwoods and softwoods, and to "wooliness" in hardwoods.

Factors affecting wood properties

In determining the wood properties, systematic sampling and examination of the tree is necessary because of effects of a number of factors.

Age. - In many species it has been shown that with increasing age, as measured in the number of growth rings from the pith, fibre or tracheid length, basic density and extractive content increase, while the angle of spirality of grain decreases. The magnitude of these changes is related to the species.

Heredity. - The general range of properties between species in cell dimensions, types, arrangements and extractives demonstrates that these properties are under strong genetic control. Within species more subtle relationships are found between parent and progeny and these relationships have been made use of in the establishment of seed orchards. The degree of improvement in wood properties which can be effected by propagation in this way is restricted to the range of values existing within the species. For practical reasons, spiral grain was the only wood property used in selection of elite trees of P. radiata for seed orchards in New South Wales.

Site. - This has been shown to have a significant effect on density in several species. The effects of site have been related to rainfall, temperature, altitude, and day length.

Rate of growth. - No evidence has been seen which proves that rate of growth has any significant effect on wood properties when wood of the same age is compared. While obvious differences exist in plantation grown wood as compared to natural grown wood this is due to the larger proportion of juvenile wood in the plantation material.

Fertilizers. - These have been shown to have some effects on such properties as tracheid length and density. Information is largely fragmentary in respect to the range of fertilizers, quantity and time of application. Due to the economic advantages of fertilization known to be possible in certain sites it is important that its effects are precisely known.

Wood properties of species

Pinus radiata. - A great deal of information has been established about P. radiata. Density, tracheid length and percent latewood increase with age while spiral grain and longitudinal shrinkage become less. The effect of age is sufficiently well documented for the physical properties of the wood on a given site for a known age of forest to be predicted.

Basic density, spiral grain, and tracheid length have been compared in wood from two widely separated sites, northern and southern tablelands of New South Wales. Although basic density was greater and spiral grain and tracheid length less in the northern material, the differences do not appear to be large enough to have any significant effect on wood quality. Strength tests on the wood from the northern tablelands has given similar values to wood from other areas.

The effects of fertilizers have not been extensively examined. On one site treated with phosphatic fertilizers no significant differences were found between fertilized and non-fertilized trees in respect to basic density, percent latewood and fibre length.

Of considerable importance in this non-durable species is permeability. With treatment it is possible to extend considerably the range of utilization. However, while the dry sapwood is permeable the heartwood is less so for unknown reasons. Fortunately both sapwood and heartwood of this species can be made permeable in the green condition by pressure steaming. It has been shown that this treatment causes the ray parenchyma cell walls to collapse so as to form extracellular spaces. The improved permeability has been related to this phenomenon and anatomical investigations suggest that it may be common to most hard pines.

Pinus taeda, P. elliottii. - Little work on the wood properties of New South Wales grown P. taeda and P. elliottii has been done. Studies in other states have shown that tracheid length and basic density increase while longitudinal shrinkage declines with age. Spiral grain does not appear to be the problem with these species as it is with P. radiata. A tendency for corkscrew formation in the tree trunk has been suggested in P. taeda and the presence of compression wood attributed to this

cause. It is thought to be strongly inherited and thus may be controlled by careful collection of seed. Uneven texture in P. taeda from plantations in New South Wales is reported to give trouble in planing and nailing.

The high resin production in P. elliottii may give difficulties in pulping but is not considered to influence unduly the utilization of sawn timber.

Anatomical investigations show similarities to P. radiata in respect to the ray parenchyma cells and these species should be amenable to pressure steaming as an aid to increased permeability.

Populus deltoides and Populus spp. - The effect of age appears to be of importance in respect to fibre length (which follows the normal pattern) and possibly reaction wood and irregular grain. Density seems to vary little with age with no regular pattern. More information seems desirable in regard to the fibre length of juvenile wood, as juvenile wood is likely to be sought for paper production. Seasoning distortion has been found to be fairly abundant in juvenile wood and may be related to both reaction wood and irregular grain.

Eight year old wood grown in New South Wales compares favourably in strength with the exotic conifers in common use in building construction. It has been processed into plywood which appears suitable for furniture and building.

The lack of heartwood and extractives imply high permeability.

Pseudotsuga menziesii. Systematic studies indicating the effects of age on the wood properties have not been seen. However, plantation or second growth wood with wide rings produces wood of uneven texture, difficult to nail and plane.

Considerable variation in density and permeability is known in the natural forests. The density variations have been related to rainfall.

Shortage of rain during the period of latewood formation (late summer) results in low density wood. The differences in permeability occur between sites and have been related to anatomical characteristics. Both of these features should be examined under New South Wales conditions.

Tracheid length, compression wood, resin production and spiral grain should also be examined.

Conclusion

Systematic studies of wood properties are required before assessment of the potential of afforestation species can be made.

The effects on wood properties of age, site, fertilizers, rate of growth and heredity should be known.

In New South Wales only P. radiata has been studied in any detail and further work is still required for this species.

Neither phosphatic fertilizers or extended geographical range of planting have been found to significantly alter some important wood properties of P. radiata.

ITEM 2 TIMBER ENGINEERING

Item 2(a) Research review (a) DFP

We are continuing studies of the performance of commercially manufactured trusses subject to loading over a long period. This includes deflection and joint slip measurements.

We have been making a mathematical study of the practicability of improving the efficiency of design of structural frames. Work is nearing completion on the refining of the computer program, intended to analyse any shape of plane framed structure having rigid, semi-rigid or hinged joints and subjected to any set of loading conditions.

We are giving some attention to necessary or desirable criteria of performance in houses. In this connection two houses, one under construction, were loaded with a field test rig. Measurements were made to determine the shear stiffness of the walls, and the bending stiffnesses of the walls and floors.

Glued laminated construction

We have designed a computer program to calculate loads and deflections for glulam beams having laminations in the core zone of lower stress grade than those in the outer zone. In this way, draft tables have been prepared for radiata pine beams up to 40 ft span. The design provides for butt-jointed laminations in the core, and scarf-jointed laminations elsewhere. The program is being extended so that it will be suitable when using laminations of more than two stress grades. Also, a sub-routine has been prepared to calculate

the cost of the material, and thus to facilitate determining the most economical combination of grades.

Engineers would know that with glued laminated beams, the effect of dispersion of defects in one lamination with respect to those in any adjacent laminations allows the use of relatively higher working stresses than is practicable with solid timber beams. However, the design approach has been on the basis of ad. hoc. experimental studies. Consequently, previously available design techniques for glued laminated beams have not always led to efficient construction. On the basis of data from a number of tests made on individual laminations and various combinations of them on laminated radiata pine beams, a theory for predicting the strength of glulam members with greater precision has been formulated. Additional studies are planned to obtain the parameters necessary for the application of this theory to practical design.

Structural design

A review has been made of the basis of calculation of tables of recommended sizes and spans for all structural members involved in house construction. Correspondingly modified tables (in comparison with those in Pamphlet 112), and also additional ones covering an increased range of structural details, have been prepared for the Code of Light Timber Framing. The revised and new tables have been made available to the Standards Association of Australia. These include designs and computer programs for the calculation of permissible overhangs for rafters, hip rafters, floor joists and bearers, including allowance where appropriate for when these types of members are notched at the support. Again the corresponding tables have been supplied to the Standards Association for inclusion in the Light Timber Framing Code.

Considerable assistance is being given in the drafting of a Timber Engineering Design Code. Associated with this, a study is being made of local and overseas test data, theory and latest recommendations and information relating to working stresses and design procedures. Some quite new engineering design approaches in respect to timber engineering are involved, i.e. the Code will be breaking quite new ground in some areas, particularly in respect to rationalized design procedures for beams and columns. To supplement the recommendations applicable to joint design that are to be incorporated in this Code, a draft has been prepared for a complementary standard which is proposed for the evaluation of various types of mechanical wood fasteners, and for the derivation of working loads and other design data for them.

To study an evident need for guidance on efficient structural design procedures for farm buildings, an investigation is being made of the special conditions associated with rural buildings in general, and the most suitable structural forms for use on farms. It is proposed to recommend appropriate design procedures for such buildings, and to produce a range of type designs that could set a pattern for the reestablishment of timber as a major structural material in the field.

It is very evident from the technical enquiries from engineers particularly that there is a strong and continually increasing interest in information to facilitate the use of timber efficiently in a wide range of structural situations. Reflecting this growth of interest, some 500 requests for assistance with a variety of structural timber design problems have been attended to over the past 12 months. Generally these have been answered from available data and some from prepared "hand-out" material. Of some interest in this area is the fact that we received 48 requests, mainly from overseas, for information on a design which we prepared for a 60 ft span timber footbridge. This design was quite novel in a number of respects and was made particularly for a competitive and attractive means of providing safe overpasses for pedestrians to cross wide and busy highways on expressways.

Scantlings

To meet a need for a simple, low cost device suitable for the commercial machine grading of timber to be employed in critical structural situations, such as scaffold planks, and other specific uses including studs for framing and cross arms, a prototype has been designed, constructed and tested. Its performance has been found satisfactory when checked by tests on scaffold planks, and also hardwood and Douglas fir scantlings. Finger jointed radiata pine scantlings, typical of material proposed for the commercial production of framing studs, have been graded initially by the prototype device and then checked by testing to failure in a laboratory testing machine.

To define the influence of defects on the tensile strength of scantlings, studies are continuing with the testing of further parcels of radiata pine and Douglas fir. Including 170 specimens representative of radiata pine and Douglas fir, some 300 scantlings have been tested in this series to date. Because of the high variability of the tensile strength of these scantlings, it now seems that the sampling may require to be very much larger, so as to yield adequate data for making reliable recommendations on working stresses.

In respect to compression strength parallel to the grain, the influence of knots in pieces of radiata pine and Douglas fir in 4 x $1\frac{1}{2}$ in. and 4 x 2 in. cross sections is being studied. The results

to date indicate a strong correlation between compression strength and modulus of elasticity in radiata pine, and the same regression for the commercial scantling as for the matched clear control specimens.

Structural plywood

Factors affecting the strength and stiffness of plywood in bending and shear have been studied.

A statistical analysis has been completed on the results of an investigation to determine the effect of veneer peeling defects and plywood assembly conditions. It has indicated that veneer quality, i.e. depth of peeler checks and their frequency, is the most important of the variables studied.

Data from this and an earlier study indicate that a reasonably high correlation exists between the bending strength and stiffness of plywood. The correlation appears to be largely independent of species, quality of plywood and veneer moisture content at assembly. The practicability of mechanical stress grading to plywood is being studied in a laboratory prototype. To supplement data previously obtained, which were almost exclusively from the testing of plywood of 5/10 in. thickness, further tests have been conducted using 3/10 in. and 9/10 in. thick plywood. There is strong evidence that a correlation of practical value, between the moduli of rupture and elasticity, exists through the whole range of plywood thickness. At this stage, it seems there may be an exception in the values calculated for three-ply loaded with the grain of the face plies perpendicular to the span. However, it seems likely that a simple empirical adjustment may overcome the apparent anomaly.

An investigation is currently being carried out to determine whether impregnation of radiata pine plywood with a copper-chrome-arsenic preservative has any significant effect on its strength properties.

Permissible sizes of defects, and relevant structural design stresses, are being studied to assist the committee drafting industry standards for structural plywood. Check tests are being conducted on commercially produced plywood containing the maximum size of defects permitted in the draft standard. To further assist the industry, tables have been prepared listing values for stiffness, moment of inertia, area and weight of both sanded and unsanded plywood of a wide variety of thicknesses and construction.

Mechanical properties of timbers

During the last year the testing of all of the seasoned specimens representing the Fijian species being appraised, and all of the green specimens of species so far supplied from the British Solomon Islands has been completed. Tabulated strength data for some of these species as tested in the dry condition have already been forwarded to the Forestry Department, Fiji, and the analysis of the remaining data in hand is proceeding.

To improve the precision of estimates made from somewhat scanty data on the strength properties of brown barrel (Eucalyptus fastigata), a further five trees of this species were sampled from New South Wales, and the specimens have been subjected to standard mechanical tests. The results of the tests on green specimens have been analyzed, and when combined with previously published data they facilitate more satisfactory estimates of the species properties.

As a contribution to international data covering reliable information on the widest range of world timbers we have done considerable work at the request of the Smithsonian Institute, USA. As part of the project, information relating to the mechanical and physical properties, general appearance, and other important characteristics of some 700 African timbers has now been tabulated. These data have been extracted from 114 references, and it involved translations from seven other languages, conversion of units, and adjustment of test values in accordance with standard reference conditions.

Mechanics of wood fracture

As part of a study of the effect of butt joints in laminated timber, a limited number of tension tests have been made on radiata pine specimens made with either three or eight laminations. The loads causing fracture in these tests agreed quite well with those predicted from a theory based on fracture mechanics that was developed for application to the design of this form of laminated assembly.

An extensive experimental program to determine the influence of notches on the strength of timber specimens has been commenced. The program is related to a proposed standard laboratory test to determine notch fracture toughness. A representative range of timbers is being tested to examine the correlation between this property and others normally obtained in the standard mechanical tests on timber.

Additionally, the effects of a wide range of factors on notch fracture strength are being studied; these include grain direction, method of notch fabrication, moisture content and duration of loading.

Item 2(a) Research review (NSW)*

The principal activity of the Section has been in the field of machine grading. This comprised developmental work on the machine graders developed by the Division of Wood Technology and research on the application of machine grading in the Timber Industry. The "Computermatic" machine grader was developed as a fully commercial machine during the period and about 10 of these machines were produced and sold. Interest throughout the world in using this machine remains high and we look forward to its wider use in overseas countries in future.

By invitation, the officer in charge of the Section attended the Anglo Scandinavian Conference on machine stress grading at Princes Risborough in 1968. The Conference adopted the system developed by the Division as suitable for use in Europe in the coming period.

Research on the uses of machine grading has followed 2 general lines: (a) Development of machine graded timber products; (b) The use of machine grading as an investigation tool for silvicultural problems. Work under (a) has established as regular commercial products machine graded ladder stiles, scaffold planks and timber for use in truss making. All these three products are now regularly available on the Australian market from firms equipped with grading machines.

Work under (b) has tackled the problem of deciding the likely structural timber yield from various alternative plantation species of pine and from fast growing hybrid poplar. Our work has shown that for NSW where its growth rate is satisfactory, of all the common exotic pines, radiata is the most satisfactory and gives the best yield of structural material. In humid sub-tropical areas, unsuitable for radiata it seems that elliottii should be preferred to taeda, caribaea or patula. The advantage of the machine grader in these investigations is that it enables large parcels of commercial sized wood to be evaluated rapidly in realistic terms.

Some joint research work on machine stress grading has been organized with the Australian National University on radiata pine and with the Queensland Forest Service and a commercial firm in that state to study slash pine.

Work on the standard testing of timber species has continued, the emphasis being on highland stringybark species which, up to now, have been little known in NSW but are now beginning to be commercially exploited. In addition to this work studies were made on hybrid

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* Prepared by H E Booth

poplar and various exotic pine species under consideration for plantation development.

Some design work has been done on nailed plywood gusset joints for use in trusses mainly to form the basis for the design of trusses made in this way from green NSW hardwoods.

Item 2(a) Research review (Queensland)

Work is proceeding at present with the installation of a 200,000 lb capacity "Amsler" universal strength testing machine. This should be operational within about a month and it is intended to use this machine:-

(a) to obtain values for the strength properties of our plantation grown conifers;

(b) to obtain comparative values for the strength properties of hardwoods with plantation grown conifers, glued laminated plantation conifers and finger jointed plantation conifers;

(c) to obtain data for use in conjunction with machine stress grading.

To date work has been undertaken in cooperation with the University of Queensland on the strength testing finger jointed hoop pine stud material.

Item 2(a) Research review (New Zealand)*

Basic mechanical testing

The results of standard tests of small clears and panel products can now be processed by computer. A summary of species testing, completed or in progress, follows:

(i) Pinus contorta: all major properties, intensive sampling, breast height bolts from all trees felled in connection with the wood quality survey, to date a total of 28 trees aged 31-39 years from four widely separated forests.

* Prepared by C R Hellawell

(ii) Pseudotsuga menziesii: major properties, 11 random samples of sawn timber from Kaingaroa and Golden Downs forests, including 4 from machine grading by Utilization Development Division.

(iii) Cedrela odorata, Swietenia macrophylla: 5-tree samples, grown in Western Samoa. All properties, green and dry, on behalf of the Island Government.

(iv) Pinus patula, (two sites); P. nigra (60 years old); Cryptomeria japonica : limited testing.

Plywood

F R I work is still centred on basic testing related to developing radiata pine structural plywood. The current work plan is confined to nominally clear $\frac{1}{8}$ in. veneer in 3-, 5-, and 7-ply panels. Reports have been written on standard bending, compression, and tension tests, and on panel shear and rolling shear tests of material from the main source, central North Island. Tests on a like consignment - 10 sheets of each construction - representing two major South Island sources are nearing completion.

The New Zealand Standards Association has accepted a draft manufacturing specification from the T D A Industry Structural Plywood Committee for processing as a Standard Recommendation. There is a pressing need to draw up design data to become a part of this Standard Recommendation. While our proposals at this stage would be "interim" in nature, real advantage is seen in being able to make them with knowledge from our basic tests, and from related investigations by collaborators in industry on veneer grading and grade effects in large sizes.

The matter of adjusting design stresses for moisture conditions in service is of particular interest. Evidently the relationships for solid timber are commonly applied, but we submit that while adjustment by the exponential method may well be justified, quantitative differences can be expected. With radiata pine, comparison of "soaked/dry" from our plywood tests with "green/dry" from solid timber for several properties indicated that the plywood was more sensitive to this extreme change. Differences were evidently not entirely explained by differing emc and the use of dry dimensions to compute plywood properties for both wet and dry condition.

Further, it is noted that design calculations are normally based on prescribed geometrical properties for a certain dry state, so it seems unwise to presume the same stress adjustment factors as for

solid or parallel-laminated timber. Internal stressing by swelling and shrinkage across the grain may be a factor with plywood in this connection.

Scaffold planks

From time to time during the past 3–4 years various sets of scaffold planks have been tested to destruction by 3- or 4-point loading after rating them for stiffness either by proof loading, or "Microstress", or by both.

These tests, largely for development purposes, stem from the concept of augmenting supplies by laminating our plantation timbers, Douglas fir, larch (Larix decidua), and possibly radiata pine, primarily for the more exacting Special Class (NZSS 1426:1965). In addition to several laminated types, solid planks of fir and larch, and of some imported Douglas fir have been included.

No part of the work has been written up in detail, but the first series was reported in our 1967 review and our Annual Report for that year, and subsequent series are referred to in the 1968 Annual Report (in press). Draft specifications for the manufacture of laminated planks of fir and pine are available. These were drawn up to provide planks of a definite standard for laboratory and in-service testing, and costing purposes.

Regarding lamination, the immediate practical outcome is that radiata pine does not show up very well, economically and otherwise; but an acceptable product may be achieved with selected 4 x 1 in. Douglas fir, deep cutting after gluing. A considerable volume of data is available to assist any review of the NZSS, and for analyses that may provide some basis for the employment of machine grading.

Laminated beams

Test beams comprising 10 laminae ex 6 x 1 in. Douglas fir of each of the three grades of NZSR 34:1968 were tested in static bending. Taken individually, the design values of fibre stress and modulus of rupture of the 15 beams of each grade exceeded the recommended values.

In a fourth set of 15 beams, arranging the laminae in order of stiffness irrespective of visual grade improved modulus of elasticity but not modulus of rupture.

Prior to his death last year A G Stanger initiated further work on the effect of depth on flexural properties, and was preparing

to study the performance of commercial scarf joints in laminated beams. These projects are postponed indefinitely.

Machine stress grading

Additional data, for Douglas fir and larch (planks), and radiata pine (4 x 2 and 8 x 3 in.) has been obtained in the course of other studies, and awaits detailed analysis in conjunction with that reported to the previous Conference.

Discussion

Huddleston: The Light Timber Framing Code is now in draft form and is being sent to the State Reviewing Committees.

Wickett: Presented a report on the testing of two designs of a composite timber-concrete elevated floor for a new sawmill at Harvey, Western Australia. The designs utilizing jarrah scantlings were intended to make use of local material, semi skilled labour and machinery and tools readily available on the building site. Tests showed a similarity in strength characteristics of the two designs, both proving more than adequate for the load for which they were designed, and both appeared to be substantially cheaper than a conventional concrete suspended floor, on the basis of estimated costs.

Parrott: A similar design has been used for 10 years in New Zealand for logging road bridges.

Smith: The strength tests carried out so far on scaffold planks indicate a maximum value and should be checked by periodic testing to determine the depreciative effect of service conditions. I would also suggest that the correlation between modulus of elasticity and modulus of rupture would be different for glulam and solid timber and require greater care in application.

Item 2(b) Research review (NSW)*

Introduction

In New South Wales many structures have been built in timber and indeed some of them have found their way into text books illustrating examples of its use.

The widespread application of timber for railway construction and public works can be attributed to two main factors. The first

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* Prepared by E B Huddleston

of these is the availability of strong durable timbers in sizes required for engineering construction. The second and equally important reason is a succession of engineers who had a feeling for timber and who were inspired by others such as Professor Warren, Nangle and Baker who carried out research and provided data which could be used by those engineers in the designing of the structures which they wished to build. In fact from my travels in various States in the Commonwealth it is my belief that the use of timber for engineering purposes is more widespread in New South Wales than in any other State. But engineering structures have to a very large extent been based on virtually defect free material. It is also true that to a large extent design stresses and design methods have been determined by empirical rather than scientifically based formulae.

In recent years attempts have been made to rationalize these empirically based practices and substitute for them those based on more precise engineering calculations.

There is considerable doubt as to the validity of the calculations being used, and this has been argued in other places. Whilst this may or may not be true, it is felt that care should be taken when we seek to apply to engineering uses very defective timber. It is only in recent years, one may say very recent years, that the relationship between stiffness and defects have become apparent and have been used. The use of this relationship has shown up practices influencing the design and performance of structures but which are extremely difficult to take account of.

Potential for timber in engineered structures

In spite of the very competitive position which alternative materials have established for themselves, it is believed that the intrinsic advantages of timber for many uses will continue to ensure a place for it in engineering structures. This of course will depend on action taken by the dealers in timber not only to produce the quality, species and items of timber required, but to ensure that deliveries of the required material will be expeditiously made without the bother commonly associated with the supply of such material.

Nevertheless, if the industry and the forester are to get the most profit from the use of timber in this way more must be done. We must all take a lesson from the people who manufacture, market and trade in the alternative building materials. Recently I have had occasion to contact manufacturers of materials other than timber in connection with some of my voluntary activities and I have been most impressed, not only with the willingness with which help was offered, but with the evidence shown to me of the intense interest being demonstrated in any likely market.

Furthermore, the price advantage previously enjoyed by timber has now been whittled away and it is surprising to learn that alternative forms of construction, and forms regarded by some as being superior to timber, can now be used in some cases far below the cost of using timber in the way which we are accustomed to use it.

In spite of all this it is believed that, subject to timber remaining available as and when required, it will continue to be used in engineering structures and if the timber engineering interests take the necessary steps to efficiently and adequately apply the available knowledge there is no reason why timber as an engineering material should not continue to hold its place and even gain in its usage for such purposes.

In introducing a recent series of lectures, Professor Roderick of the School of Civil Engineering at Sydney University pointed to the tremendous task which will confront the world, and Australia, in the next 20 to 30 years and indicated that to achieve the developmental program which will be necessary all structural materials, and in this he included timber, will have to be used to full advantage. If we carefully examine the trend since the conclusion of the 2nd World War we can well realize that this is so, but some of us looking back on that 20 odd years may remember that steel, aluminium, concrete and plastic have all made inroads into the traditional use of timber. I contend that timber has been misplaced from some of its markets through lack of supply of suitable material in suitable condition at the time at which it was required, rather than from any deliberate desire on the part of the user to change to something else.

Requirements

(a) It is essential that steps be taken to provide adequate data for use by engineers. The recent move by the Standards Association of Australia to prepare a Code of Practice for engineering design in timber is a good one, but in addition we need to get out to meetings of the Institution of Engineers, to conferences where engineers gather and to any other place where we may obtain an audience of these people and talk about timber. We need to talk of the unusual jobs which have been done. We need to list the precautions taken to overcome some of the disadvantages associated with timber such as shrinkage and finally, most important of all, we should not continue to follow the practice which has been so common in the past of ignoring difficulties which arise from the inherent properties of the material in the hope that they will go unnoticed by the engineers who have to use it. Engineers may be careless enough not to notice these defects, but if they are, and I don't believe they are, the customer who has to pay the bill in making good the defects arising

from them is very conscious of the fact that the defect causing the expense is due to one of the inherent properties of timber.

(b) Above all it is necessary to avoid the type of suggestions which we have repeatedly had that design in timber is complex and only organizations such as the Division of Forest Products, the Division of Wood Technology and one or two of the universities are capable of handling these problems. I don't believe that such statements are true, but if they are true the outlook for timber engineering is indeed glum.

In fact it is known that a number of engineers are particularly competent in this field and I am sure that many of the others not normally working with timber could do so, and do so satisfactorily, if they were confronted with a job requiring the use of timber.

(c) Most importantly we have to take steps to ensure that the engineer is able to obtain the timber, and the products manufactured from timber, when he requires them. In saying this I don't intend the statement to be in any way restricted. If an engineer wishes to use a beam and he can only obtain that beam by paying an exhorbitant price, to my mind the beam is not available to him. I believe that we as timber research organizations, particularly those concerned with the application of research to industry should be taking all steps possible to encourage industry to meet requirements.

Dangers inherent in uncontrolled glulam and similar manufacture

Although in this State only two manufacturers engage regularly in glulam manufacture, it is known that some timber merchants and some small builders without proper workshop facilities are manufacturing glulam members. Quality control in most of them is unsatisfactory and our laboratory has been called upon to investigate difficulties arising from unsatisfactory manufacture.

Each failure which occurs, even though it may not be disastrous and only require immediate measures to rectify it, comes under notice and is widely discussed. In my activities associated with the Building Science Forum I am privileged to meet many architects, builders and engineers and through such contacts hear of difficulties which are being experienced. In fact I learn through this source of difficulties arising on jobs with the use of material which when it is sought to investigate them are claimed not to exist!

At this stage it is worth drawing attention to a report prepared for the Victorian Sawmillers' Association by consulting engineer, Mr J A Taylor, who was engaged by that association to examine

timber utilization and report to it. The report is worth reading. Mr Taylor points to the lack of control at industry level and the general lack of research development by the industry. He also speaks out against the use of green scantling. Speaking of what is called "your most exclusive use in Victoria of green scantling" he says it has such a poor image, that a significant number of builders are presently questioning whether they can afford to accept a product which is difficult to use well, adds cost to a house, increases construction time and maintenance and interferes with customer relations. To emphasize the point which he makes he quotes the cost of using the unseasoned timber in a building, and the additional costs arising from such use is more than the cost of seasoning the timber before use. He makes a number of recommendations in his summary which are worth noting the which are worth following.

Need for investigation of
construction methods

Our research into the engineering use of timber should not stop with the timber itself. Everyone will be aware of the apprehension felt at the intrusion of steel into the almost exclusive timber domain of house framing. Steel studs are more expensive than the timber studs. The fixing problems associated with steel are greater than those associated with timber. The timber industry is prepared to go along allowing the use of timber in house framing as it has been used for many years. The steel industry, entering the field to compete with timber, has faced up to the necessary alteration in construction by developing the fixing methods needed and are now achieving a position where they will be more than competitive with timber. We must continue to emphasize, that as far as the user is concerned the price of material is not what he pays for the individual pieces delivered on the job, but is what he pays for the finished job ready for his use. Facts such as those mentioned by Mr Taylor in his report and those being followed by the steel industry to make steel competitive with timber are ones which should receive as much if not more attention than the problems related to the material itself.

Finally let us look objectively at the predictions made with regard to the trends in supply and demand in the next decade or so, and avoid becoming embroiled in the sectional battles between rival timber species interests to the detriment of future timber usage.

Discussion

Jones: The recent report of the Austis Research Committee tackles a number of the problems mentioned by Mr Huddleston. This report sees as a first priority the need to develop a properly

engineered house construction system using heavy section stable wood components. Another need expressed by the report is for the development of a system of grading which grades the wood in whole structures rather than in single pieces. Not only the presence but also the position of some limiting imperfections is important when viewed in the light of a piece of wood taking its place in a structure.

Huddleston: This leads to the case of sawmills producing components and not timber.

Jones: The Austis report also mentions the need to improve communication between research bodies and industry.

Smith: Communication might be a matter for the industry and not the research bodies - it is difficult to get information through to all levels of application. In Queensland, the associations digest technical and research information for distribution to their members, and this system seems quite effective.

Boyd: It is not possible for research people to put out material in the several different ways necessary for industry use. It would be better for an industry appointee to rewrite material to satisfy the end user.

Jones: The Austis Committee considers there is a tremendous field of knowledge that has never been published, and this material should be available to industry. It is not so much a change of format of existing reports as making sure that all work is reported.

Item 2(c) Prototype testing*

By prototype testing we mean the proof testing of timber engineering components in order to verify their performance. The usefulness of prototype testing is that it enables the design of a component required in reasonable numbers to be refined by test and the most economic design to be produced for the particular situation.

A feature of overseas timber research laboratories is the generally good facilities they possess both organisationally and in equipment for carrying out this function.

A special mention must be made of the work of the F P R L at Princes Risborough which takes special care to provide a service of this kind. Now under the control of the Ministry of Technology, the F P R L by providing this service alongside that of TRADA, has been able to increase vastly the volume of timber engineered components

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* Prepared by H E Booth

used in building construction in Britain. A further feature of prototype testing is that it increases the confidence in, and knowledge of, designers about timber. It demonstrates that timber products can have a place in engineering and stimulates architects and engineers to use timber products in building with increased confidence.

In Australia up to now we have no code requirements generally applying to proof tests of timber engineered units. Individual authorities have formulated requirements, e.g. the truss testing requirements of the Federal Capital authorities. The provisions on proof testing given in the T E D H, though useful, are not comprehensive and do not lay down a clear guide for prototype testing and acceptance. There is some prototype testing done at present but it has not been developed as a definite method of promoting the use of timber engineered components. Rather it is accepted as a last resort and to be avoided if at all possible. The Timber Advisory Committee in New South Wales, with technical assistance by the DWT, has sponsored at the University of Sydney, Department of Agricultural Science, a program of prototype testing of hardwood roof structures. The aim of this work initially is to establish by testing a basis for design of roofs made from hardwood. In order to obtain predictable structural members, machine graded wood of known stiffness properties has been used in the structures.

Acceptance of the results of this research can at the moment be expected in our State Housing Authorities' building program since they are not bound to closely follow the standard structural provisions of the building ordinances.

We consider that it is a matter of importance to stimulate the use in building practice in Australia of engineered timber components. DFP should submit for incorporation in the SAA draft code considered proposals for prototype testing. These testing provisions could closely follow the provisions of the BS code CP112. Once the prototype test procedure is coded then laboratories such as our own can commence testing work to stimulate interest in, and use of, timber engineered components. The feed back from prototype testing can, in addition, be expected to benefit timber design methods as data accumulates.

Discussion

Smith: For realistic assessment, it is necessary to test a prototype under actual service conditions.

Cokley: This has occurred in respect of a house (in Brisbane) constructed entirely of plywood. In this way, all aspects

of usage are covered, not only the engineering ones.

Boyd: I think the problem has been oversimplified. While it is desirable to have the facility for prototype testing, it is still necessary to assess the properties of individual components, otherwise the process is too chancy, particularly in view of the high cost of prototypes. It is also essential to define performance criteria for structures when subjected to both short and long term testing.

Huddleston: Two prominent structures in Sydney based on prototypes are the Sydney Harbour bridge, which has proved to be a highly satisfactory structure, and the Opera House.

Vaile: How are inherent variations in the strength of timber allowed for in prototypes?

Booth: In this situation, strength variations are included in the design of the prototype which is then tested, redesigned and retested until found satisfactory. It is necessary to know the approximate range of properties of the raw material in the initial stages of design.

ITEM 3 PLYWOOD AND GLUING

Item 3(a) Research review (DFP)*

General

In the last two years the Division has carried out an extensive research program and has also maintained close contact with the plywood industry through plant visits, lectures and demonstrations. Assistance has been given to the Plywood Association in developing quality control in the industry and much time has been devoted to the preparation of standards including specifications for Pinus structural plywood, blockboard, and preservative treatment of timber and plywood.

Veneer logs and cutting. - In peeling research effort has been directed towards understanding the factors involved in veneer peeling and assessing the suitability of different species for plywood manufacture.

The process of veneer formation has been studied microscopically in 5 species. In the latest study a film was made of veneer formation in a Shorea sp. (The film was shown later at the Conference).

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* Prepared by K F Plomley

The peeling characteristics of a wide range of indigenous and exotic timbers have been evaluated, including the following:-

Pinus radiata, P. ponderosa and plantation-grown Araucaria cunninghamii.

Thirty five British Solomon Island spp.

Plantation-grown teak (Tectona grandis) from Papua-New Guinea.

Experiments in peeling thick veneers have been continued. Sloanea woollsii, a species denser than those previously tested, has been peeled satisfactorily to 0.3 in. thickness.

In plywood production studies the effect of accuracy of billet centring on yields of volumetric and narrow veneers is being investigated. Preliminary work has been concerned with the mathematical relationship between centring error and the production of waste and narrows from cylindrical and conical billets. It has been shown that relatively small deviations from correct centring result in very significant increases in waste and narrows.

Gluing. - In addition to tests of available commercial adhesives the properties of adhesives formulated in the laboratory have been investigated. It was shown that for bonding Eucalyptus sieberi, a relatively high density species, paraformaldehyde and shell flour filler had an important influence on bond quality after immersion in boiling water. Adhesive formulations for plywood manufacture based on quebracho tannin were also developed.

With the aim of gaining a better understanding of glue bond formation, wood adhesive interactions and the effect of moisture content and pH changes on PF resin properties were studied. Also, the Physics Section has begun some basic studies of the behaviour of wood surfaces in relation to wetting and absorption.

An investigation of glue line fungicides for control of decay in plywood was begun in collaboration with the Preservation Section. Further work was done on the effect of treatment and gluing variables on the bond quality obtained with PF adhesives and CCA treated veneers.

Service behaviour. - Studies have been made of distortion in plywood assemblies unbalanced by the use of veneers of different species, thickness and moisture content in the outer layers.

The hygroscopic movement, rate of moisture exchange and emc of some thin panel materials e.g. 3/16 in. and 5/16 in. thick coachwood plywood, 3/16 in. and 5/16 in. tempered hardboard and 3/16 in. particleboard, were measured over a range of relative humidities and temperatures. In the plywood most of the total movement in the plane of the panel occurred between 0 and 8-10% mc. The rate of sorption of hardboard was greater than that of both plywood and particleboard. The movement in plywood was less than that of hardboard and particleboard.

Weather exposure tests of plywood were continued and are reported under item 3(b).

Strength properties of plywood. - The effect of peeling and assembly factors on strength properties has been studied in collaboration with the Timber Engineering Section. Panels 0.5 in. thick made from veneers of yellow walnut (Beilschmiedia bancroftii), white cheesewood (Alstonia scholaris) and red tulip oak (Tarrietia peralata) were used to investigate the effect of veneer quality, adhesive, moisture content at assembly, and peeler check direction depth and frequency on mechanical properties.

Exploratory work was also done on the forming of veneers into plywood with compound bends.

Item 3(a) Research review (NSW)*

The main activities carried out have been as follows:

(a) Development of manufacture of commercial glulam from New South Wales hardwood species. This work has achieved the successful setting up of manufacture of commercial glulam from New South Wales hardwood species in our industries. It was necessary to tackle this problem from three aspects:

1. Determination of the most satisfactory, commercially available, adhesives for this purpose.
2. Determination of those species which could be successfully glued under practical conditions to produce durable gluelines.
3. Determination of the correct commercial procedures; for example: moisture contents, machining tolerances, end jointing procedures, clamping pressures and curing conditions.

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* Prepared by H E Booth

An important part of the work has been the establishment of the proper quality control routine to be followed by manufacturers and from this work has come the development of our glueline cleavage test. This test can be carried out with simple equipment in the glue laminating plant. Our work has consisted in developing simple equipment and investigating the cleavage performance of satisfactory hardwood glulam in this test.

(b) Development of tannin based adhesives in the plywood industry. Parallel with the work of the Division of Forest Products we have been developing the tannin based adhesives for plywood industry uses. This work is a continuation of our earlier work on radiata bark tannin and we have extended the work to include production of both plywood and particleboards.

We know that these adhesives can be used successfully in commercial conditions for both these applications.

(c) Minor research topics have included work on the uses of cross-linking PVA's; determination of optimum gluing conditions for certain New South Wales brushwood species which are difficult to glue and evaluation by our standard testing methods of various glued products from wood offered to the building industry. In this respect the DWT 30-cycles test has continued to be a useful means of evaluating the performance of unknown glued timber composite building products.

Item 3(a) Research review (Queensland)

Research in this field has been limited primarily to studies with commercial organizations into laminating of sawn timber; particular reference has been paid to the use of plantation species.

Studies in the plywood field have been limited to assistance to industry in alternative methods of preservative treatments and subsequent application of finishes.

Industry has been encouraged to operate through the Plywood Association particularly in regard to Quality Control. Efforts to encourage major users to require PAA certification are becoming effective.

Item 3(a) Research review (NZ)*

Glue bond strength. - The immediate bond strengths of 18 readily available cold setting adhesives with radiata pine were

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* Prepared by C R Hellawell

compared by means of the glueline cleavage test. They included 8 R F or P R F, 2 M U F, 2 U F, 3 P V A types, 1 epoxy, and 2 caseins, used strictly in accordance with maker's recommendations. The joints were made and tested at 11–12% moisture content and the density of the sapwood timber at test averaged 0.48, ranging from 0.43 to 0.51 over the 15 joints with each glue.

The P V A group gave the highest average failing load, 117.2 kg; the caseins gave the lowest, 77.3 kg, and were the only ones to exhibit cohesive failure. The R F, P R F group averaged 111.7 kg, and except for one M U F that was slightly below, all others lay within the lower end of the range of this group.

Finger joints. - Five lots of commercially jointed 1 or 2 in. radiata pine have been tested in static bending, primarily for "acceptance purposes".

Viewed in conjunction with the published work by A G Stanger, these show the importance to joint efficiency of joint geometry in relation to the finished dimensions. In bending, only the best types of joint would give members at least equivalent to No. 1 Framing.

The implication for structural use in bending is to minimise or eliminate butts intersecting the tension face, and there would seem to be scope for clarifying which orientation of the fingers is the better for this purpose.

Moisture content of plywood. - The study described in the 1967 review related to the moisture content of radiata pine in service, has been neither formally reported nor fully analyzed. The broad practical finding is that all constructions generally came between the extremes of moisture content exhibited by solid timber and hardboard, 3/16 in. 3-ply being much the same as solid. It is clear that, unprotected, the outermost veneers will respond very rapidly, and it may be that some conclusion can be reached about the depth to which changes are significant for various properties.

* Discussion - see page 34(a)

Item 3(b) Plywood exposure tests*

Panels exposed on lecture room at DFP. - After more than 12 years' exposure only the overlayed panels are of interest, the surfaces of the panels without overlay having deteriorated severely. The unpainted "Crezon" still appears to be in good condition, although it is discoloured and the surface is softer than it was initially. The cream pigmented paint over "Crezon" is checked and is peeling. There is also one case of cracking through the "Crezon" though the exact depth cannot be seen.

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* Prepared by K Hirst

* Discussion

Cokley: indicated Queensland's appreciation of the very good work being carried out by B J Sullivan of PAA and of the fact that industry was assuming a larger share of technical service. This was supported by the Chairman (Dr M Jacobs).

Jones: It is apparent in some areas that development gets ahead of technology. For example, in the case of glulam, this product has been manufactured by some small firms without considering the degeneration in glue bond that can occur under exposed conditions and without proper quality control.

Booth: In tests to assess the effects of moisture content cycling, and even storage on bond quality, it was found that gluelines deteriorate fairly rapidly in structural joints using blackbutt, spotted gum and, sometimes, tallowwood. On the other hand, this does not occur in species such as Sydney blue gum, red mahogany and brush box.

The madapollam overlayed panels are still in good condition.

Adhesion of the oil paint to the aluminium foil overlay is poor and the paint is peeling freely from the surface.

Generally, the aluminium filled coatings have stood up much better than the cream pigmented paint, and alkyd based paints better than oil based ones.

Panels exposed at Highett. - The silky oak panels have now been exposed for approximately 5 years and the kauri panels for 2 years.

The plywood appears to have deteriorated by a number of different mechanisms, of which splitting is the most obvious. Following splitting, splinters form at the corners of the splits giving a furry appearance, and finally fall off. Surfaces also show signs of abrasion by wind, sand and/or water. Finally there appears to be removal of non-cellulosic materials, probably by the action of ultraviolet light and/or leaching by water.

Biological attack by brown rot and lichens has also been observed, but at present is of little importance.

The effect of thickness is very noticeable. On unpainted panels of both species length and width of splits increase and frequency decreases with increasing thickness of face veneers.

With silky oak roughness also increases. Painted silky oak panels with the tight side out show less checking, flaking and cracking with increasing face veneer thickness. Panels with the loose side out and with 1/32 in. thick face veneers are in much better condition than those with thicker faces, but there is little difference between 1/16 and 1/8 in. face veneers. There is not sufficient deterioration in the painted kauri panels to show any significant differences.

Panels laid up loose side out generally have thinner and more frequent splits than those assembled tight side out, but the difference in split width appears to decrease with longer exposure. Split length is equal or greater with tight side out. Cracking of the painted specimens is less with the loose side out with 1/32 in. face veneers, but with thicker face veneers is less with the tight side out.

After about the same period of exposure kauri generally has finer, longer and more frequent splits than silky oak. Roughness is approximately the same, but silky oak appears to be much more

furry. Cracking of the painted surfaces is generally more severe on kauri than on silky oak, except in the case of panels with 1/32 in. face veneers loose side out.

Hypalon finishes have chalked more than the other finishes, and also have checked and cracked more severely.

The effects of peeling quality and moisture content at the time of assembly are not very pronounced.

Discussion

Smith: With regard to exposure, I consider it important to investigate thermal effects on moisture distribution in panels.

Cokley: Were variations in performance of thick and thin face veneers related to changes in moisture content? This could be important in Queensland where surfaces exposed to the sun could reach temperatures of 160°F.

Plomley: Performance differences are sometimes attributed to differences in shrinkage stresses.

Item 3(c) Developments in impregnated plywood*

There appears to be in the plywood industry a need to develop an efficient rot-proofing system for veneers. A simple treatment system for both small and large veneer mills would assist in the promotion of plywoods prepared from indigenous brushwoods. The sale of a decay resistant plywood would help the industry to compete with imported plywoods as a decorative cladding for external and internal use.

DFP have, we believe, been working on certain aspects of preservative treatment with copper-chrome-arsenic salts but to date only limited information has been made available. We at DWT would appreciate a knowledge of any profitable experimental line of approach that CSIRO could suggest and also a report on the degree of progress made in this important field of wood preservation.

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* Prepared by R S Johnstone

Item 3(c) Preservation of plywood by glueline additives*

The preservation of plywood by the incorporation of suitable chemicals in the glue has been a subject for research for some time and has come into commercial use to some extent, but has not received the attention warranted by its potentialities. The method has important advantages in ease of control, elimination of extra handling costs and efficient usage of preservative. The major difficulty is that the preservative chemicals must be added to the glue in high concentration, without interfering with gluing processes and effectiveness and without constituting a health hazard.

Considerable success has been achieved in protection of plywood against borers by use of chlorinated hydrocarbons and against termites by use of arsenic trioxide, but what is needed is a general purpose preservative which will protect the plywood against borers, termites, decay and mould fungi, and protection against fungi is much more difficult. Some promising experimental results have been achieved in Europe with pentachlorphenol in the glueline, and at least one commercial preservative for glueline use has been developed.

Preliminary tests of glueline fungicides are now being made at the Division and initial results have been obtained for several preservatives incorporated in the glueline of coachwood plywood (3-ply) of varying veneer thickness. These were tested against several fungi and it was found that sodium pentachlorphenate added to the glue in solid form at the rate of up to 20% by weight gave a fair measure of protection to 1/16" veneer but much less to 1/8" veneer. A commercial solution could not be incorporated at such high retentions, but at 12-15% it gave similar results. A proprietary preservative for glueline use gave much poorer control and a new fungicide thiabendazole, included because it is highly toxic to some fungi and can very easily be added to glues, gave almost no protection. It should be pointed out that the conditions of decay testing were very severe, but CCA impregnated plywood of the same type showed no attack.

The initial results are thus rather unpromising, but the work is being extended using other formulations. More work is also contemplated to test the effectiveness of arsenic in the glueline against borers as well as against termites.

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* Prepared by E W daCosta

Preservation of plywood by glueline additives

Preservative	% in glue	Veneer thickness (in.)	Percentage weight loss caused by:-			
			Lenzites trabea 7520	Coniophora olivacea 1779	Fomes lividus 7904	Trametes versicolor 7521
Control	-	1/8	7	25	32	44
		1/16	17	38	42	40
Sodium pentachlorphenate	5	1/8	5	15	51	34
		1/16	6	17	29	26
	10	1/8	6	13	44	29
		1/16	2	14	19	24
	20	1/8	5	12	39	28
		1/16	2	12	14	12
Pentachlorphenol	12	1/8	9	15	42	24
		1/16	2	11	19	14
Thiabendazole	2	1/8	3	24	49	58
		1/16	17	51	34	53
	5	1/8	7	36	48	55
		1/16	9	42	41	38
Proprietary preservative K	10	1/8	2	22	37	41
		1/16	17	44	28	55
	21	1/8	5	14	18	44
		1/16	18	23	17	53
CCA impregnation (0.6 lb/cu ft)	-	1/8	1	0	0	0
		1/16	1	1	0	1

Item 3(d) The treatment of veneers and plywood by methods and chemicals not currently used*

The plywood industry in Queensland particularly and in Australia generally, faces problems of species variability not found in other countries. Similarly the conditions of end usage are also extremely variable. At present over 100 major species are utilized in Queensland and the Northern Rivers of New South Wales, and with few exceptions, these have low to medium densities, contain economically high percentages of sapwood volume and with few exceptions are of low durability against insect and fungal attack. In production it is impracticable to reject sapwood and final assemblies may contain multiple species.

The industry initially was based on cold peeling, air or low temperature drying and cold pressing. In North Queensland logging conditions were such as to necessitate stockpiling over the wet season with consequent pre-manufacture insect infestation. Uses were primarily as internal sheeting, furniture and decorative panels. Losses from insect damage were high.

In consequence major research into preservatives was aimed at protection of the veneer against insects, particularly Lyctus and this resulted in the hot immersion treatment using boric acid. Costs were high and damage to veneers resulted. Subsequent to 1946-47, the development of the momentary dip process reduced costs, increased production rates and reduced damage. This was followed by mechanisation of the dips and conversion to borax to enable the use of fungicides and ferrous metals. Over the period 1947-1950, manufacturing processes changed from cold press using casein adhesives to synthetic resins and this in turn to the use of high temperature driers and hot presses using synthetic resins. Emphasis by the industry has been on structural and external sheeting with high durability of the adhesive bond. The percentage of thick plywood has increased. These changes in manufacturing processes and usage have changed the emphasis on preservation. Any existing insect attack is normally sterilized by the high temperatures in the driers and hot press.

Studies I have made since 1947 lead to the strong conclusions that:-

(a) particularly using acid catalysed resins and under the hot press conditions, there is an apparent hydrolysis of the starch granules in the veneer which render it less liable to attack;

(b) For other than the face and back veneers, there is an impermeable surface impregnation of resin such that attack can only be initiated from the edge or

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* Prepared by K Cokley

ends of the veneer. Attack is also reduced by the use of surface sealants and overlays and by the use of edge sealing.

(c) There is a measurable residual concentration of formaldehyde which can persist for some months and this also inhibits attack by insects and fungi. Moisture content is low and this also inhibits Lyctus attack.

(d) Post-manufacturing practices in wrapping and early usage followed by surface protectants such as paints and lacquers again reduce the possible hazard of insect attack in service. There are major problems due to non-standardisation of veneer thickness which may range from 1/28"-3/20+", storage of veneer after peeling and drying and the continued usage of air and low temperature drying and cold or low temperature pressing.

The result of these changes in practices may be summed up by the statement that less than 0.01% of reported infestation is found to have occurred in the manufactured sheet but severe loss still occurs in veneers. Loss by decay in uses such as boats is however increasing.

The change in usage has also resulted in a change in emphasis on the end purpose of preservative treatment. At present and for the next few years at least, the order of demand should be placed on:-

(i) Protection against decay

(ii) Protection against fire

(iii) Protection against insects, including termites

(iv) Protection against marine organisms

(v) For specialised application, protection against mechanical and chemical deterioration.

It is implicit that such preservative treatments should be applied if possible during manufacture and should not detrimentally affect adhesion or appearance; where water soluble preservatives are used, treatment should be carried out on veneers prior to drying.

This is also the implication that when general purpose treatment is given, then treatment must be considered in terms of the bulk of production and not only for susceptible veneers as for treatment against Lyctus.

Alternative method of application

Vacuum pressure systems. - These have been used but the results are extremely variable with species. Material must be pre-stripped for certain rain forest species to avoid "sticking", it must be block stacked and on present evidence production rates are less than for the momentary dip. Capital costs are high.

When multi salts are used poor penetration occurs, adhesion difficulties are present and species characteristics are masked e.g. colour.

Similar comments apply for finished plywood where, for synthetic resin bonded sheets, penetration is limited to edge and end grain and severe problems occur in drying after treatment. Discoloration occurs.

Treatment by vapour process. - The "Cellon" process offers promise in treatment of finished plywood but although overseas tests show promise, evidence to date indicates problems due to species. There would also be difficulties in sitting such units in a plymill due to risk of fire and explosion.

Spray systems. - For several years tests have proceeded in Queensland mills with the use of spray systems. These have followed four lines, viz:-

(a) Spray or drip feeds at the lathe
Trials of these have proceeded at two mills, using dieldrin emulsions. There are a number of practical difficulties in use of a spray at this point and present results are not promising; however, results using a drip feed have given promise.

(b) Sprays after clipping
These have given promise. Currently four mills are experimenting. Mechanical problems exist with regard to location of jet systems to give a uniform spread without excessive wastage. It appears on present evidence that a slight increase in concentration and block stack time may be necessary to compensate for the mechanical effect of the rollers in the momentary dip.

A major study is proposed with North Queensland mills to determine treatment conditions. For a number of reasons, including ready detectability of distribution, boron salts are proposed as the test preservative.

(c) Spray before reeling
In terms of efficiency of treatment, this offers promise. Limited trials have shown that problems exist in storage systems of reeled veneer, however, industry is being encouraged to examine this further.

(d) Sprays after hot pressing
This was tested where emphasis was placed on the face and back veneers of plywood. Excellent results were obtained and production rates were not significantly affected. It was combined with water sprays used to "recondition" the plywood after hot pressing. Complete penetration of face and back edges was obtained and approval had been given to one mill to operate on this basis as a commercial treatment using non-susceptible inner plies.

I consider this type of application to be particularly suitable for "high skin treatments" such as fire retardent application or for suitable solvent type preservatives.

Pretreatment before peeling. - This was originally studied by Wilson during 1936-1939, but was not applied commercially; a similar related practice treated commercially has been the inclusion of chemicals in boiling pits to prevent "tannin stains" in slicing.

Currently an experiment is planned to determine whether treatment by vacuum pressure treatment of peeler blocks using CCA will enable veneers to be subsequently glued more effectively than can be now done. This is of particular interest for wide sap species and plantation pines. Problems of heartwood treatment are still present.

Alternative preservatives

Currently the principal preservatives used in Queensland are:-

(a) Dieldrin which has been approved under the T U P A for:-

(i) at a concentration of 0.005% w/w for protection against Lyctus;

(ii) at a concentration of 0.1% w/w (subject to review) for protection against termites. Restrictions are stated in that no protection against decay is given.

(b) General purpose treatment is by CCA salts applied in practice to the finished plywood. Problems in this regard have been stated and at present it cannot be considered as being the most suitable treatment for plywood using mixed species. Other preservatives which have been tested at a commercial pilot level are:-

(i) Chlordane/PCP emulsions. - The chlordane has a lower L D than dieldrin and offers certain advantages. PCP is incorporated as a fungicide. No adhesion problems exist at the levels tested; however, present advice is that application of this type may be limited.

I am inclined to give serious thought to alternatives to chlorinated hydrocarbons. There are severe restrictions in many countries and for uses such as containers their acceptance may be doubtful.

(ii) Calcium/boron mixtures. - Boron is a good fungicide, effective against Lyctus, Anobium and Hylotrupes. At higher concentrations it is of reasonable efficacy as a fire-retardent salt. Problems of fixation are present.

Plant trials have been carried out using a double momentary dip at a Brisbane mill using calcium salts and boron. In addition to chemical reaction during block stacking, precipitation was accentuated by mechanical drying.

No problems in gluing with phenolic resins were found and Type A bond tests were satisfactory.

Currently chemical analyses to determine the degree of fixation and fire resistance tests are in progress. Present results indicate 80% fixation of the boron.

No problem with respect to discoloration or chemical blooming were encountered.

The principal aims in the use of this formulation are to provide insect protection, some fungal protection but primarily to give resistance to fire.

(iii) Copper pentachlorphenate. - Studies have been made using double-dip to produce copper PCP and interest has been shown by one major plymill in Queensland. Results are not conclusive and when examination is made of plywood so produced, there is some doubt as to whether adequate retentions are obtainable in all species.

(iv) Oil soluble preservatives. - For special applications such as ammunition and storage crates, PCP/oil treatments have been found reasonably applicable. Approaches by the Plywood Association to service authorities have been favourable.

For marine purposes, the use of copper naphthenate applied by either cold soak for small quantities or by hot and cold process is being considered. Subsequent gluing problems may be encountered; this aspect is still awaiting investigation.

(v) Preservatives to be developed by DFP. - The Division has also agreed that CCA's were not optimum preservatives for plywood and has undertaken to study suitable alternatives. Progress was reported at several Conferences e.g. the interaction of arsenicals and adhesives. I would strongly recommend that this work should proceed.

General discussion only

Plomley: As far as Lyctus attack on plywood is concerned, it is possible to obtain a satisfactory control by additions of toxic substances to the glueline as well as by veneer treatment. At present our main interest is on gluing veneers treated against decay. The problem of gluing veneers treated with CCA at relatively high loadings has not yet been solved satisfactorily. In laboratory tests the substitution of nickel or zinc for copper in CCA did not make much difference to the gluability of veneers. Tanalith U was the best of a number of preservatives as far as gluability was concerned, but is not an adequate preservation treatment due to its leachability. We are also interested in the possibility of controlling decay by adding toxic materials to the glueline primarily to avoid gluing problems.

Tamblyn: Since the last conference there has been no apparent interest in treating waterproof plywood. Most veneers can be treated by dipping but the problem is to glue these dip treated veneers. For thicker veneers a preservative treatment is necessary, as glueline treatment would not be adequate in this case.

Bryant: Does the loss of pentachlorphenol or phenate during hot pressing constitute a health hazard?

Foxton: Yes.

Cokley: Penta added as a water emulsion to veneers has been tried in Queensland but loss of penta during hot pressing becomes a health hazard and we were verbally advised by the Queensland Health Authority to discontinue this practice.

Foxton: This hazard was created by adding penta to the glueline as an emulsion rather than as a solid.

ITEM 4 WOOD PRESERVATION

Item 4(a) Research review (DFP)*

Important aspects of our work in wood preservation since the last conference are summarized in this review. Items listed in the Agenda for later discussion are mentioned only sufficiently to preserve continuity and perspective.

Field and marine tests

Field testing of preservative is an important part of our work and our main source of practical information on the comparative merits of different treatment under actual service conditions. Our tests of rail sleepers, poles, posts, cooling tower timbers, building timbers and small specimens comprise some 20,000 pieces of timber installed in about 50 selected field and marine sites throughout Australia and Papua-New Guinea. We also have a number of field tests to determine the natural durability of untreated timbers. Some current results from these tests are as follows:

(a) Tests of small treated specimens. - Tests of boron preservatives in pine sapwood stakes have shown that a straight boron compound such as "Timbor" gives little protection in ground contact at loadings of almost 1 lb/cu ft. Addition of 30% arsenic has approximately doubled the life but even so there have been many failures within 5 years. Painting has produced only a small benefit.

Tests of commercial CCA preservatives in pine stakes are showing complete termite resistance after 6½ years in the ground at Narrandera at loadings as low as ¼ lb/cu ft. This indicates that a fixed arsenic content as low as 1/20 lb/cu ft is adequate to prevent termite attack.

Some new commercial CCA formulations are under test in 3 States at a range of loadings in pine and eucalypt stakes. Although it is too early to assess relative performance, all preservatives are proving less effective in eucalypt than in pine stakes. This is one of the most important conclusions reached in recent years - that most preservatives and particularly CCA salts perform better in pine than in eucalypt. We are worried at this result which is discussed further in another agenda item.

We have two tests of preservatives against marine borers - one installed 10 years ago and the other 18 months ago. The first test in 4 ports has shown that CCA is very good in pine but much less satisfactory in eucalypt and that creosote is fairly good in both timbers and generally a little better in eucalypt than in pine. These tests are further discussed in another agenda item.

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* Prepared by N Tamblyn

(b) Rail sleepers. - Over the years we have treated about 12,000 sleepers for service tests in 6 Australian States.

Recent inspection of tests in Tasmania installed about 14 years ago show that untreated timbers (messmate, silvertop and alpine ash) have a life of less than 11 years compared to an estimated life of over 20 years for these timbers treated at 1000 psi with preservative oils. We are sure that treatment is practicable and economically desirable in Tasmania and are hopeful that some positive action will be taken soon.

Our extensive tests in the mainland States are indicating quite clearly that high pressure treatment of less durable hardwoods with creosote or pentachlorphenol in heavy oil can provide a technically satisfactory answer to diminishing supplies of naturally durable timbers. At the last inspection of the Victorian tests only 2% of the less durable treated eucalypts had failed after 12 years service indicating an average life in excess of 20 years under moderate to heavy traffic conditions.

Tests of pine sleepers in South Australia, some installed as far back as 1936, show that creosoted sleepers fitted with plates have a life of about 30 years. In more recent tests the effect of varying the cross section is being examined but as no failures of these treated pine sleepers have occurred in the first 10 years, conclusions are not yet available. However, when the best cross section is determined and the best rail fastenings used lives in excess of 30 years are likely.

The need for better rail fastenings has been demonstrated in a recent survey of causes of failure of durable eucalypt sleepers in the mainline between Murray Bridge and the Victorian border. Results have confirmed an earlier survey in Victoria which showed that over 90% of durable sleepers fail mechanically because of loss of spike-holding capacity at the rail seat. If wood is to hold its place as a rail sleeper much more attention must be paid to rail fastenings and devices to reduce end splitting.

(c) Poles. - Our eucalypt pole tests in two Mastotermes areas in North Queensland were inspected recently. After 10 years' service there is no indication that creosote or CCA salts are less effective against Mastotermes than other termite species. However, addition of ½% dieldrin to creosote and pentachlorphenol has enhanced their resistance to termite penetration into the untreated heartwood. There is no arsenical creosote in this test, but service tests in Victoria and New South Wales have now been installed by the PMG and SEC to determine the effect of adding about 0.4% As_2O_3 to standard K.55 creosote. There should be results within the next few years.

(d) Cooling towers. - We have 3 tests of treated and untreated slats in cooling towers. The first test has shown that untreated hardwoods, almost irrespective of their natural durability, are more susceptible to soft rot in cooling towers than coniferous timbers and should not be used as thin slats unless the hazard is known to be low. The second test of many different preservative treatments is already showing that CCA salts at about 1½ lb/cu ft are more effective than creosote, pentachlorphenol, copper naphthenate, tributyltin oxide etc. at high loadings. In the third test, only recently installed, the effect of timber species on preservative performance is being examined.

(e) Natural durability. - A ground contact test is now being installed in 5 localities from North Queensland to Victoria to determine the natural durability of the heartwood of about 80 Australian timbers. There are about 4000 specimens and most species are represented by 5 trees so that variation between trees can be assessed.

(f) Joinery. - A test has been planned in cooperation with the Radiata Pine Association to determine whether untreated heartwood in CCA treated pine is likely to decay in external joinery, weatherboards, veranda floors etc. This is a difficult test involving much work in selection of material and preparation of joints and test panels but it should yield much valuable information.

Fire resistant preservative

The burning of CCA treated fence posts in grass fires is now recognized as an economic and psychological problem urgently needing solution. We have worked on this for the last 2 years and now believe we have found a satisfactory answer by modifying existing CCA formulations to permit addition of phosphoric acid and a zinc compound at a chemical cost of probably less than 2 cents per post. Leaching tests indicate high fixation and burning tests have been very satisfactory with no posts damaged in our best formulation compared to 100% destroyed in the unmodified CCA. However, all our tests are not yet completed and we have still to prove that the toxicity of the CCA components is unimpaired. It will be several months before we can be sure of the result. We have applied for a patent so that if successful the new formulation will be available to everyone in Australia.

Arsenical creosote

We have continued our studies on arsenical creosotes and are convinced that incorporation of 0.3-0.4% As_2O_3 in creosote will help to protect the heartwood of poles against termite entrance where there is only a narrow band of creosoted sapwood. The chemical cost of this arsenic additive is only about ½ cent/gallon.

Although it is easier to incorporate arsenic in vertical retort creosote we can add more than 0.3% to coke oven creosote if it is heated sufficiently. We have isolated some of the creosote compounds which react with arsenic trioxide and determined the molecular structure of their arsenic complexes. We have found a cheap method of synthesizing these complexes so that they can be added in much higher concentration if required. We are hopeful that this may improve creosote performance against marine borers.

Coke oven creosotes

A detailed study has been made of the coke oven creosote now being produced at Newcastle and we have no doubt that it is at least as good as our standard K.55 creosote. Its penetrative properties and cleanness are satisfactory, its toxicity to fungi and termites is excellent and its permanence is probably a little better than that of vertical creosote. Gas chromatograms show it to be chemically very similar to standard creosote specified in America today.

Penetration of preservatives

Work has continued on the preservative treatment of radiata pine heartwood and we have been aided in this by supply of suitable material through the Radiata Pine Association. In our latest study we have compared diffusion treatments of green heartwood with various pressure treatments of dry and green material preconditioned by steam and vacuum treatment and by immersion in bacterial cultures. Results are discussed in another agenda item and it is sufficient here to say that creosote oil penetrates pine heartwood much better than waterbornes but that preconditioning by steam and vacuum treatment does considerably improve penetration of aqueous solutions. The long high vacuum process developed by the Queensland Forestry Department did not produce satisfactory results. It should be recorded that this beneficial effect of steaming was reported at the last Conference by the Division of Wood Technology and that we have now confirmed it for much less protracted steaming periods. We have not yet determined optimum schedules but intend to continue the work. We have made a further study of the effect of incising on the penetration and retention of creosote in eucalypt poles of 3 species - mountain grey gum, spotted gum and messmate stringybark. Results have confirmed our work reported at the last Conference and again shown that the increase in retention is of the order of 10-20% for those species where an improvement would be desirable. In our opinion this is not sufficient to warrant use of parallel incising as a standard technique in pole treatments.

We have also examined the effect of Boultonising (drying timber under vacuum in hot creosote) on the treatability of hardwood rail sleepers and obtained very promising results. These will be discussed later.

Centre rot in poles

Some cases of premature failure of creosoted poles have occurred in the Melbourne area because of rot in the untreated heartwood. We have examined about 30 of these and our interim conclusion is that the centre rot is mainly caused by entrance of fungi through barrel checks after treatment. This trouble may be developing earlier in Victoria than in other States because of the lower heartwood durability of our pole timbers and we call attention to the need to watch the position in other States particularly in Queensland where poles are treated in greener condition and are presumably liable to some splitting after treatment.

Timber microbiology

In the microbiological field much work has been done of immediate practical significance and there has also been a large amount of valuable fundamental work which is extending our knowledge in new areas.

Applied work has included laboratory studies on the decay resistance of rainforest timbers including species from the Solomon Islands and the setting up of durability field tests as already mentioned. It has also included the bioassay of wood preservatives such as the new Australian coke oven creosote and a range of new organo-tin and organo-lead compounds. Work is also in progress on the development of a plywood preservative by adding fungicides to the glue.

Fundamental work has included further studies on the effect of timber species on the toxicity and permanence of preservatives, on the effect of fungal and bacterial successions on preservative performance in ground contact and in cooling towers and on the role of bacteria in decay of treated wood. Work is also proceeding on the microbial detoxification of creosote and copper preservatives, and on the genetics and physiology of wood destroying fungi.

In this review it is difficult to do justice to all this work and a few only of the results or the ways in which we are thinking will be mentioned here. These are:-

(a) The new Australian coke oven creosote has higher toxicity than the standard K.55 vertical creosote and is slightly better than a typical American creosote.

(b) Some organo-tin and lead compounds perform well in laboratory decay tests but we do not know enough of their permanence, their long term resistance

to chemical or biological detoxification, or their insecticidal properties to recommend their use in ground contact.

(c) There is need for a new laboratory test method to determine the relative durability of different timbers used above ground in external joinery, weatherboards etc. We are attempting to develop a suitable rapid evaluation technique.

(d) Study of the wide range of fungi and bacteria which can colonize preservative treated wood, without themselves causing gross decay, is a new field of research. We believe that study of this microbial activity in treated wood and its effect on the substrate and on the toxicity and permanence of preservatives will help in the development of better preservatives in the future.

(e) We have established that under some conditions, particularly in cooling towers, bacteria can produce decay in treated wood, especially that treated with CCA preservatives. The practical importance of this is being examined and we are also looking at the possibility of using some motile forms of these bacteria to increase the permeability of wood before treatment.

Timber entomology

With the return of Mr Howick from a 9 month entomological study tour abroad under a Churchill Fellowship we are now intensifying our work in timber entomology and have just built a new laboratory and insectary to cope with the extra work planned.

While abroad Mr Howick visited most of the recognized authorities on Hylotrupes (European house borer) in England, Europe and South Africa and we are now well informed on the biology and habits of this dangerous insect and ready to assist where possible in preventing its establishment in Australia or in planning its eradication if it penetrates the quarantine barrier. Mr Howick also visited many laboratories to look at the broad spectrum of research in timber entomology including techniques for breeding of test insects, methods of testing preservatives and modern methods of control and eradication.

Since the last Conference our research in timber entomology has been concerned mainly with the establishment of Lyctus toxicity thresholds for arsenic and fluorine compounds. This has been a detailed and thorough investigation and as it is the subject of a paper later in the Agenda I will not enlarge here except to remark that we

are seriously perturbed at the sodium fluoride results and the accumulating evidence that it volatilizes from the wood.

Work has also continued on the Lyctus susceptibility of hardwoods from Fiji and the Solomon Islands. We have made susceptibility gradings for 61 species and tentative gradings for another 23 species. Other work has included the continuation of covered field tests to determine termite thresholds for boron compounds and also preparation and weathering of material for laboratory termite tests by the Division of Entomology to determine toxicity of coke oven creosotes.

On the entomological side we have also been cooperating closely with quarantine authorities, particularly on the treatment requirements for wood in shipping containers. To save time I will not enlarge on this but will try to answer any questions you may have.

Item 4(a) Research review (NSW)

Preservation Chemistry

The search for improved techniques for the preservation of Pinus timbers was continued. Presteaming green Pinus radiata had beneficial effects on conventional vacuum pressure impregnation with copper-chrome-arsenic salts. In addition Pinus lambertiana, Pinus elliottii, Pinus muricata, Pinus ponderosa and Pinus taeda were all subjected to this treatment. The increased permeability has been related to changes in wood anatomy (see report of Wood Structure and Identification Section).

Low pressure (50 psi) soaking of 8" x 2" green P. radiata gave satisfactory core loadings of boron salts.

The comparative permeability of 23 common rainforest timbers to pressure treatment with copper-chrome-arsenic salts was assessed. Preservative penetration was most satisfactory in the following nine species; yellow carabeen, white birch, brown alder, coachwood, sassafras, bollywood, silver sycamore, camphorwood and grey persimmon.

The pressure treatment of green tulip oak scantling with boron compounds was examined in detail. Predrying or presteaming was necessary to obtain sufficient uptake of boron in the core of the timber. The addition of strong boron solutions to an alginate-wood flour mixture, used as a coating on green timber, did not produce satisfactory immunization of tulip oak since the core loadings after diffusion were often below the requirements of the Timber Marketing Act.

Development work on the use of a pressure Boucherie method for treating green eucalypt poles (the method involves the use of pole caps to force the preservative through the end grain) was carried out, in association with commercial interests.

Satisfactory penetration and retention were obtained in eucalypt poles to 45' in length, but the method has some problems e.g. possible excessive checking after treatment, snigging damage, effluent disposal.

Studies are continuing into the effect of varying moisture content on the treatment of timber of pines and eucalypts with waterborne salts.

Plywoods treated with copper pentachlorphenate have been exposed in durability trials.

Timber mycology

Following the completion in May 1967 of field studies on sapstain and decay fungi in logs and sawn timber of radiata pine, about 2,500 fungal isolates have been investigated in detail. A number of papers on this work will be published in 1969.

A study was made for the Standards Association of Australia of the draft method for testing mould attack on wood products.

Particleboard treated with various concentrations of aldrin and boric acid was tested for its resistance to decay. Aldrin treatment gave no protection, and boric acid would have had to be used at uneconomic concentrations. Momentary dip treatments with copper 8-hydroxyquinolinolate are still under test. This preservative is very useful because of its low toxicity to man.

The decay and stains found in highland eucalypts were examined and a report on these aspects is in preparation. Studies of decay and staining due to logging damage of hoop and radiata pines have not yet been completed.

All treated timber submitted as a result of failure in field tests or service is being carefully examined, and a number of isolates have been obtained. It is hoped through this to obtain a better appreciation of the fungi that tolerate current preservatives.

Cultures of wood decays are being supplied to the University of New South Wales, where a systematic study of the capacity to effect biochemical transformation is in progress. Fungi are known to be

effective in producing many novel chemical changes, but comprehensive study of such behaviour is just beginning.

Timber entomology

(a) Anobium. - A survey of the distribution of Anobium punctatum in New South Wales has been completed, and reprints describing this work are available from the Division. Investigation of its bionomics continues, and cultures are being maintained on artificial media.

Wood treated with low concentrations of tributyl-tin oxide was very toxic to Anobium. Thresholds for aldrin and boric acid in particleboard were determined.

Tests are under way of the effectiveness of water emulsions of chlorinated hydrocarbons for treatments (in situ) on wood surfaces against both Anobium and also Tribolium confusum (used in bio-assay techniques).

(b) Lyctus. - A survey of Lyctus populations is under way at 80 locations in New South Wales, and 3 in Queensland. So far Lyctus brunneus has been collected from 30 of these, while there have been three other species of Lyctus and one unidentified Lyctid.

Lyctus brunneus, L. parallelocollis, L. discendens and Tristaria grouvellei are being reared for toxicity threshold testing testing of insecticides and of wood preservatives.

The use of dieldrin impregnated membranes, for example bitumen-asbestos sheeting, was considered in the low profile flooring study. Work was carried out to test the stability of dieldrin at the temperature (300°F) at which the product is manufactured. The effectiveness of the dieldrin against Tribolium confusum was unaffected if exposed to this temperature for no more than 10 minutes.

(c) Bostrychids. - The degrade of hardwoods by bostrychids is being studied. In pole seasoning yards (Armidale, Warnervale and Yarras) light traps are being used to determine the presence of these insect pests and to predict infestations and the timing of insecticidal applications. A field spray test at Armidale is under way. In the laboratory, bostrychids are being reared on artificial media, in order to obtain large numbers of beetles at predetermined times for behavioural and insecticidal studies.

(d) Other. - The biology of a species of Pyemotes, a mite predacious on wood boring insects; is being studied.

As part of a cooperative effort with the Organization of Economic Cooperation and Development (O C E D) and Maritime Service Board, samples of Scots pine (Pinus sylvestris) have been installed in Sydney Harbour to determine the full range of wood borers and marine fungi that attack submerged wood, and their geographical distribution. This is the first such test site in the Southern Hemisphere. Complete data on water temperature, oxygen content, etc. are being compiled.

General

A field test of poles pressure treated with copper-chrome-arsenic salts plus a water repellent has been installed at Moss Vale (Belanglo S F). In cooperation with a timber preservation company, creosote, CCA salts and CCA salts plus water repellent are being compared in their effectiveness in reducing the splitting of poles.

A further test to determine durability against decay and termites has been installed at Pennant Hills as part of an Australia-wide survey by Division of Forest Products, CSIRO. Cooperative testing has been in progress for many years with this organization at sites in Sydney, Taree, Narrandera, Wallerawang, Wyong and Wauchope, and has provided valuable information on the performance of wood preservatives.

Item 4(a) Research review (Queensland)

Research in the preservation field has been principally of an applied nature. Specific items of interest are:-

(i) Studies on modified "empty cell" treatments for readily treated timbers.

(ii) Studies on the distribution of preservatives in hardwood species and the resistance of salts deposited in vessel cavities to leaching.

(iii) Major studies on a commercial basis have been commenced into the application of oil-borne preservatives to local species. Currently these studies are in association with the Queensland Railway Department. Present emphasis is placed on PCP/oil solutions.

(iv) Service tests of stakes installed in 1954 have continued.

(v) Preliminary experimental arrangements have been made into leaching of large size sections treated with CCA. It is intended to use radio tracer techniques in these studies.

Item 4(a) Research review (New Zealand)*

Non-pressure processes

Boron treatment trials using a hot and cold bath system followed by diffusion at 120°F were completed. Core loadings of 0.2% BAE can be obtained in 2" thick Pinus radiata.

The method may have some use for producers wishing to gauge green pine and treat to eliminate boron compounds from planer shavings in boiler grates.

Studies on the possible redistribution of boron compounds in timber in service for 5-10 years indicate that there is no redistribution.

Experiments have been carried out on the dipping of green $\frac{1}{8}$" P. radiata veneers in 10%, 15% and 20% solutions of K33. Tanalith NCA and Celcure AN. Veneers will be glued with a hot press phenol formaldehyde resin and shear tests carried out.

Pressure processes

As outlined at the 13th Forest Products Research Conference, the following standards for retention zones have been accepted by the New Zealand Wood Preservers' Association for commodities treated with CCA salts.

Marine timbers	- $\frac{1}{2}$" - $1\frac{1}{2}$"	from	the	surface	0.5% CuO
Poles	- $\frac{1}{4}$" - $1\frac{1}{4}$"	"	"	"	0.24% CuO
Posts	- $\frac{1}{8}$" - 1"	"	"	"	0.22% CuO

Treatments of round produce of minor species have continued. Red alder and Lawson's cypress did not treat satisfactorily whereas rewarewa and Populus eugenii and P. regenerata treated well.

Japanese cedar posts treated by the Rueping process with 5% PCP in oil had poor sapwood penetration. Although nett absorptions

* Prepared by C I Hutchinson

of 5-6 lbs/cu ft were achieved the penetration was mainly through checks to the intermediate heartwood.

Service tests

Monthly observations were made on P. radiata window sashes which have been constructed with both through and stub tenons. Sashes have been treated with boron and CCA preservatives with and without water repellents.

Soft rot was found in P. radiata treated with creosote and in service 19 years as a box culvert. Soft rot fungi have been isolated from P. radiata treated to marine retention and from kauri, rimu and tanekaha all treated with CCA preservatives.

A new instrument for non-destructive testing of poles has been evaluated and is satisfactory. The instrument is a sonic decay detector and in tests on standing, treated softwood poles and poles removed from service, decay was detected wherever it occurred. The instrument will be used for all service test pole inspections in future.

Gravevards

At Whakarewarewa graveyard, the oldest posts remaining are 28 year old Corsican pine and European larch treated with creosote by the hot and cold bath process. 83% of the Corsican pine posts remain although moderate to severe decay is present in all posts at the groundline. 90% of the larch posts remain and decay is moderate in all posts.

Laboratory toxicity tests

A test of 6 CCA preservatives at 6 loadings of oxide (0.05-1.00 lbs/cu ft) with three fungi on P. radiata has been completed. The results have not yet been evaluated but it appears that for Lenzites trabea and Poria monticola the threshold value is around 0.2% copper oxide. Poria vaillantii, the third fungus which is very copper tolerant, did not reach a threshold value.

When tested against Chaetomium globosum there was a high weight loss in the treated blocks up to 0.5 lbs/cu ft. A marked reduction in weight loss occurred at this point but the weight loss continued at 5-10% to the highest treatment level (1.0 lbs/cu ft.).

An evaluation of New Zealand produced non-standard creosote is under way.

Four blocks of 2" x 2" P. radiata treated with Tanalith CA have been examined after three years' exposure in the sea at

Mt Naunganui. The copper sulphate loss was 19%, arsenic 9% and sodium dichromate 8%.

Similar test blocks treated with K33, Celcure A and Tanalith CA indicate that after one year's exposure in the sea there is no overall loss of chemical compounds. However, there is a marked movement of the copper compounds to the outer layers of the blocks with a corresponding reduction in the inner layers. Loadings of the copper components in the outer 1/16" have increased 100–200% when compared with laboratory controls.

Mycology

Studies on the ecology of fungi infecting untreated and preservative treated P. radiata sapwood have continued. The succession of fungi in ground-line zones may be summarized as proceeding from primary moulds to soft rot fungi to secondary moulds and primary basidiomycetes (white rots) to secondary basidiomycetes (brown rots).

Antagonisms between primary basidiomycete colonisers and other members of the wood flora were studied in agar plate culture.

The primary basidiomycete (Polyporus semipileatus?) isolated from test stakes suppressed the growth of most members of the Moniliaceae, Dematiaceae and Epicoccum nigrum of the Tuberculoriaceae. Trichoderma viride, Gliocladium catenalatum, Aspergillus fumigatus, Fusarium sp. and three basidiomycetes inhibited the growth of Polyporus semipileatus. With Chaetomium globosum and Polyporus semipileatus there was mutual inhibition of growth. These studies of fungus interaction may explain in part how primary basidiomycete colonisers invade wood when fungal activity is at its highest. Interaction studies are continuing.

The effect of progressive decay, resulting from natural infection in the field, on the chemical composition of P. radiata sapwood is also being followed. This will provide information that may help to interpret data of population fluctuations within the wood when the ability of the fungus to utilize the substrate is related to the composition of the wood. In this way it may be possible to predict whether a particular fungus was physiologically active or inactive within the wood at a particular time during the colonization process. Lack of this essential information often results in the importance of some fungi being over emphasized purely because they were isolated in comparatively large numbers.

The succession of fungi on preservative treated stakes of P. radiata (0.1 lb/cu ft CCA) have been studied. The succession of fungi was the same at ground-line, above ground-line and below ground-line. The dominant fungi colonizing all zones were Cladosporium elatum, Cephalosporium sp. and Penicillium sp. These fungi were shown to be particularly tolerant to the preservative components when tested in agar plate culture.

An experiment is in progress to determine the efficacy of a CCA preservative when blocks treated to various retentions are first exposed to micro-fungi and then to attack from one of the internationally recognized bio-assay organisms used with this type of preservative.

The relative efficacy of 6 CCA preservatives at 6 retention levels was tested using the soft rot fungus Chaetomium globosum. There was a marked reduction in weight loss in the treated blocks at 0.5 lb/cu ft but at retentions up to 1.0 lb/cu ft, weight losses of about 10% were recorded.

Discussion

Cokley mentioned some of the problems of treatment of low density species, such as jelutong.

Experimental work is being done with the Department of Railways and industry in the use of pentachlorphenol in oil for Queensland species not amenable to high pressure treatment.

In order to improve the termite resistance of rail sleepers on the Mt. Isa line, a test is under way to study the effectiveness of the addition of aldrin to PCP/oil preservatives. One thousand sleepers are involved in the test. Five thousand samples are involved in the service tests of stakes by the Department. Mr Cokley also announced that a new laboratory was to be constructed in Brisbane for preservation, chemistry and plywood work.

Johnstone: Has there been any work on the preservative treatment of Populus deltoides in New Zealand?

Parrott: No, but poplars do treat well, at least in the sapwood.

Dale: We have done some work on the non-destructive testing of poles using the instrument "Pole-tek". Gross defects seem to affect sound reflections in an irregular manner.

Parrott: We have tested some brand new New South Wales imported poles. White mahogany gave a positive result. Bloodwood gave indications of unsoundness. It seems that species do react differently. Of the softwoods tested, Douglas fir, larch and pine can be reliably tested with the instrument.

Cowan: Will creosoted rounds used in vineyards have any toxic effect on the vine or crop?

Dale: Vines are not affected to any extent and there is no risk to the flavour of the wines.

Martin: We have investigated the condition of radiata pine tile battens in some 18 year old houses. No deterioration was observed. Concrete tiles had been used but there was no sarking and the battens had plenty of ventilation.

Parrott: An examination has been made of the radiata pine window joinery in four twenty year old houses in the Auckland area. The material consisted of both heartwood and sapwood but all are in sound condition.

Cokley: The vacuum pressure diffusion method of impregnation does not answer all problems. Heartwood cannot be treated by this method. Presteaming as tested by DWT will help to remove resin blockage. The terms "sapwood" and "heartwood" are quoted very freely but there appears to be no easy practical way of assessing in the field what is heartwood and what is sapwood in softwoods prior to treatment. The terms "treatable" and "non-treatable" are suggested instead. With regard to pole usage in Queensland, 90% of new poles are being treated. During the last 2 years we have had about fifteen suspect poles reported to us but on examination only two had more than slight attack. One was very severely affected by soft rot. Stacking conditions were suspected.

We have no major problems from checking. Poles should be dried after treatment, before despatch to districts that suffer high temperatures.

In conjunction with the State Pole Committee a full check was made of more than 20,000 poles in detail, and of data for more than 100,000 poles. Four poles were found to be split to the heartwood resulting in some termite attack but this was easily eradicated. Only a few were affected by fire.

Ten percent only of veneers in Queensland are now treated with fluoride. Industry has done everything one could reasonably expect but it is a fact that 40% of these veneers did not have an

adequate loading in terms of legal requirements of 0.1% sodium fluoride.

Smith: We may need to give further consideration to the problem of inherent tendencies to splitting of some of the species currently permitted for poles and piles. Can CCA treated conifers be confidently recommended as preferable to high durability hardwoods for cooling tower construction.

Tamblyn: Yes. Natural durability ratings do not apply to cooling towers, but very good results are obtained with CCA treated pine and we are now trying CCA treated hardwoods.

Da Costa: With regard to the hardwoods, the fill is the problem. The large structural members of the tower are not in danger, but it would be preferable if all construction was in treated timber. However, the sizes required would present difficulties. We still recommend the use of tallowwood.

Colwell: Multisalt diffusion is being carried out in New Guinea. An examination of external timbers used on one hundred houses in Port Moresby, built in 1955-56, showed that most untreated Araucaria and hardwood have failed and that treated Araucaria is now starting to fail after 14 years' reasonable service. The material was painted but maintenance was not very good.

Cokley: Firms operating treatment plants should do more process control work. This will help us to help them get proper technical control. I would like a lead from conference to encourage industry training.

Moss: I look forward to the day when we can hold a timber preservers conference. I fully appreciate the need for technical development. As regards quality control we will do the best we can within the economic limits possible.

Tamblyn: Queensland mentioned the difficulties of high pressure treatments. Are you certain that there are such difficulties?

Cokley: Samples were sent to Hickson's representing 15 species for high pressure treatments. Only two were satisfactory. Similar results were obtained for material sent to DFP.

Tamblyn: We do not claim treatability for species over 50 lb/cu ft. By boultonizing the range can be extended slightly. The brushwoods may be useable as high pressure treated railway sleepers. Thousands of high pressure sleepers throughout Australia are giving good results. It is unfortunate that Queensland has used a dip treatment which has been unsatisfactory in our tests and throughout the world.

Cokley: Tests involving boultonizing are going on at present. More importantly, we have been trying for 20 years to interest the Department of Railways in treatment processes. The objections have been based on economics. We have to find out if the unions will handle them. Service results from hot and cold bath treatment have not been too bad, especially for resistance to weathering. We would need half a dozen high pressure plants to meet requirements. We must live with the species we have.

Smith: We have lots of durability class 2 species material. If we can stop the severity of checking we can satisfy needs.

Item 4(b) Treatment of radiata pine heartwood*

At the last Conference we reported some preliminary tests on the treatability of radiata pine heartwood and summarized our results by saying that there appeared to be a pronounced effect of locality on heartwood permeability, that penetration was improved both by increasing the pressure and the pressure period and that conventional treatment of green heartwood was not as good as treatment of dry material. At this last Conference the Division of Wood Technology also reported their finding that steaming of green pine heartwood for several hours at about 260°F significantly improved its permeability.

Since the last Conference we have made a further series of tests on heartwood material supplied through the Radiata Pine Association and cut by Sapfor at Tarpeena in South Australia. This material came in 5" x 5" cross-section and we recut it to about 5" x $2\frac{1}{2}$" to give 120 pieces each 9" long from a total of 12 trees. We have previously proved that these short 9" lengths were quite long enough as end grain penetration in refractory pine heartwood is almost negligible.

After various diffusion and pressure treatments, sections were cut from these 120 pieces to illustrate the penetration obtained and these are shown in the picture which has been circulated. In this picture each of the 12 vertical rows represent a different tree but all material in any one vertical row is cut from the same piece of timber and is either end or side matched over a length of only 4 feet.

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* Prepared by N Tamblyn

Horizontal rows 1-3 are boron dip-diffusion treatments made on green heartwood at the moisture content of the living tree which in this material was almost always between 30 and 40%. Unfortunately the boron penetration does not show up clearly because of the difficulty of distinguishing between the pink and yellow colours of the turmeric test in a black and white picture. However, in general the penetration pattern was rather poor after only 2 weeks diffusion (less than $\frac{1}{2}$"), was reasonably good after 4 weeks and was appreciably better after 8 weeks blockstacking. There is little doubt that a dip-diffusion treatment for 4-6 weeks would give quite good protection of most pine building timber and this should be kept in mind when considering the results of the various pressure treatments illustrated in the picture.

Rows 4-8 represent a small pressure treatment test on only 3 trees to determine whether some of the bacteria which colonize wood in cooling towers can increase permeability by attacking the torus which closes the pits in pine heartwood. In these tests the green heartwood was "ponded" in the bacterial cultures for 6 weeks before drying and treating at a normal pressure schedule. The treatment was done with a water solution of red dye and the figures in the centre of the specimens show the solution absorption in lb/cu ft. Results were not encouraging though there is always the chance that we may find a motile bacterium which will selectively attack the pit structure.

The double row 9a and 9b represents air dry control material given a standard treatment of $\frac{1}{2}$ hr vacuum followed by $1\frac{1}{2}$ hrs at 200 psi using the same red dye. As can be seen most trees were more or less refractory and the two halves (a and b) of each piece of timber behaved quite similarly.

Row 10 shows the effect of a similar pressure treatment on green material preconditioned for 4 hrs before treatment by two alternate steam and vacuum schedules. This preconditioning resulted in visibly better penetration though the increase in solution absorption for the 5 trees with refractory heartwood was only about 11%.

In row 11, the material was treated air dry by the standard schedule (as in row 9) except that the pressure was maintained overnight. This also resulted in visibly better penetration and excluding the abnormal tree with a knot (tree 10) the average increase in solution absorption was 59% compared to the controls. This long pressure period appears to have been better than the 4 hrs steam and vacuum preconditioning though the matching has not permitted a direct comparison of rows 10 and 11.

Row 12 was a standard creosote treatment and it seems clear that our penetration problem in radiata heartwood lies with waterbornes and not with creosote. We certainly need to study this more to determine why the more viscous creosote penetrated so much better than water solutions.

Row 13 was air dry material given a very severe treatment of 400 psi overnight. This treatment has caused some damage to the wood (see tree 11) but has very considerably improved penetration and has increased the retention by 73% compared to the matched controls.

Row 14 was green material given two alternate steam and vacuum schedules over 4 hrs and then pressure treated at 200 psi overnight. Except for tree 7 it is a good treatment though the average increase in solution absorption was only 35% compared to 59% for the dry material similarly treated overnight.

Row 15 shows the result of pressure treating green material at 30-40% moisture without presteaming using the long vacuum treatment developed in Queensland for eucalypt poles. It did not give satisfactory penetration and the solution absorption was reduced by 36% compared to the controls.

The results of this test suggest that a combination of steaming, a long pressure period, and the maximum pressure which can be applied before damage occurs, should give fairly good penetration of pine heartwood.

When I was in America earlier this month I was impressed by the development there of entirely automatic computerized pressure plants and it seems that with much less automation we could easily run unattended overnight pressure treatments to cope with a good deal of the pine heartwood problem where virtually complete penetration is required. The alternative to this would be to segregate the sapwood for critical pressure treatments and perhaps couple this with diffusion treatments for building timbers where they are more or less protected from leaching. As a long term alternative we might also consider the possibility of selecting elite trees with permeable heartwood for mass propagation by cuttings. That trees with permeable heartwood do occur is evident from the penetration obtained in tree 1 in the picture. This tree penetrated well in every treatment given.

Discussion

Foxton: Bacterial ponding to improve permeability may have a similar effect to treatment with hot creosote. The latter appears to dissolve some of the pit constituents. The same effect

may be produced with xylene, hexane or other organic compounds.

Moss: In looking at new treatment procedures it is desirable to devise a method which can be used with existing plant.

Johnstone: South Australia might have had better results if they had used a more severe presteaming treatment.

Parrott: Radiata from the Bay of Plenty area, comprising the major producing area, does not appear to have this problem but from some other localities it does. Specifications demand penetration for 0.4 in. from the heartwood faces in sawn material to be used in ground contact.

Item 4(c) (i) Boultonizing of sawn hardwoods*

Results of an experiment to compare air drying and boultonizing of Queensland rail sleeper timbers, followed by 1000 psi treatment, are as follows:

(A) Retentions in case in pcf determined by extraction

Species	Boultonized		Air Dried	
	Range	Mean	Range	Mean
Satinay	9.9–19.1	15.0	5.1–6.0	5.8
Scribbly gum	11.2–15.4	13.7	8.1–11.2	9.8
Rose gum	15.4–18.0	16.8	11.5–14.3	12.6
Brush box	10.6–13.3	12.3	1.9– 5.5	4.1

(B) Overall retentions of creosote in pcf determined by weighing

Species	Boultonized*		Air Dried	
	Range	Mean	Range	Mean
Satinay	7.1– 9.0	7.9	4.7– 6.6	5.7
Scribbly gum	5.0– 7.8	6.8	10.0–15.8	13.0
Rose gum	8.7–11.9	10.1	12.7–17.3	15.7
Brush box	4.4– 8.6	5.9	1.6– 3.4	2.5

* Overall retentions based on weight after boultonizing. True overall retentions would be 2–3 pcf higher than those given because of creosote absorbed during boultonizing.

* Prepared by F A Dale

Item 4(c) (ii) Boultonizing round timbers*

Experimental work on the boultonizing of karri poles has now been completed, and papers are being prepared for publication. The process is particularly well suited to karri poles which are virtually impossible to air dry within acceptable limits of splitting and checking.

General results were reported to the 1967 Conference for poles with mid-length diameters of 10–14½ in. and sapwood thicknesses between $\frac{7}{8}$ and $1\frac{7}{8}$ in. Similar satisfactory results have been obtained for poles with mid-length diameters of 5–10 in. and sapwood up to 2 in. thick.

For both small and large poles with sapwood up to about 1 in. thick, satisfactory drying was obtained when our experimental plant was operated at a creosote temperature of 230–240°F. for about 9 hr with the pressure decreasing from 11 to 25 in. of Hg. vacuum. Under these conditions, the inner $\frac{1}{2}$ in. of sapwood dried to an average moisture content of about 20% while the outer $\frac{1}{2}$ in. fell to about 2–5%. This is a particularly good feature of the process because many of the fine surface checks characteristic of boultonized poles close up and remain closed when the sapwood increases to generally higher emc values. Much longer drying times of up to 20 hr or so are necessary if all of the sapwood in poles with up to 2 in. of sapwood is to be dried below about 25%.

Another advantage of boultonizing for karri is that the pattern of checking that starts to develop early in drying facilitates simultaneous impregnation with creosote. Average sapwood loadings by toluene extraction are about 8–10 lb/cu ft for sapwood up to about 1 in. thick with outer $\frac{1}{2}$ in. values being 10–16 lb/cu ft depending on density. Treatment at 200 psi for 1–2 hr appears to increase the average sapwood loading by about 1–2 lb/cu ft.

Commercial boultonizing trials have been carried out in Western Australia, and an order placed for the supply of 1000 karri poles 60 ft long. Thus, it is now possible to install treated poles in service within one week of felling.

Some experimental work has also been carried out on the boultonizing of jarrah, spotted gum and messmate stringybark poles. Results were good for jarrah and spotted gum which checked in a similar way to karri, but not so satisfactory for messmate stringybark which tended to resist checking and had little penetration of creosote. There is a fairly clear indication that density of the wood influences checking pattern and, consequently, drying rate. Boultonizing appears

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* Prepared by J E Barnacle and F J Christensen

to be more satisfactory for timbers with air dry densities greater than about 50 lb/cu ft.

In the next phase of the boultonizing project, work will be carried out on sawn timber from several Queensland species.

Discussion

Cokley: For application to engineering and large section uses we are carrying out tests on the impregnation of Queensland hardwoods by various methods. It appears that boultonizing is a possible answer to the penetration problem. Is a dual system necessary for boultonizing/pressure treatment?

Dale: It is a matter of throughput. For the boultonizing it is only necessary to have a relatively cheap vacuum cylinder and a large vacuum cylinder could be used in conjunction with a much smaller high pressure cylinder.

Moss: The industry is very interested in this process and its own investigations are well advanced. Boultonizing would be a more economic possibility as the industry could not carry large stocks of sleepers for 6-9 months air drying.

Smith: Would internal checking of the order illustrated be a disadvantage in relation to spike holding properties?

Dale: Our rail fastening methods are not necessarily the best and the use of the screw spike could overcome many problems. New Zealand methods are better than ours and they aim to get 30 years' life from a pine sleeper.

Item 4(d) Effect of timber substrate on preservative performance*

At the last Forest Products Conference, we presented some laboratory data on the effect of timber species on the performance of CCA preservatives against decay fungi, suggesting that this effect was far greater than anyone had anticipated. Since that time, evidence has accumulated rapidly, showing that this effect is also very marked in field tests. What is particularly noticeable is that CCA-treated eucalypt sapwood shows results greatly inferior to pine sapwood given similar treatment. This is disturbing because so much of the laboratory, field and service data on which we have based our assessment of CCA

* Prepared by E W daCosta

preservatives has been obtained on pine timbers. The extent of the differences are shown in the table:

COMPARATIVE PERFORMANCE OF PRESERVATIVES IN PINE AND IN EUCALYPT TIMBERS

Hazard	Location	Preservative	Retention (lb/cu ft)	Soundness rating	
				Pine	Eucalypt
Decay in field stakes ($1\frac{1}{2}$ yrs)	North Queensland	CCA	0.75	100	81
Decay and termites in field stakes ($3\frac{1}{2}$ yrs)	New Guinea	CCA	0.75	98	70
"	"	Zinc-chrome-arsenic	0.75	68	2
"	"	Copper penta-chlorphenate	0.4	72	25
"	"	Creosote	8.0	90	48
"	"	Penta-chlorphenol (5% in oil)	8.0	95	77
Marine borer attack ($9\frac{1}{2}$ yrs)	Port Hedland	CCA	1.75	86	0
"	"	Creosote	10-20	54	68

The first two lines in the table show that deterioration is evident in eucalypt field stakes treated with CCA at a very early stage and develops rapidly, whilst pine stakes are virtually intact. Succeeding lines show that the difference is present with other preservatives as well as with CCA. Moreover, the effect is not confined to fungal attack and its most spectacular occurrence has been in marine borer attack as shown in the table. This will be dealt with elsewhere in the Conference.

It is obvious that this between-timber difference is of extreme practical importance and it is also of considerable scientific interest as no satisfactory explanation of it has yet been found. For both these reasons, the Division of Forest Products has embarked on an intensive research program aimed at finding the reason and the extent of these differences. Research in the Division and elsewhere has shown that the leaching behaviour of CCA is very different in pine and in eucalypts, but the size of the differences so far found

would not apparently explain the wide difference in early field performance; moreover, the leaching factor would not explain differences found in laboratory decay tests on unleached blocks. Again, it is known that hardwoods are much more susceptible to soft rot by microfungi and bacteria than are softwoods and it might be thought that the rapid deterioration in tropical field tests was due to soft rot. Our field data records do not discriminate between different types of decay, but it does not seem to us that the decay observed could be attributed entirely to soft rot. This question will be investigated at our next inspection. In any case, our laboratory results were obtained with basidiomycete decay fungi. At the moment, we feel that these differences between timbers are due either to a different distribution of the preservative within the wood cell or to the formation of very different fixation products. Eucalypts and pines have wide differences in the chemical composition of their extractives, hemicelluloses and lignin, as well as in fine structure, and any of these could affect fixation of CCA.

We have commenced a study of the problem on analytical lines by modifying the wood of Pinus radiata and Eucalyptus regnans before CCA treatment and measuring the effect on difference in CCA performance in laboratory leaching and decay tests. Once we know which treatments reduce or remove the difference between the timbers we will be able to assess which of many speculative explanations is most likely to be correct and to develop better preservative treatments for the eucalypts.

As another line of investigation, Dr Greaves is comparing the patterns of fungal and bacterial colonization of CCA treated pine and eucalypt stakes in tropical soil. In both cases a large variety of organisms is present, but differences are already showing between the two timbers, and investigation of these may throw some light on the different field performance.

Finally, we have taken steps to close the most important gap in our knowledge that relating to the size of the species effect in treated cooling tower fill. Since this is subject mainly to soft rot attack and requires much more CCA for protection than other forms of timber, we would expect that the inferiority of eucalypts and probably other hardwoods to pine, would be even more marked here, but have no results back yet from our exposure tests of various treated timbers. Until we do so, however, we would suggest that only treated softwoods be used for cooling tower fill.

Further research is urgently needed, including better arrangements for a prompt and thorough post-mortem on any premature failures of CCA treated timbers through decay and soft rot. Until more data are available, we would suggest that pine be preferred to eucalypt timber for CCA treatment where availability and mechanical suitability

are even approximately equal and that higher retentions of CCA should perhaps be specified for hardwoods than for softwoods.

Discussion

Smith: Basic differences between the performances of species and preservatives probably will be found to be related to wood structural differences. It could be useful to look more at micro rather than macro distribution of preservative. For example, check the structural nature of the "dead spots" (those not penetrated) in areas away from vessels.

The explanation of apparent anomalies may be found relatable to the heartwood penetrability problem. Possibly the poor performance of hardwoods compared with softwoods with some preservatives is related to lower degrees of permeability of cell walls despite good retention within lumina.

Cokley: In practice, differences in cell wall absorption are hard to determine, but probably most of the preservative within the lumen may be substantially inoperative. The study should not be limited to pines and eucalypts. Better to ensure the study results are representative of softwoods and hardwoods.

Item 4(e) Natural finishes on wood*

Reasons for the investigations started in 1966 were:

(i) A large and increasing quantity of timber particularly Western red cedar and Californian redwood had been used during the previous few years, unfinished and stained.

(ii) The Division had received enquiries over the years on the effect of exposure on the appearance of wood and for information on types of finish to use.

Eventually it was decided to establish a test fence simulating vertical weatherboards and using different timbers, preservatives and finishes. The fence was exposed in April 1966.

Timbers used were Californian redwood, Western red cedar, radiata pine, alpine ash, brush box, and King William pine.

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* Prepared by W D Woodhead

Preservatives used were Tanalith C, Esso "Protecwood" (5% PCP in dieseline), creosote, a proprietary oil stain based on the "Madison" formula, and pigments in oil. For comparison several samples were dipped in "Woodzone" and clear finished with exterior varnish.

Some conclusions can be made in regard to the performance of the different combinations after a period of 3 years exposure. These conclusions apply primarily to Melbourne and might not be quite the same in different climatic conditions.

The main conclusion is that for exterior panelling CCA treated radiata pine and probably other pines, can rival Californian redwood and Western red cedar. There are however, four qualifications attached to this and these are:

(i) It should be stained with an oil stain of a proprietary brand, or at least some sort of oil, to reduce checking.

(ii) The surface should preferably have a sawn finish to absorb more oil, thus reducing checking, and also to make checks less obvious.

(iii) The industry should consider using twisted shank nails to provide more restraint and to reduce cupping. These are used for weatherboards in the USA and nail manufacturers here can produce them. They are about twice the price of ordinary ones, a small item in cost particularly as the treated radiata pine is slightly more than half the cost of the cedar and redwood.

(iv) To reduce cupping the boards should be erected bark side in. The other conclusion of importance is that the two imported timbers appear to justify the claims which have been made for their performance. The test boards which were oil stained are virtually perfect after 3 years and do not require maintenance.

Some other observations from the test are:

(a) Surface mould attacked all the untreated timbers except redwood and Western red cedar. No decay was observed.

(b) Two coats of proprietary preservative oil stain prevented mould, and reduced checking and differential fading on all the timbers. Life depends on the type of surface: the less dense timbers have a better retention than the denser ones.

(c) Sawn face boards retain pigment better than dressed boards upon which erosion is apparent.

(d) The home made stains made by mixing pigments in oil with Esso "Protecwood" erode and chalk badly; they are a cheap finish, possibly suitable for fences.

(e) Electroplated cadmium nails corrode and stain timber after only a short period of exposure. They are not recommended for exterior use.

(f) Brush box, King William pine and alpine ash performed well with a coating of oil stain.

(g) Pressure creosoted radiata pine performed well. A report on the investigation is being published.

It is proposed to continue maintenance on the fence as required.

Discussion

Smith: Did twisted shank nails restrain cupping and what was their effect on splitting?

Woodhead: We did not use twisted shank nails. The backs of some boards were grooved with the aim of decreasing cupping but without success.

Cheal: Plastic coated nails might also be satisfactory.

Bryant: What commercial finishes were used?

Woodhead: Only one, probably based on the Madison formulation.

Parrott: Better results have been obtained with commercial versions of the Madison formula than with those made up strictly to the formula, presumably due to additives.

Rumball: RPA has eighteen commercial finishes under test. An assessment after 12 months' exposure is being prepared. Fineness of pigment grinding has a significant effect on durability.

Cokley: Results on commercial clear finishes are inconsistent particularly in tropical and subtropical areas. Indigenous species should be included in tests as well as Pinus radiata. It is probable that users will reject the finishes at present available because of the maintenance required.

Item 4(f) Suitability of imported and Australian timbers for external joinery*

One of the most frequent and most difficult types of enquiry received at the Division of Forest Products over the past year or so, has been that of the suitability of imported timbers such as meranti, merbau and hemlock for external joinery. There are four difficulties in answering such queries:

(i) Many of the timbers are unfamiliar to us and poorly described in the literature.

(ii) Some of them are extremely variable, the one trade name covering several different species of widely varying properties, but similar appearance.

(iii) Whilst some timbers are obviously highly suitable for external joinery, there are others which, while not of such high durability, could possibly give adequate service in normal conditions. It is difficult to assess this possibility by any means other than expensive and lengthy exposure tests under service conditions.

(iv) It is also difficult to assess the decay hazard in various constructions and localities, as it is governed by a complex interaction of weather, microclimate, standard of craftsmanship, detailed design etc.

There are a number of other questions which are "open". If a timber is non-durable but reasonably absorbent (e.g. ramin) will it be adequately protected by dipping in a water repellent preservative after full fabrication? If it is non-durable but not very absorbent, will such a dip improve either its durability or its appearance and paint holding properties sufficiently to be worthwhile? Are superficial treatments such as may be afforded by commercial CCA treatment to refractory pine heartwood adequate or are they negatived by surface checking?

It is not possible for us to make experimental assessments of all timbers but we are taking steps now to answer some of the more urgent general questions. We plan to set up immediately a small outdoor exposure test simulating painted joinery. It will be the forerunner of larger tests aimed at comparing, under field conditions, oilborne preservatives and the durability of partially treated Pinus radiata heartwood and will serve as a pilot test for them. This first test will compare non-absorbent and absorbent timbers for softwoods

* Prepared by E W daCosta

and hardwoods; will assess the protection given by dip treatments; and will, for example, assess our ability to select by appearance the risky and safe forms of meranti. It will be used also, and equally importantly, to correlate field test results with the results of various laboratory tests conducted on matched material. At present, there are a number of relatively quick tests we can apply in the laboratory, but we just do not know how reliably the comparisons obtained would apply in service. Ultimately, we must have some rapid laboratory or field test for evaluation of timbers or preservatives. Full scale exposure tests are too expensive and too long to answer all problems.

Until more experimental data are available, the following principles are suggested for assessing suitability of timbers:

(i) Assessment should be on the basis that the timber will be used in the least favourable microclimate in the State of sale, e.g. timber sold in Adelaide must withstand the most severe climatic conditions in South Australia but not necessarily the worst in Queensland.

(ii) It should take into consideration the type of use e.g. requirements will be higher for window sills and stiles than for cladding and higher for painted than for stained joinery. We should also consider costs of replacement, i.e. 20 years life may be tolerable where replacement is easy, but 60 years should be aimed at where major repairs might be involved.

(iii) Unless timbers are known to be extremely suitable, they should be given a water repellent preservative dip.

(iv) Where the timber is variable, e.g. meranti, it should be assessed on the basis of the lease suitable form (it is rather doubtful whether selection on density and colour is really effective).

Discussion

Parrott: Radiata pine is now approved by lending authorities in New Zealand for exterior joinery use. The timber must be basically clean, straight grained stock, and treated to an intermediate loading with CCA. Finger jointed radiata is approved as well as full length clear stock. Phenolic resorcinol or resorcinol glues must be used in the finger joints. Approval for radiata has been based largely

on developmental work carried out by the Forest Service.

Cokley: Too much imported material of doubtful durability is used for external joinery. Supplies of our own species suitable for this purpose are limited, but many imported timbers used are no better than many local species banned for this application and tests of treated material are very desirable. A lot of publicity has been given to the use of water repellents, but a guaranteed standard of performance cannot be given.

Smith: Some joinery components need higher durability than others. Sills are an example, particularly in view of high replacement cost. Lower durability species can only be recommended for partly or fully protected exposure. Not all species are suitable for external joinery even if treated. Tendency to checking on exposure is a most important factor.

Use of meranti and other low durability imported species suggests a shortage of suitable Australian species. This is not so, and efforts should be directed to making greater use of our species, rather than testing or improving the performance of imported timbers.

Lamb: I support the investigation of suitable joinery species. A serious problem is the detection of decay which may vary with different conditions of exposure. It would be good to have a reliable test to check suitability of species for this purpose.

Beesley: The proposed RPA-DFP test is expected to answer some of these questions. Material will be exposed in Adelaide, Melbourne, Sydney and Innisfail; joinery will be painted and unpainted, but all will be impregnated. There will be different conditions of exposure to different hazards. The assistance of the Division of Wood Technology would be appreciated. The facilities of JTRU will be used at Innisfail.

Bryant: Meranti has been banned in New South Wales for external joinery. TDA should push the use of suitable, readily available local timbers.

Tamblyn: Any treatments of timbers for external joinery must be considered in terms of trade practices. Momentary dips have already been approved overseas and we are faced with making decisions on their suitability in Australia. A life for joinery of up to 70 to 80 years is required, but existing dip treatments will only give up to 15 years or so. Do we exclude any species that will not give 50 years' life, whether treated or not? Do we settle for a short term palliative or insist on long term protection?

Huddleston: I support Mr Tamblyn. We have to use some species for external joinery which we do not like; these will need protective or preservative treatment. In New South Wales, tallowwood sills will last for 50 years, even without proper painting.

Moss: In TPAA it is desirable to draw a distinction between preservation and protection. The TPAA would like to participate in evolving suitable recommendations.

Cokley: I am glad to see plans have been made to do tests on external joinery but I do not agree with the proposal to test only one species. Water repellents appear to be all right for pines but variable for other species. Even so, one sanding back of timber so coated can remove the water repellent.

Tamblyn: Dipping gives end grain protection.

Jones: Large volumes of timber and its status are involved in external joinery. There are differences of opinion as to which practices should be followed, and areas in which there is not enough knowledge. It would assist industry if an unequivocal statement could be made on a code of practice for external joinery. My industry tries to follow documented recommendations.

Brabin: In Tasmania, myrtle beech and Tasmanian oak were the main species used up to 3 to 4 years ago; a little celery top pine was also used.

I am in favour of having a code of practice, and regard how timber is used as being perhaps more important than natural durability. With good design, more readily available and cheaper timbers could possibly be used.

Da Costa: Pressure impregnation is the ideal treatment but it has difficulties and it may be necessary to compromise. For example, parts of radiata pine are impossible to treat. We are not particularly interested in imported timbers but three have been included in the proposed test to assess their suitability.

Item 4(g) Forest diseases and their effect on timber utilization(NSW)*

The forest product is the actual yield/acre from forested land less wastage from disease, decay, insect damage, forest fires and storms.

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* Prepared by D Hartigan

The forest product is thus variable in quantity and quality and the standardization required to make it a saleable commodity comes very late in the cycle of production.

It is hair splitting to speak of the study of fungal and other micro-organic attack applied to living trees as being different from that applied to cut timber.

In effect, wastage starts in the forest and the same groups or succession of organisms are responsible for deterioration of wood products right through to the processed article.

With a natural product like wood it is difficult to see how much can be done to modify the impact of disease and decay on the ultimate yield unless the timber species are segregated and grown for particular purposes.

Whatever the risks of monoculture the management of forestry must proceed in the direction of exploitable species whose growth habits are more clearly defined so that control of quality can start earlier.

If this view is accepted then the short answer to the question "what is the future of hardwood?", is the success foresters have with growing selected species quickly.

I agree however, that this is not the usual meaning attached to this question and the reason for this seems to be a matter of time.

Wood users look upon timber as a raw material and the stock in hand is the forest reserve available or likely to be available over the next 40 years or so.

Foresters on the other hand are charged with the responsibility of providing timber in perpetuity and the next 40 years is only a bagatelle.

The user must guide the grower to some extent, but the latter should also be able to comment on the long term feasibility of certain trends in wood usage. Foresters debate at length the merits of pine versus eucalypt culture but compared to agriculture, a tremendous lethargy seems to hang over forestry operations and this is not confined to Australia.

Growing trees is not attractive economically and that is why the task is left to Governments in the main. It is also the over-riding difference between forest products and silvicultural research.

In order to breach the tremendous disadvantage of long life cycles it might be expected that foresters would have done a great deal of work on fast growing species, segregating them for special trials and carried out extensive work in rapid propagation techniques, including fertilizer programs, developed new machinery for planting, felling and transport and in fact lead agriculture in applied genetics. Some such work has of course been done, but it is not enough.

Poplar growing is attracting attention amongst private growers and also some Pinus growing for the reasons that some realization on effort is possible within a life time or less.

This seems to me to be the hub of the matter. What can the timber technologist do to make fast growing species acceptable to the public? In this age it is no longer a question of growing sculptured trees or beautiful trees, but rather growing wood because wood is the basic forest product. Arboreta and parkland forests belong to a different compartment of endeavour altogether and efforts to combine multiple usages in forests are largely fanciful.

It can be anticipated that any attempts to speed up forestry are bound to run into problems, particularly biological ones; but in any case biological losses occur at present and are proportional to the "improved" value of the timber stands we are developing.

Most of the world forests which are in ecological equilibrium are old forests. There is no biological problem because natural scavenging balances production. It is only when timber users attempt to rob the next generation of their timber that defect percentages start to go up and quality deteriorates.

In Australia we are fortunate or unfortunate (depending on which way you look at it) in that we must reforest, and the most promising way of doing this is with Pinus spp. The only matter in dispute is whether we can accelerate current programs.

Any worthwhile progress must mean a departure from established forestry practice with all the dangers and pitfalls that entails. It also means the exercise of some imagination.

In pines there is good evidence that soil sterilization in nursery beds results in larger and healthier plants for planting out in the field. The proviso is that sterilized beds must also be quickly inoculated with a suitable mycorrhiza fungus, otherwise the improvement is not lasting.

Alternatively if seedlings are inoculated on germination with selected mycorrhizal fungi, the chances of failure at planting out are diminished.

The value of mycorrhizas can be convincingly demonstrated in laboratory tests - the mycorrhizal plants in one experiment being almost one foot taller than their counterparts bereft of mycorrhizas, of the same age and growing under the same conditions.

Translating results like these into silvicultural practice calls for some changes of techniques. If the financial advantage of the modification in terms of faster growth does not outweigh the costs of implementing them then the case lapses, however my feeling as a result of work done on a laboratory scale is that there would not only be faster growth but the methods would also be cheaper in the long run. All that is needed is a new attitude towards nursery propagation. Practically the same comment could be made about superphosphate addition to young pine plantations in certain areas where improvements have been found to follow addition of phosphorus.

The speed of growth of poplars and Eucalyptus grandis without any silvicultural attention leaves little to be desired, but the end product, at least with the eucalypt is unsatisfactory as a timber. This is the common story of forest grown eucalypts and is the reason why Australian experts caution overseas Governments about eucalypt plantations (see Boden Report to Government of Pakistan, Pakistan Journal of Forestry 18:3 July 1968). Boden points out inter alia that these problems (of severe internal growth stresses) are not encountered to the same degree in Australia where growth rates are generally slower than those found overseas. Perhaps so but it would be nice to report that attempts have been made to relieve growing stresses in standing trees by appropriate physiological means, however, apart from slicing the trunks of kurrajongs I know of no efforts in this direction.

A genuine effort seems to have been made to mate circumstances to species with some eucalypts like E. pilularis and the sowing technique with jiffy pots looks like a real advance.

Nursery problems with Rhizoctonia and algae (following overhead irrigation as practiced by APM) have been apparently overcome but it is reasonable to assume that accelerated methods will continue to run into these sort of difficulties.

The final aim of exploiting fewer species more intensively than is at present practised leaves open the debate about putting too many eggs in one basket.

At present we have a first class epidemic in Western Australian E. marginata - Phytophthora cinnamomi being the causal agent. This is receiving world attention particularly where eucalypts have been planted as a monoculture introduced species. The Australian attitude towards this circumstance seems to oscillate between that of the entrepreneur business man who sees no immediate threat to his equity and the forester who sees little future in eucalypts.

In terms of what has been said above, jarrah seems a rather poor prospect as a forest product. It just takes too long to grow into a quality product.

Should Phytophthora appear in eastern state eucalypts the same observations will apply. There will be plenty of time to realize on the existing stands but the future of long cycle species will be clouded.

The approach towards a disease like Dothistroma in New Zealand again illustrates the optional flexibility of growing short cycle species.

Dothistroma is not likely to spell disaster to Pinus radiata, it will only add to the cost of growing it and with progress in breeding even this cost may be reduced. The original advantage of fast growth still puts radiata a long way ahead of rival species.

The time must arise all over the world and sooner in Australia than most places, when the only timber harvested will be that which has been planted, so it is not too soon to be looking at growing methods right now.

Discussion

Beggs: The view given on the consequences of this disease seems unduly gloomy. Something can be done in logging control to limit its spread; it is now known that the extensive use of mechanical equipment in logging in recent years has been a significant factor in the relatively rapid spread of the disease.

Parrott: Spraying a copper salt for control of Dothistrima in New Zealand costs no more than 2¢/cu ft of timber, i.e. control is not uneconomic. This is for radiata pine.

Jones: Foresters should consider the ultimate utilization of the timber more than is generally done at present. Too much emphasis is placed on economics in forestry, which can be seriously unbalanced by heavy "on-costs" in utilization. Because of the long

rotation of forest crops, it is sometimes difficult to compare economics of forestry with beef grazing and sheep. However, an independent investigation in Queensland estimated that for one large area forestry was more economic than the other two land uses.

Beggs: Foresters do consider ultimate utilization, but it is difficult to plan ahead for short rotation forest crops and much harder to predict the utilization requirements for long rotation crops. For this and economic reasons foresters are tending to favour short rotation high yield crops.

Hanson: The forester does take account of utilization problems as far as he can get information, but the sawmilling industry cannot state the types of timber it will require in future. Even technologists cannot indicate clearly the most desirable timbers for future utilization.

Huddleston: We cannot ignore the effects of forestry practices on utilization and must take these into account when planning the effect of sawmilling allocations on broad utilization of the timber.

Item 4(h) Protection of timber before and during conversion*

The two previous papers have dealt exclusively with timber in service. May I take you back to the problems that occur in the forest and mill. The assumption with timber in service is that the timber you receive is free from degrade, but this is not necessarily so, particularly with our non-durable species.

Stain will develop in Pinus radiata within two days to one week in summer when logs are left on the ground in forest or sawmill. Decay takes a little longer - three to four weeks. In winter this unprotected period could be extended to six to eight weeks. Correct stacking procedure will extend the safe storage time for untreated timber.

Problems of protection start immediately the tree is felled. Bark damage during felling provides sites of entry for stain and surface fungi. With increasing mechanization the extent of bark damage is likely to increase, as well as problems of damage to the standing tree. Here there is the problem of butt damage as well as removal of large strips of bark from the tree.

Possibly the cheapest method of protection is one of management to remove promptly logs from the forest and dry them as fast as possible, but avoiding seasoning degrade. Although this is possible for one in. boards, there are certain difficulties with round timber. Air

* Prepared by R Kierle

seasoning of logs for poles may extend for three to six months, particularly in winter. Decay may start in the poles within this time, and cause loss in strength properties. When such a pole is treated, early failure can be expected with drastic effect on the image of treated timber.

Log sprays incorporating a fungicide and insecticide have given satisfactory protection to hardwoods and softwoods. We have sought to use a spray the components of which are commercially available. On the North Coast there have been tests to protect hardwood from bostrychid attack. For softwoods, the combined spray has given good protection, especially against bark beetles. Penetration of the spray, as indicated by dyes, can be uneven. Similar results have been found by Japanese workers.

Log sprays are important for protection of high quality logs. If protection for fire damaged timber is sought, then selection of logs is absolutely essential. Only grade 1 logs can be profitably sprayed, as shown by results from work on Moss Vale logs. In grade 1 logs are of diameter 10 in. or greater, and are free from stain.

Following the 1968-69 fires, the protection of fire damaged softwoods has become an important problem. Certainly it is safer to leave timber standing for as long as possible rather than clear fall and have nowhere to store logs. The safe storage time for standing timber will depend on the date of the fire and the ensuing weather. At Moss Vale, with its fire in March, there was a safe storage time for standing trees of 6 months, yet at Casino, with fires in late November, the safe storage time was probably as short as 2-3 months. As soon as stain starts in the tree, it would be logical to clear fell softwoods P. elliottii, P. taeda, and P. radiata and store either under water sprays or in ponds. Comment from other forest services on how they dispose of salvage timber would be appreciated.

After boards have been cut, there are problems of air drying, which must be fast enough to beat fungal invasion. Normally we use the sapstain dip PCP and borax, and this has been successful where drying to 20-30% occurs within 2 weeks or so. Frequently, on the NSW coast, high humidity and temperatures have made it impossible to air dry timber within this time, and serious problems with surface mould have occurred on the dipped timber. Although in some cases there has been a delay of a day or a week, poor drying itself can give the same result. In these circumstances, the solution could be kiln drying or drying in predriers.

For P. radiata the best way to obtain clean timber appears to be rapid drying and storage under cover. The sapstain dip is effective, but protection afforded by the dip starts to break down after two weeks.

Discussion

Cokley: I agree with Miss Keirle's comments. Sapstain control is used by the case industry but in some instances control and post-seasoning is minimal because of the added cost. Sapstain control on round timber should be used more by industry.

Moss: The preservation industry is most appreciative of the Division of Wood Technology's assistance with this problem.

Colwell: Sapstain control is only possible within time limits, but in New Guinea timber must be extracted the same day. Has any work been carried out on water shedding carrier to prevent loss of chemical after rain?

Keirle: No

Item 4(i) Report of Wood Preservation Committee

Since the last Forest Products Conference there have been 3 meetings of the Wood Preservation Committee and there has also been a good deal of correspondence between members (Messrs Clifford, Cokley, Edwards and Tamblyn) on various matters. Unfortunately, we have been unable to arrange a meeting so far this year mainly because of absence of one or more members abroad since early March, and the full personnel will not be available for some months yet. This emphasizes the need for all members to have alternatives and possibly for this Conference to appoint a 5th member to the present 4-man Committee so that the effect of an absence will not be so great.

The Committee has had very many items to discuss and at the last meeting there were more than 20 items on the agenda. It is obviously impossible to report all these at this Conference and I have therefore selected only a few to illustrate the type of work in which the Committee is engaged.

Standards

All meetings have had to spend considerable time discussing preservatives, treatments, retentions and other controversial matters

relating to the Australian Standard on preservative treatment of building timbers which is being drafted by the TM/14 Committee. In this Standard the Wood Preservation Committee has functioned as a technical advisory body and it appears likely that we will continue in this role as other wood preservation standards are prepared. We believe that this is desirable in the interests of technical competence and of uniformity between Standards Committees and we are prepared to give the time and to put the necessary effort into this work if required. However, it would be helpful to us, and strengthen our hand, if this Conference would agree that this is a function of the Committee and put it on an official basis as a recommendation to the Standards Association. It should be remarked that we are not seeking any autocratic powers as our attitude has always been that after we have made our recommendations the final responsibility should rest with the full Standards Committee.

New preservatives

The Committee is constantly being required to make decisions on the acceptability of new preservatives well in advance of their possible inclusion in any standard. We regard this as one of our most important functions as it helps to obtain uniformity of approval between States and offers industry a way of obtaining a relatively quick decision. In the last 18 months we have been required to make recommendations on the new coke oven creosote, on the change in Celcure A dry salt to a paste formulation with slight change in component ratios, on the CCA formulation developed by Pioneer Chemicals, on the zinc-chrome-arsenic formulation now being used for some specific treatments of building timbers, on a copper pentachlorphenate formulation approved for plywood in New South Wales, and on the use of tributyltin oxide and lauryl pentachlorphenol as alternatives for pentachlorphenol in dipping preservatives.

In assessing the new coke oven creosote the Committee visited the Newcastle works, reviewed all the evidence available including the extensive tests made by the Division of Forest Products and then prepared an interim specification. In the case of the CCA preservatives leaching tests were considered desirable and these were done by the Division of Forest Products at the request of the Committee which also required submission of test results from the Celcure Division of Rentokil in England. On the basis of these tests we considered that the new Celcure A(P) was satisfactory but that the Pioneer formulation as originally proposed would benefit from the addition of more chromium. This has been accepted and I believe that our Committee has served its function well in this case. In regard to tributyltin oxide the Committee has obtained as much information as possible from manufacturers and from other laboratories but has so far not defined its degree of approval as it is still uncertain of the stability and permanence of this compound in all uses.

Plywood preservative

There has been some controversy in preservation circles as to whether preservative treatment of plywood by addition of toxic chemicals to the glue is a suitable process for acceptance in an Australian Standard.

The Preservation Committee has spent a considerable amount of time on this and we have been somewhat disturbed at the number of variables inherent in this process and at the lack of information on the importance of some of these. Apart from this, the Committee has been unable to obtain from any of the protagonists for glueline additives, any simple method for demonstrating that the treatment has, in fact, been done. This may not be too difficult with an arsenical additive but at present we have no easy method for detecting the presence of chlorinated hydrocarbons such as dieldrin, chlordane etc. in the glueline. We have made some limited recommendations to the TM/14 Committee but are not yet prepared to go as far as industry would like in this regard.

Shipping containers

This matter has been discussed and the Committee has recommended that the following principles should be followed in any decisions taken:

(a) That the standard of safety should be very high indeed as unlike normal wood preservation where a 90% effective treatment is usually considered good, quarantine cannot contemplate taking a 10% risk.

(b) That an acceptable treatment should be visible - that is "it should be seen to have been done" or else it should be capable of easy detection by a spot test.

(c) That Australian requirements should be acceptable to Health Authorities in other countries.

(d) That untreated naturally durable timbers should not be accepted because of the difficulty of identifying even our timbers let alone those from other countries which are claimed to be durable.

Treatment of pine building timber

The need for an opinion by the Committee as to whether general treatment of pine building timber is desirable in Australia was raised at the 1965 Conference. We have kept this in mind but have not yet

felt ready to make recommendations. It is obviously a complex issue of great economic importance and the Committee is very conscious of its responsibility in this matter. We will continue to give it our attention and will approach the Conference when we feel able to make some definite recommendations.

Future status of the Committee

We believe that the Preservation Committee is serving a very useful function in dealing with items referred to it at each Conference and with many other matters which arise between Conferences. In recent years these other matters have formed a large part of the business of the Committee and these have mainly concerned industry, standards, quality control and the requirements for uniformity in approvals between New South Wales and Queensland.

At present the Committee has no status except in its relation to the Forest Products Conference and it seems desirable at this point for the Conference to consider whether it should be given more official standing as a technical advisory body on wood preservation in Australia and whether or not it might be affiliated with the Timber Preservers' Association. The opinion of the Conference on this would be helpful.

Discussion

The question of industry representation was discussed. Cokley supported inclusion of industry, but both Division of Forest Products and Division of Wood Technology were concerned that some of the functions of the committee might be prejudiced by the presence of industry. They felt that many items discussed at present could not be dealt with openly in the presence of industry representatives.

Moss: I am concerned over the delay in research results being made available to industry. The result is that industry tends to duplicate some of the work.

Huddleston: The members of the committee are representatives of their Departments and there should be no difficulty in substituting in the event of absences.

Tamblyn: There are other groups acting as subcommittees for the Standards Association as well as the Preservation Committee. Sometimes the recommendations of these groups conflict with the Preservation Committee's opinions. I wonder whether the Preservation Committee should be authorized to set Technical Standards.

Muncey: This conference cannot direct the Standards Association to do anything.

Boyd: The Standards Association of Australia would be only too happy to draw on the committee for advice and the committee should draw the attention of the Standards Association to their willingness to act in an advisory capacity.

Muncey: The committee should feel free to act as it sees fit and to coopt additional members as and when required.

Moss: Industry wants to cooperate in general terms and would be available for joint consultation at any time.

Brabin: I would like to query the stringent recommendations of the committee as regards containers. Quarantine has advised that neither boron nor BFCA treatment is good enough for container linings, as it claims that live borers have been reported in one lot from NG Freighters. ANL want to use keruing, and got temporary dispensation to use karri with Woodzone dip for 50 containers. Are the restrictions necessary?

Bryant: Are requirements the same in all ports overseas? What about the insects in imported timber, aren't these a bigger risk?

Cokley: The requirements concerning penetration show an ignorance of timber characteristics and are impractical. Most timbers, including Queensland and New South Wales rain forest timbers cannot be treated to these requirements without special selection of sapwood. This also applies to radiata pine. Quarantine should be approached to amend their requirements.

Beesley: Wood use is discouraged in the Quarantine publication. Restrictions are not universally applied but Quarantine can inspect any containers at any time. They will favour properly certified material.

The insects they are most concerned about are two not yet established in Australia, Cryptotermes brevis and Hylotrupes bajulus. Not enough is known about the resistance of Australian timbers to the former.

Not enough containers are in use yet to assess risk of undetected entry.

DFP should not petition Quarantine. Industry should apply pressure and Quarantine can then come to us for expert advice or industry should ask for a conference.

Jones: We are very disturbed by the paragraph discouraging use of wood linings or crates. We need to regain trade lost to cartons, and are now hit below the belt by a Government publication. The position is very serious, and I feel that DFP should list adverse items in booklet and make Quarantine listen to objections.

Parrott: Containers properly treated will obviously be favoured.

Huddleston: I doubt the importance of Cryptotermes. It is extensive in Northern Chile, but there is none south of Valparaiso which is the same latitude as Sydney. Cryptotermes is already in Queensland, therefore the quarantine precautions seem to be unnecessary.

Tamblyn: Sirex is still prohibited although it is now established here. The extent of danger is not important, and Quarantine do not try to judge the risk, nor can entomologists assess it. In containers, boron can't be guaranteed not to leach and arsenic applied by dip-diffusion is only in the first $\frac{1}{4}$ in. of treated timber. I cannot see how DFP can help but we will try if requested.

Muncey: I doubt the value of industry approach via DFP. Messrs. Tamblyn and Beesley are in an invidious position and their hands are tied. Pressure on Quarantine is needed from all sides, and it would probably be better for us to be in the position of being an expert witness.

Item 4(j) Report of fire retardant committee

Beesley introduced the report of the Committee by giving a brief resume of the Committee's history, since its formation at the 1963 Forest Products Research Conference. The Committee's mandate was to:

> Coordinate the recommendations of participating members for the treatment of timber with fire-retarding chemicals;
>
> Advise the Forestry Departments of New South Wales and Queensland on acceptable standards for fire-retardant treatments for timber, as required under State timber marketing legislation; and to
>
> Develop a test program for the fire rating of Australian timbers and built-up timber structures and for the evaluation of fire-retardant treatments.

The first task the Committee undertook was to determine the Early Fire Hazard Index (Australian Standard A.30-1958: Fire Tests on Building Materials and Structures; Part III) for a range of Australian timbers and to determine the effect of two commercial fire-retardant impregnation treatments on this Index. The results of these tests were released to the timber industry in January, 1969, in the form of a report - "The Early Burning Properties of Ten Australian Commercial Timbers", by J Beesley, J J Keough and A W Moulen.

At a special session of the 1967 Forest Products Research Conference (attended by representatives from the South Australian Public Buildings Department, the New South Wales Board of Fire Commissioners, the Perth Fire Brigades Board and the Victorian Department of Health) discussion ranged around the burning of treated building timbers and of similarly treated fence posts. As a result of these discussions and in order to avoid any confusion which might arise about the behaviour of preservative treated building timbers in a fire, the Committee arranged a series of tests to determine the effect of pressure impregnation with copper-chrome-arsenic preservatives on the early burning properties of Pinus radiata. Mr Keough was then asked to report on the results of these tests.

Keough explained that the burning tests performed at the Building Station had been made on P. radiata from various sources, hoop pine from Queensland and on some Eucalyptus obliqua obtained from Tasmania.

The Early Fire Hazard Index for untreated pine (determined on a composite sample from South Australia, New South Wales and New Zealand) was 68. Treatment with CCA preservatives, at either 0.35 lb/cu ft or 1.0 lb/cu ft reduced the Index to about 60 (within the range 63-58). With hoop pine, a slightly better result was obtained because the untreated timber had an Index of 68 but when impregnated with 0.35 lb/cu ft of CCA this fell to 55. Similarly, with E. obliqua preservative treatment improved the performance of the timber (untreated wood E F H Index 58, impregnated wood, E F H Index 48). With neither radiata pine, nor the hardwood was the E F H Index for wood machined after treatment any different from that of wood treated after machining.

Measurements were also made on the total weight losses as a result of both burning and "after-glow". The apparatus used was described and typical results quoted.

The Building Station had arranged for the tests to be made of the fumes from burning treated wood. In their report, the Division of Occupational Health, New South Wales Department of Health, stated

that even at a retention of 1.0 lb/cu ft the breathing zone sample was well below the maximum allowable concentration of arsenic in the air. In the smoke plume, the concentration reached the maximum allowable concentration, but: "Although arsenic is released in the plume of fixed CCA treated timber a hazard in fatal terms is unlikely from the arsenic".

Discussion

Muncey: Spread of flame in a normally furnished room is so influenced by the furnishings that the wall material has no effect.

Keough: There is no legislation to control linings in rooms which are generally decided on aesthetic aspects but limitations are imposed on escape corridors. Likewise, in ships above a certain size, linings for companionways are controlled in respect of combustibility and smoke generation.

Keough: There are no regulations in New South Wales to control thickness of timber except for structural purposes.

Tamblyn: You have referred to after glow at air velocities of 150 fpm. What about the 2000 to 3000 fpm values occurring on blowup days.

Keough: At these velocities weight losses of up to 100% can occur in a few minutes in both treated and untreated material.

Cokley: Are lending authorities likely to use afterglow as an objection?

Keough: I doubt it. At fires, firemen ensure nothing is left smouldering, as required by insurance companies. Afterglow is a serious hazard in bush fires; once the fire has passed, a house looks all right but then goes later.

Tamblyn: If a marked reduction in glowing and rate of burn can be obtained, then this would be a good selling point for treated wood in buildings.

Muncey: Work on fire retardants is very important to the timber industry and should be continued along general lines. Would Mr Keough comment on the cost and time involved in fire spread tests?

Keough: There is a fair amount of both involved. However, if of general interest to industry, then help can be given. If of interest to only a few commercial firms, then a charge would be made.

Cheal: Fire retardant treatments are particularly important in rural building schemes.

NOTE: The meeting decided that there would be no change in the constitution of the Committee, which would continue to report to the Conference.

Item 4(k) The desirability of investigation into waterborne preservatives other than copper-chrome-arsenic salts*

Commercial application of preservatives in the utilization of timber and timber products was initiated in 1939 with the use of water soluble salts such as boric acid for the treatment of veneers susceptible to Lyctus. The alternatives of sodium fluoride and sodium fluosilicate presented health and control problems and the former salt was not commercially applied until the late 1950's and then limited to veneer. In Queensland its use in this field has been replaced by dieldrin emulsions due to operational problems and by doubts as to its efficacy under tropical storage conditions.

Sawn timber followed a similar pattern and treatment began in 1946 with the immunization of Lyctus susceptible species using boric acid which was later replaced by the sodium salts. Again the emphasis was necessarily placed on preservatives used in building construction. Durable species were in sufficient supply for external and engineering uses.

From approximately 1950, consideration was given to the need for general purpose preservatives and for economic reasons these fell broadly into two groups:

(a) Creosote and creosote/oil mixtures, used in southern states for engineering and communication systems e.g. poles.

(b) Water-borne multi-salt formulation such as Tanalith for building construction; this type of salt was found to be ineffective.

This resulted in the introduction of copper-chrome-arsenic proprietary formulations based on the original "Ascu" and "Greensalt" preservatives and these became significant in the industry from approximately 1956-57 due to the rapid expansion of softwood usage and the sharp increase in demand for durable materials for poles, posts and external building material. Two important applications were for protection against soft rot organisms and for protection against marine organisms.

All formulations were based on hexavalent chromium, arsenic as pentoxide and copper either as the oxide or as the sulphate; they were aimed at maximum fixation by interaction with wood componenets. Current Australian usage would now be greatly in excess of 1000 tons/year. In Queensland major usage began in 1961-62 although field tests were initiated in 1954 and a Brisbane plymill treated veneer to 0.35 lbs/cu ft using Tanalith C.

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* Prepared by K V Cokley

Over subsequent years commercial formulae were modified and concurrently research organizations appeared to concentrate on these types of preservatives and their effectiveness in "Toxic Score".

Both in the laboratory and in service applications, it has developed that whilst these CCA salts are in general good preservatives, their local applications are different to overseas countries where they were first developed.

Major problems developed which have been such as to justify a review of the present policy in the use of these salts. These may be listed as follows:

(i) The effect of species upon component balance and fixation. - It is now clearly evident that many species show irregular penetration and component balance such that the "general purpose" and "fixed" nature of these salts is affected. Ionic mobility of components is markedly different in various species. Queensland, New South Wales, and tropical areas such as New Guinea are vitally affected by these aspects. However, there is also increasing evidence of non-balance of components in softwoods such as Pinus radiata.

(ii) The influence of extractives, water quality and temperature on solution stability. - These conditions are well known and will not be commented on further. They require constant solution control in States within which they may vary widely.

(iii) The problem of ignition and "after-glow". - From a commercial application, there are major disadvantages in the use of these salts and are of particular importance in southern states where softwood usage for fencing material, poles etc. provides a major market.

All research workers are aware of this problem which currently is being examined by the Fire Retardant Committee of this conference. The Division of Forest Products has patented an additive. Additives can be used to reduce this problem but service trials as to their long term effect and their effect on fixation are still in their early stage. Certain uses such as power poles require considerable study before such additives can be adopted commercially.

(iv) The tolerance of certain fungi and organisms and the effect of species. - Both in the laboratory and commercial service, it is becoming evident that there are a number of organisms and fungi tolerant to economically high levels of preservatives. This may be illustrated by the failure of a treated pole which contained in excess of 2 lb/cu ft of CCA, by the continued development of pre-treatment fungal attack and by the selective destruction by Teredo

of piles treated to 2 plus lb/cu ft although severe Limnoria attack in service has not yet been established. There are also very strong indications that present levels of CCA salts may be ineffective against bacterial attack.

Examination of the zone of deposition of salts in hardwood species shows that the greater bulk of preservative is deposited in the vessels and vessel walls but that the fibres, as such, are unprotected.

This type of deposition also results in ready leaching of salts injected into the timber and shows major differences to softwood species.

The effect of species characteristics upon effective loadings is now accepted although certain overseas workers on softwoods have dissimilar evidence.

(v) The effectiveness on manufacturing practices and markets. - This is of particular application in industries such as plywood manufacture where adhesives are used. At present the gluing of material at high level retentions of preservatives is subject to grave doubt. It is my opinion that gluing at and above 0.35 lbs/cu ft is commercially and technically unreliable. Again, plywood treated with CCA gives major problems in redrying and in discoloration. This is of importance in cabinet and fancy species.

(vi) Economics and material sources. - The components in CCA are high priced, particularly the copper and chromium salts. Cost of copper salts appears to be increasing rapidly. In the case of the arsenic component, it is evident that the purity is significant and supply appears to be limited to sources in Sweden. Australian arsenic is unsuitable unless specially pretreated or predissolved.

It is technically undesirable to allow an industry to be dependent to any great extent on materials imported and of limited source. After consideration of all factors, including those cited above, it is the considered opinion of this Department that major studies should be initiated into alternative preservatives. Salts which could be included are those such as zinc-meta-arsenite, and in particular it is pointed out that the Division of Forest Products developed in approximately 1930-35 a mixed zinc-arsenic preservative which gave excellent long term service results inclusive of North Queensland. Over the years, limited studies of this formula in our laboratory have given promising evidence of suitability.

In the formulation of such research however, I would strongly urge that commercial organizations with their excellent research facilities should be invited to participate. This could be coordinated

by the Preservation Committee operating on behalf of the Forest Products Conference.

As the preservation industry is treating for three distinct usages, viz. (a) internal protection of building timbers; (b) exterior building timbers; (c) engineering and power usage, it is considered that research should attempt to develop different preservatives for each purpose such that they are readily identifiable. Of these I believe that in the future waterborne preservatives will be limited to use (a) and (b) and that oilborne preservatives will be applied to use (c) purposes and for large cross-sectional building members such as plates where painting or other finishes do not apply.

I would emphasise that I do not suggest rejection of CCA preservatives. They are the best available commercially in Australia. However, I do recommend that their limitations be recognized and as such effective and economic alternatives require examination. As this requires a period of study before acceptance early initiation of such studies is desirable.

Discussion

Huddleston: Why can't you glue at loadings more than 0.35 lb/cu ft?

Cokley: You can in the laboratory but tests in six major Queensland ply mills, four with very good quality control, gave severe problems, e.g. surface deposits. Maple veneer retained 80% of the total chromium on the surface in 1/16 in. veneers and it is very costly to wash veneers. I believe other problems are due to hexavalent chromium reactions with resins.

Moss: CCA is satisfactory in North Queensland in most cases. Preservation development is much faster there and closer cooperation with the research bodies would be welcomed.

Bryant: What was the zinc-arsenic preservative?

Tamblyn: Zinc meta arsenite, developed in the 20s. The CCA's are much better. Recently ZnCrAs failed in New Guinea after 3½ years in the ground at 0.75 lb/cu ft and this was better than ZMA.

Bryant: At the last conference Mr Cokley stated that a fixed boron preservative had been made. What is the position?

Cokley: Pressure of other work prevented further development.

Plomley: Commercial gluing of CCA treated veneers is not as good as can be obtained in the laboratory. It is affected by treatment, gluing procedure and species. The limit for consistently satisfactory gluing appears to be about 0.5 lb/cu ft.

Johnstone: I agree with this.

Booth: I also agree. Radiata is very good but CCA is not good where hardwoods are to be glued.

Parrott: We are getting satisfactory gluing up to ground contact loadings in laminated beams. Incidentally, branding is better than a variety of loadings to prevent misuse of treated material.

Da Costa: The final form of the element in the preservative is most important in relation to its effectiveness.

Item 4(1) Treatment of poles and posts by sap replacement or sap displacement*

Boucherie treatment or sap displacement of softwood poles has been established for a long time and is successful when fixed CCA preservatives are used. The sap replacement method of treating fence posts has been widely used in Australia since its introduction by DWT and DFP.

More recently the Boucherie method has been proposed for the treatment of hardwood poles in Australia by a company which has made tests in New South Wales and Victoria with a variety of species, with the assistance of DWT and DFP.

With enough trouble and preservative, complete treatment of the sapwood from butt to groundline and beyond can be achieved in most cases. The self-sealing pressure cap we have devised eliminates most of the trouble experienced with earlier devices in making a quick and satisfactory seal.

The company concerned would like official approval so that they can offer treated poles to the electricity suppliers. Before this can be considered the following question must be resolved:

(i) What effect will splitting after treatment have on the life of the pole?

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* Prepared by F A Dale

(ii) Is specific gravity good enough to measure effluent concentration?

(iii) Can the effluent be used again with or without reconstitution?

(iv) How can quality of treatment at the stump be effectively policed?

(v) What effect will patchy treatment above groundline have on life?

(vi) What other factors affect treatment, e.g. species and time of felling?

The process is very attractive for remote areas e.g. in TPNG, but it cannot match pressure treatment in Australia for hardwood poles. It could be given conditional approval for Class 1 or 2 durability poles in country districts to enable use of smaller poles.

Sap replacement is a very simple and cheap do-it-yourself method of fence post treatment but from time to time we get samples of very poor treatment. In most cases it is obvious that one or more of the basic conditions have been ignored, but in a few instances there were no obvious causes of failure. We are considering further investigation of factors such as species, time of cutting and temperature but this may not be warranted if the present drastic restrictions on the sale and handling of small lots of CCA, in Victoria at least, are not relaxed. The method is basically sound and fills a small but very necessary place in timber preservation. Many users have got their first introduction to treated fence posts by using it. It is analagous to servicing your own motor car.

Is there sufficient demand for further work on this method?

Item 4(1) Treatment of poles and posts by sap replacement or sap displacement (New Zealand)

A study of preservative treatment of rimu poles by the suction sap displacement method was undertaken in 1963. The results have not yet been published.

A proprietary copper-chrome-arsenate preservative of the highly fixed type was used. Adequate sapwood penetration and net dry salt retention up to at least 4 ft from the butt were obtained. However, the ratio of the components of the preservative was altered

as it passed up the pole, the copper component being absent or present as a trace only, at the top. There were no major problems as far as the mechanics of the process were concerned.

It is considered that the results obtained would give adequate protection against high decay hazard in the groundline area. The most likely point of failure however, would be on the top of the pole, where the method of treatment did not allow any end penetration of the heartwood. The fact remains however, that in view of the very high standards set for commercial wood preservation in New Zealand, the results of this trial are not encouraging.

Discussion

Parrott: In 1963 some 5 ft posts were treated by suction sap replacement. Penetration of copper beyond 4 ft from the butt was not achieved and the method is regarded as unsatisfactory. Even when excess solution is sucked through, copper penetration is poor. Some poplar posts were treated in this manner but the heartwood showed decay at the top of the post after 4 years in service.

Johnstone: The Division of Wood Technology found good penetration and retention at the butt, but the method would not be suitable with fissile timbers as checking would expose untreated heartwood. An advantage of the method is that, if fixation can be delayed, diffusion would improve distribution. It is also a useful method for research purposes as it offers a means of separating ions and enables observation of fixation.

Huddleston: In New South Wales approval is given to a preservative treatment and is based on the loading and the penetration. Method is not specified so this method can be used.

Cokley: The method is discouraged now in Queensland, treatment by conventional systems is recommended.

Item 4(m) Arsenical creosote

The manufacture of arsenical creosote (AC) and the intended use of it in preservation of poles has been reported by us at the last Forest Products Conference. Further tests in cooperation with the Division of Entomology, CSIRO, have established the effectiveness of AC against a variety of economically important termites, Nasutitermes exitiosus, Coptotermes lacteus and C. acinaciformis. In laboratory

tests, AC drastically increased the mortality of the test termites, whereas termites exposed to controls treated with straight vertical retort creosote had a mortality rate similar to those exposed to the untreated wood. It appears that creosote is not very toxic to termites but rather it is at least unpalatable.

We carried out a detailed study of the water soluble and insoluble fractions in arsenical creosote. When AC is introduced into wood it undergoes fixation, and resistance to leaching is greatly increased. In practice, we expect this property to contribute to the permanence and lasting effect of the arsenic in AC treated poles. The fixation can be almost doubled by holding the treated timber at an elevated temperature, as was found in tests with radiata pine.

Arsenical creosote has been extensively tested in commercial pressure impregnation plants in Victoria. During six months use it proved satisfactory in all respects in the treatment of eucalypt poles and other timbers. The penetration, cleanliness and plant behaviour were similar to those experienced with non-arsenical creosote.

The advent of natural gas will result in the phasing out of vertical retort creosote, which hitherto was the main oil preservative available in Australia. We have carried out tests to determine the applicability of high temperature coke oven creosote which is now available in Australia. High temperature creosote has sufficient capacity to react with As_2O_3 to produce AC with adequate arsenic concentration for the treatment of poles.

For some purposes high loadings of arsenic in oil preservatives could be useful and having this possibility in mind an effort was made to isolate from creosote compounds which react with As_2O_3. In this direction some progress has been made.

Discussion

Cheal: What is the cost?

Tamblyn: About 1/2¢/gallon for 0.4% chemical. Koppers would not charge much extra for incorporation.

Moss: The 1/2¢ in one million gallons used by Hicksons is not insignificant. However, it looks like a breakthrough. Treaters are concerned at the implication that creosote alone is not good enough.

Huddleston: Why not advertise added protection and charge for it.

Foxton: Koppers have underestimated the difficulties. Arsenic is a cumulative poison and 5 to 6¢/gallon would be a more realistic figure as chemical companies are very safety conscious. The benefits are only indicative as there are no long term test results. Organo-arsenic could be added for specific purposes. Treaters would not hold 10,000 gallons for a single purpose.

Tamblyn: The health hazard is exaggerated. Five thousand tons of arsenic is used in wood preservatives throughout the world each year without any ill effects. Koppers say there is no danger in adding arsenic to creosote. Marine creosote could be fortified with organo-arsenic concentrates. In Victorian plant tests the operators added the arsenic and there was no extra cost.

Cokley: Two plant operators have been affected in Queensland, one by Celcure and one by Tanalith.

Item 4(n): Treatments for marine piling (DFP)*

Marine tests of pressure treated timber in four Australian ports - Port Hedland and Kwinana scores after $9\frac{1}{2}$ years

Preservative	Nominal Retention	Pinus radiata		Roun eucalypt	
		Port Hedland	Kwinana*	Port Hedland	Kwinana
Creosote oil	10 lb	40	0	23	67
Heavy creosote	10	33	9	78	78
Creosote oil	20	67	25	23	89
Heavy creosote	20	87	75	78	100
Creosote/tar	20	33	0	78	89
Boliden S25	1.5	67	75	0	44
Celcure old	1.5	93	100	0	56
Celcure A	1.5	93	93	0	22
Tanalith C	1.5	93	100	0	78
Boliden K33	1.5	80	100	0	67

	Turpentine	Jarrah
Port Hedland	50	21
Kwinana	71	19

* Kwinana: One complete frame not recovered for 1969 inspection

* Prepared by J Beesley

SCORING SYSTEM: Figures represent "percentage of soundness" (i.e. 100 signifies no deterioration). Categories recognized are "sound", light attack, heavy attack, destroyed.

Item 4(n) The service life of marine piling in tropical waters in Queensland and alternative methods for protection of piling*

Prior to the initiation of commercial treatments using CCA salts by Queensland firms the utilization of timbers for marine piling was based on:

(a) Utilization of resistant species such as turpentine, and removal of sapwood.

(b) Employment of mechanical barriers such as metal sheaths, concrete pipes filled with sand and driven to protect from high tide level to mud line.

(c) To a limited extent only, the floating collar developed by Johnston of Maritime Services, Sydney.

Preservative treatment was limited to surface coatings of K55 creosote and for marine craft to copper naphthenate. Major or permanent construction was usually based on concrete.

Timber piling was limited to small structures, maintenance of wooden units and to fender piles, whose service life may vary from less than 1 year to 15-20 years. Other than limited research by centres such as the Australian Museum and Melbourne University, the mechanisms by which marine organisms attacked timbers and the causes of varying resistance of species was neglected; similarly the effects of harbour conditions upon the severity of attack by marine organisms do not appear to have been studied; these effects include the presence in industrial areas of organic insecticides such as dieldrin or oil pollution. The systematic studies of Watson, Johnston and Iredale appear to be equal to any such studies made overseas with the exception of specialized laboratories such as the Marine Biology Laboratory, US Department of the Navy.

Based on the available evidence it was generally accepted that copper containing preservatives would give protection against both Teredo and Limnoria. Watson however, had found that K55 creosote was ineffective against the latter.

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* Prepared by K V Cokley

In approximately 1964, harbour authorities began major usage of CCA treated hardwood piling timbers. To date in Queensland approximately 4,500 such piles and jetty timbers have been used; I would estimate at least a similar number of pieces have been used for purposes such as oyster stakes. This trend was accentuated by the development of the tourist industry in North Queensland and the heavy demand for island jetties and boat harbours, located from the border to North Queensland reef resorts.

In January, 1969, reports were received of failure of a group of CCA treated mooring piles in a boat harbour at Bowen, North Queensland. Initial reports indicated that seven from a total of 50 were affected. Subsequent inspections by boat and diving parties showed that with few exceptions 47 piles, including a number of untreated turpentine were in such poor condition as to justify urgent replacement; treated piles were primarily spotted gum and ironbark.

They had been treated by a Rockhampton plant over the period January-March 1966. Moisture content at treatment was over the range of 17-30% and treatment was to a nominal retention of 2 lb/cu ft. Delivery and driving was over the period February- April 1966. It is significant that May-June 1966 was a period of high rainfall. To date one pile only has been fully examined. This was sampled at intervals from mudline to the top. Three interesting aspects emerged:

(i) Attack was by teredines as shown in the attached appendix. No Limnoria attack was evident in this pile.

(ii) Chemically there was significant depletion of salt components below the tidal zone such that residual effective salt was concentrated in the outer 1/16" of sapwood only. Copper was most affected.

(iii) Analysis was necessary of all components and of the gradient through the sapwood.

There were major changes in component ratio. In addition it was found the most severe damage was at mudline where complete destruction of the section occurred. The relative concentrations and distribution of preservatives is shown in Table 1.

Subsequently, analyses were made of sections cut from above the tidal zone from all treated piles. These showed a mean salt retention of 1.8 ± 0.57 lb/cu ft i.e. within normal distribution. Gradients and salt balance were satisfactory.

At present the tentative conclusion has been reached that the rapid attack was due to salt depletion due to installation prior to complete fixation. Other studies have shown that a fixation time

of approximately 6 weeks is necessary for hardwood species.

Significantly in the areas of low concentration it was found that depletion was of the salt contained in the vessel cavities, but that salt was still present in the vessel walls. In many cases, it was noted that initial entry of the organism was through fibres i.e. between vessels.

As a result of subsequent studies, the following may be stated:

(i) CCA treated hardwood in Moreton Bay showed moderate attack to half of the treated depth. No depletion of salt appears to have occurred, other than of copper sulphate. Analyses are continuing.

(ii) Severe attack by Nausitoria of a treated fender pile at Darra had occurred. Of interest is the fact that the severe attack appears to be on one side only with attack in the heartwood, some of which does not appear related to the infested sapwood.

(iii) Studies of piles from other Queensland areas show light attack in some treated piles but, in all cases, salt concentration appears satisfactory.

(iv) Of interest is the recent examination of a treated turpentine round sample exposed in Bowen where only very slight attack occurred over 4 years. Limnoria (also in heartwood) and Sphaeroma were present.

(v) Inspections have been carried out in a number of ports, particularly Brisbane, Maryborough, Dunk Island, Townsville, Bundaberg, but with isolated exceptions no severe attack has been found. Surface CCA treated sawn hardwood has been completely destroyed. Examination is proposed of all piles in Queensland.

It appears that Crustacean attack has been insignificant to date. Bankia is present in two structures in the Brisbane River. A review of overseas work and consideration of the relationship of attack and salt retention leads to the following tentative conclusions:

(a) The effectiveness of CCA salts in tropical waters against Teredines with economic levels is in doubt. Leaching by salt water appears to be a factor.

(b) Creosote is relatively ineffective on past data against Limnoria.

(c) In consequence, on present knowledge, for effective general protection commercial treatment should be based on a double treatment; I believe this will materially assist in fixation. In view of the lower fixation in hardwood species and the need for protection in depth, softwood species are preferred; this of course implies scarfed sections for long piles.

(d) It is increasingly obvious that studies are necessary to determine the mechanism of attack. At present I consider the overseas evidence in relation to fungal and bacterial action by Limnoria and Teredo respectively could explain the relative effectiveness of the preservatives. Steps are in hand with local preservative firms and the Department of Harbours and Marine to initiate such studies; action is in hand with the Queensland University to assist.

(e) At present this Department does not feel justified in retaining general approvals for marine purposes under the Timber Users' Protection Act. A minimum test program of 6 years will be necessary before definite conclusions can be drawn. In the interim, recommendations have been made on the basis of a minimum of 1.5 lb/cu ft at a minimum depth of 1.5 in. in softwoods. We feel that serious consideration should be given to suspension of the current draft SAA documents on wooden piles until these aspects are resolved.

Alternative methods of protection

Preliminary studies are in progress on the use of protective sheathing such as fibre glass wrapping, and a re-examination of the economics of concrete collars is proposed. Trials of CCA and double treatments PCP/oil are proposed. Major studies are planned on the effect of salt water on leaching of CCA and on the use of other preservatives, principally copper naphthenate. It is also desirable to study the effect of high temperature creosote and the use of wide sapwood rain forest species.

TABLE I Chemical analysis of CCA treated pile - Bowen Harbour

Sample Position	Pole Position	Analysis % w/w			Total salts % w/w	% components			lbs cu ft
		Hex* Chromium	$CuSO_4$	As_2O_5		Hex Chromium	$CuSO_4$	As_2O_5	
Outer 1/16"	4'	1.85	0.48	0.45	2.78	66.55	17.27	16.18	1.75
x section (a)		1.28	0.69	0.58	2.55	50.20	27.06	22.74	1.61
inner core		1.22	0.80	0.63	2.65	46.04	30.19	23.77	1.67
Outer 1/16"	20'	1.20	0.89	0.23	2.32	51.72	38.36	9.92	1.46
x section		1.02	0.58	0.55	2.15	47.44	26.98	25.58	1.35
inner core		0.70	0.17	0.36	1.23	56.91	13.82	29.27	0.77
Outer 1/16"	26'	1.56	0.96	0.20	2.72	57.35	35.29	7.36	1.71
x section		1.18	0.42	0.43	2.03	58.13	20.69	21.18	1.28
inner core		1.10	0.35	0.20	1.65	66.67	21.21	12.12	1.04
Outer 1/16"	28'	1.23	1.00	0.41	2.64	46.59	37.88	15.53	1.66
x section		1.13	0.42	0.48	2.03	55.67	20.69	23.64	1.28
inner core		1.11	0.25	0.03	1.39	79.86	17.97	1.14	0.88
Outer 1/16"	Toe	1.36	0.77	0.09	2.22	61.26	34.68	4.06	1.40
		1.29	0.86	0.38	2.53	50.99	33.99	15.02	1.59
		0.42	0.09	0.03	0.54	77.78	16.67	5.55	0.34

(a) Diagonal x section 0.69 $CuSO_4$ % w/w
0.73 " "
0.73
0.77

(b) Nominal $CuSO_4$ 21.5-24%
$Na_2Cr_2O_7$ 37.6-41.8%
As_2O_5 30.7-34.2%

*Total chromium recorded as $K_2Cr_2O_7$

TABLE II Ratio of inner core to outer 1/16"

Chemical compound	Pile position				
	4 feet	20 feet	26 feet	28 feet	Toe
$CuSO_4$	1.67	0.19	0.36	0.25	0.12
As_2O_5	1.40	1.57	1.00	0.07	0.33
Hex chromium*	0.66	0.58	0.71	0.90	0.31
lb/cu ft	0.95	0.53	0.61	0.53	0.24

* Total chromium recorded as $K_2Cr_2O_7$

TABLE III Chemical analysis of CCA treated piles - Mud Island

Species and laboratory no.	Pile sample position	Analysis % w/w			Total salts	% components			lb/ cu ft
		Hex* chromium	$CuSO_4$	As_2O_5		Hex chromium	$CuSO_4$	As_2O_5	
Ironbark 1834, 1835, 1836, 1838	Inner core	1.52	0.11	0.64	2.27	66.96	4.85	28.19	1.57
	Outer 1/16"	1.89	1.18	0.76	3.83	49.35	30.81	19.84	2.64
	x section	1.64	0.74	0.68	3.06	53.59	24.18	22.23	2.11
Spotted gum 1839, 1840, 1841, 1842	Inner core	0.44	0.05	0.37	0.86	51.16	5.81	43.03	0.54
	Outer 1/16"	2.01	1.09	0.51	3.61	55.68	30.19	14.13	2.27
	x section	1.13	0.61	0.41	2.15	52.56	28.37	19.07	1.35

* Total chromium recorded as $K_2Cr_2O_7$

x Diagonal cross section

APPENDIX I – Marine organisms found in CCA treated marine piling
(Identifications by W J Smith)

A – Bowen pile

CCA treated spotted gum (Eucalyptus maculata)
(1) Dicyathifer caroli – predominant
(2) Bankia sp. (B. grenningi?)
(3) Teredo tristi
(4) possibly Bactronophorus subaustralis (on basis of only one incomplete extremity seen)
(5) Martesia striata
No evidence of Limnoria or Sphaeroma attack was noted.

B – Mud Island piles

(i) CCA treated spotted gum and grey ironbark (Eucalyptus drepanophylla):–
(1) Teredo tristi
(2) Teredo poculifer
(3) Bankia grenningi
No crustacean attack observed

(ii) An adjacent untreated turpentine pile was attacked by Sphaeroma terebrans. No attack by Teredinidae seen.

C – Maryborough wharf

(i) CCA treated spotted gum piling –
A Teredinid borer, probably Nausitora queenslandica from the location

(ii) Superficially CCA treated grey ironbark sawn waling – destroyed by Nausitora queenslandica

(iii) CCA treated satinay and grey ironbark piling – unattacked

(iv) Untreated turpentine (Syncarpia glomulifera) and satinay (S. hillii) piling – some unattacked, some attacked to a variable degree by a Teredinid borer, probably Nausitora queenslandica.

D – Brampton Island

CCA treated spotted gum piling attacked by Teredinidae, including T. tristi.

E - Bowen experimental sample

CCA treated turpentine, 6 ft long round section -
(1) Top - Sphaeroma terebrans to ¼" deep on perimeter
(2) Mid-length - Limnoria lignorum (fairly heavy) and Dicyathifer caroli (light), both initiated from internal heart shakes
(3) Bottom - Limnoria lignorum (heavy surface attack); Sphaeroma terebrans (ready attack to ¼" deep) Teredinidae, including Dicyathifer caroli (light) Attack from end grain, in end splits and internal heart shakes.

F - Bundaberg

CCA treated spotted gum piling -
(1) Martesia striata to ⅜" deep
(2) Bankia grenningi
(3) Teredo sp., probably T. tristi
Very light attack just commenced.

Discussion

Parrott: We have had no recorded failures in CCA treated Pinus radiata piles in tropical waters. In a leaching experiment, sticks 8 in. long by 2 in. x 2 in. with sealed end grain were exposed for 3 years and compared with matched laboratory specimens. Mobility of copper salts was noted.

A pile removed after 3 years' service in Auckland, although not attacked, showed severe loss of copper, and copper mobility to the outside of the pile. It is proposed to repeat the leaching experiment with 2 in. blocks over 12 months to measure the redistribution of copper to the outside and to measure loss.

Howard: What will Queensland University be asked to do?

Cokley: Define the problem, find the mechanics of attack, whether it has a fungal or bacterial precursor and approach the problem from the biological as well as the chemical aspect.

Tamblyn: The use of CCA treatment for eucalypt marine piling north of Sydney is not recommended. Double treatment with creosote and CCA is satisfactory and would probably become available if it is specified. It is important to note that copper determinations must be associated with the form present, e.g. copper oxalate is not toxic.

Huddleston: The work of the Standards Pile Committee has been held up by lack of agreement between members. There is a proposal to disallow CCA treated piles north of Sydney. Another difficulty is that of getting proper identification of marine organisms. The market was partly lost to timber in Sydney due to a change in wharf design, but large numbers of wooden piles are still needed for mooring piles and fenders.

Riley: The decision to put in CCA treated piles in Queensland was made by the Department of Harbours and Marine, not by the Forestry Department.

Item 4(o) New oil-borne preservatives*

In the past few years, there has been a wide use of oil-borne preservatives in Australia for the dip or brush treatment of external joinery and other timbers in buildings and also in boats. Most of these have contained pentachlorphenol (PCP) in combination with water repellent waxes and resins, and occasionally with stains or pigments. Pentachlorphenol has the advantage of being highly toxic to almost all fungi and reasonably permanent, but it is very unpleasant to handle and may be dangerous to health. It can be objectionable in formulating factories, in factory dipping of joinery, or in brush application on site. If used for food containers, it may cause tainting or discolouration. Also it is not highly effective against termites or borers, and there is some doubt as to its permanence in some formulations and applications.

Although pentachlorphenol is doing a good job and is acceptable to most users, we feel that possible substitutes should be evaluated. One such substitute is tributyltin oxide (TBTO) which is being used increasingly. We are often asked our opinion on this. It is more fungitoxic than PCP, but opinions differ widely as to just how much more. Some users claim TBTO is 10 times as toxic as PCP but laboratory experiments at this Division suggest that a figure of 4 or 5 times would be more realistic, i.e. it would take at least 1% of TBTO to give the same protection as 5% PCP. There is some doubt as to the permanence of TBTO, which has not had any long use in service and, like PCP, its effectiveness against insects is not outstanding.

It is debatable whether more than a very small proportion of these preservatives is used in applications where protection from insect attack is important. Where it is important, the use of an organic arsenical may be preferable to the present system of combining a fungicide with some chlorinated hydrocarbon such as chlordane. A

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* Prepared by E W da Costa

number of oil soluble arsenic compounds are available and the Division has recently applied for a patent on some novel types, analagous to those formed in arsenical creosote. All such compounds are highly effective against insects and many may be highly fungicidal as well.

There are a number of other possible substitutes and it may be well worth testing preservatives used in other fields such as textile preservatives, agricultural chemicals and slime preservatives. To be acceptable, the preservative must be colourless, durable, compatible with paints and resins, present no health hazard in handling, and be reasonably cheap. Because of its colourless nature, zinc naphthenate is being used in some preparations. It is not as fungitoxic as PCP or TBTO, but may be adequately so for most applications.

Item 4(p) Toxic levels of insecticides to Lyctus (DFP)*

Laboratory compulsion tests to determine the toxicity of arsenic (As_2O_5), sodium fluoride and borofluoride against Lyctus have been or are about to be completed. Below is a summary of the present position with regard to these tests:

(1) Arsenic (As_2O_5)

Three lyctids, L. brunneus, L. discedens and Minthea rugicollis were used in laboratory tests to determine the toxicity threshold for arsenic pentoxide in three susceptible timber species, namely flame tree (Brachyton acerifolium), white birch (Schizomeria ovata) and spotted gum (Eucalyptus maculata) of densities 34, 40 and 62 lb/cu ft respectively. The tests also included matched material treated with two copper-chrome-arsenic formulations of differing arsenical content.

Results showed that the toxic threshold when expressed as percentage As_2O_5 (oven dry wood basis) was not appreciably affected by the timber species, the wood density, the test insect or the form in which the arsenic was introduced into the wood. All untreated specimens were heavily attacked but matched material containing 0.01% As_2O_5 showed only minimal larval activity. With the copper-chrome-arsenic preservatives similar results were obtained at equivalent arsenic retentions, indicating that the toxicity of these preservatives to Lyctidae is unaffected by the presence of the other components. Taking into account, commercial methods of timber impregnation, variation of pick up within and between charges, allowance for such possibilities as unusual susceptibility in a particular piece of wood and the need for sufficient arsenic for positive analytical control, a safe core retention of 0.03% As_2O_5 wt/wt (oven dry wood basis) is suggested as

* Prepared by A Rosel

most likely to meet the practical requirements of the industry and is recommended for general adoption. As a guide the equivalent retention for the copper-chrome-arsenic preservative Tanalith C would be 0.17% equivalent to dry salt loadings ranging from about 0.05 to 0.10 lb/cu ft for densities ranging from about 30 to 60 lb/cu ft.

(2) Sodium fluoride

Redetermination of the toxicity threshold for sodium fluoride was considered necessary following some evidence that the original tests with Lyctus brunneus made many years ago may not apply accurately to other species of Lyctidae. In this test the same three test insects and timber species which were in the arsenic test have been used. In the case of flame tree and white birch significant larval activity has been noted at the 0.1% sodium fluoride level, calculated on solution absorption, and in one specimen there has been beetle emergence. White birch treated specimens have also shown significant larval activity at the 0.14% sodium fluoride level. Chemical analyses are at present being made to check the accuracy of these retentions and it is anticipated that results will be available for the Conference. Beetle emergence has occurred in all three timbers at 0.06% sodium fluoride which was the next lower concentration tested. Generally, these results apply to the three test insects. It is emphasized that the sodium fluoride retentions permitting adult emergence and significant larval activity are subject to analytical check. However, as these calculated retentions are so close to the present accepted commercial loading of 0.1% sodium fluoride it would appear that some alteration to this loading may be required.

(3) Borofluoride

The test of borofluoride under the same conditions as those for arsenic and sodium fluoride, has not reached the stage where any practical assessment of the results can be given.

The attention of the Conference is drawn to the considerable evidence amassed by G Becker and W Berghoff - The Hydrogen Fluoride Evaporation of Inorganic Fluorine Compounds from Wood, Holz als Roh- und Werkstoff Bd. 21 (1963) s.346-362.

Becker reports that HF evaporation from treated wood starts immediately after treatment and that as much as 15-25% of the fluorine content may be evaporated within 2 hr.

The evaporation is affected by factors such as time, salt concentration, air humidity, air capacity, possibility of adsorption, temperature, air flow, properties of the wood and alkalinity and the distribution of the salt within the wood.

Another factor to keep in mind is the demand of glass for fluorine. This may cause depletion of the fluoride content during chemical analysis.

Summing up 0.03% As_2O_5 is a safe loading against Lyctus

0.1% NaF (previously stated to be sufficient - based on work done by Cummins more than 30 years ago) is apparently insufficient probably because of its volatilization. Certainly the analyses so far done indicate that there is a major discrepancy between what we calculate went into the wood and what we have found.

It appears that - (1) We should put NaF up to 0.2%

(2) We should investigate whether this loading depletes sufficiently with time to eventually lead to attack.

Item 4(p) Toxic levels of insecticides to Lyctus

Toxicity of sodium fluoride to Lyctidae

Insect and tree species	Highest concentration of NaF (% OD wood basis) showing	
	Emergence	Slight* larval activity
Lyctus brunneus		
Flame tree	0.026	0.095
Spotted gum	0.029	0.057
White birch	0.099	0.144
Lyctus discedens		
Flame tree	0.056	Larval activity less than ½ cm - 0.095
Spotted gum	0.057	" " " " " " - 0.095
White birch	0.060	0.144
Minthea rugicollis		
Flame tree	0.056	0.095
Spotted gum	0.057	0.056
White birch	0.060	0.146

* Larval channels noted greater than ½ cm in length

Discussion

Bryant: In the light of information on the volatility of sodium fluoride, it is hard to understand why this has not led to trouble up to now.

Cokley: Tests show Lyctus brunneus emergence at 0.1% in some instances - possibly species density or nutrient concentration is a factor. Results in the table presented indicate that the minimum should probably be raised to 0.2%.

Tamblyn: I agree that the fluoride level should probably be raised.

Kierle: What are the possible effects of age of insect strains on the Division of Forest Products tests?

Tamblyn: No difference has been found in the activity of long inbred strains of L. brunneus compared with new strains. Strains of L. discedens and Minthea rugicollis are relatively new.

Item 4(q) Pretreatment factors influencing treatability and performance of timbers

Now that the vacuum pressure treatment has been established for some time, we find it more and more necessary to consider factors in the history of the wood between felling and treatment which may influence the treatability or even the performance in service of the timber. This covers a wide range of possibilities and I intend to touch only on some which we are, or will be, investigating, and even in this field to ignore the usual topics of drying methods, which may be dealt with elsewhere.

Firstly, we need to know more about the occurrance of incipient fungal and bacterial attack in round timbers during seasoning. These may cause significant loss of strength, but more important is its effect on preservative uptake. It may enormously increase uptake of preservative and if present in only a few posts or poles in a charge may greatly increase charge scatter and lead to quite erroneous opinions as to the median or minimum retentions in a charge. With creosote, it may lead to localised overtreatment and bleeding, and with both creosote and, especially, CCA could possibly have an effect on the subsequent leaching and protective effect of the preservative. We need to know more about the distribution of such microbial attack both among and within poles, e.g. is it more likely to occur on top poles or where poles cross in a stack?

The increased permeability caused by microbial attack is detrimental in easily treated species such as Pinus radiata but could be turned to advantage with refractory timbers. "Ponding" of poles to improve treatability works well overseas and Dr. Greaves' laboratory tests here show some improvement in both pine heartwood and eucalypt sapwood. For many eucalypts, a relatively small increase in permeability could make a big improvement in retention and distribution of creosote in the sapwood. It may not be necessary to "pond" the poles. Heavy inoculation with suitable organisms after barking, perhaps coupled with a slight delay in initial stages of drying (? by spraying) may be all that is required. "Biological incising" may help with moderately refractory timbers such as pine heartwood and Callitris sapwood, and might even have some effect on eucalypt heartwoods, e.g. in "case" treatment of sleepers, where some loss of strength in outer layers would be of little detriment.

Another point on which more information is required is on localised "wet spots" in timber, especially in Pinus radiata. Some of these seem to be present in the tree. They may be associated with bacterial infection (as is some "wetwood" in US hardwoods) but we have been unable to find clear evidence of this. We have seen cases of untreated sectors in P. radiata fence posts due apparently to slow drying of the points where the posts were in contact in the drying stack. This needs investigating.

Discussion

Keirle: The microbial attack is seen at the bottom of a stack rather than at the top.

Moss: How could one detect microbiological attack in advance of drying? Is there an optimum moisture content during drying at which infection takes place?

Da Costa: The optimum moisture content is between fibre saturation point and almost fully saturated, say 40-100%. Attack may be detected macroscopically by change of colour, surface softening or the appearance of fungi on the surface.

Tamblyn: We are trying the effect on penetration of steaming shortly after cutting. Some tyloses form in the sapwood during drying and it is thought that by steaming the wood we may prevent this by killing the cells before the tyloses can be formed.

Moss: Boultonizing shows the way in this type of approach.

Christensen: Decay in poles increases retention. There is a possibility of poor retentions being obtained at the bearer positions of air dried poles due to high residual moisture contents at these positions.

Cokley: I favour the hot treatments because of the sterilizing effect. Insects can emerge from CCA treated poles.

Christensen: In boultonizing it takes 18 hr to reach a temperature of 150° in the centre of a 12–14 in. diameter pole.

Item 4(r) Cryptotermes brevis (Walk): Survey work in Maryborough*

The first known active infestation of the exotic termite species, Cryptotermes brevis (Walk), in Queensland, was discovered in Maryborough, Queensland in 1966. Gay (1967) refers to the only other recorded infestation in Australia. This infestation was apparently confined to one chair imported from New Caledonia.

History of infestation in Maryborough

The West Indian drywood termite C. brevis was identified by Division of Entomology, CSIRO, in April 1966, from specimens forwarded to them by a Maryborough householder some time previously. In May, 1966 further specimens were collected from the same site and identified by Forestry and Primary Industries entomologists, confirming the continued activity of the infestation.

Subsequently, in November 1966, a survey was undertaken on an area of approximately 1/10 sq mile surrounding the site of this finding. From the 237 premises examined, 7 infestations of C. brevis were identified. These and two other infestations suspected to be C. brevis, but unconfirmed due to the absence of soldier caste specimens, were fumigated with methyl bromide at 1 lb per 1,000 cu ft in April 1968.

Survey and eradication work was carried out under the provisions of the Diseases in Plants Act, Queensland. It was first necessary to proclaim C. brevis a noxious disease under this Act.

During this period efforts were made to trace the origin of the infestation. These proved unsuccessful. It was not even possible to determine with any certainty which house of any of the three groups of infestations might have been infested first. No attampt has been made to estimate the age of infestations although

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* Prepared by N Heather

the worst would have been established for many years before 1964, when the first enquiry to CSIRO is believed to have been made.

Since Maryborough is a small port and also a refit base for island trading vessels entry could have been direct although there is an equal likelihood that it occurred through another port.

With the completion of fumigation of infested houses in the first area, survey work was commenced on a surrounding area. This survey, when complete, will extend the total coverage to approximately 1 square mile. One boundary of this new area is the Mary River which, with wide banks free of buildings, creates a barrier to natural dispersal over one mile wide in parts.

Observations over the period of the survey indicate that C. brevis is much more destructive than the common native species C. primus. Not only is damage more extensive but it is restricted to interior parts of buildings where costs of repair are much higher.

All infestations have occurred in hoop pine or kauri timber. Because of the high proportion of these timbers in the homes in the area this cannot be taken as an indication of any inherent immunity in other timbers.

It is anticipated that an account of some aspects of the survey work will be published.

Discussion

Huddleston: What type of damage occurs?

Riley: The attack is internal and occurred in painted wall sheeting where they could enter because of poor constructional practices.

Smith: The mode of infestation is similar to that with C. primus. Initial infestation occurs possibly some years before being detected. Droppings are not generally noticed in dwellings where normal cleaning would prevent any accumulation.

ITEM 5 UTILIZATION

Item 5(a) Research Review (DFP)

Species assessment

In 1961 a systematic study of the properties of the principal timbers of Fiji was commenced in cooperation with the Fijian Department

of Forestry. During this study, which has now been completed, 38 timbers were intensively tested.

In 1965 the Division undertook a study of the more important Solomon Islands timbers in a similar way to the Fijian study.

Thirty-four species were included in the program; eighteen of these being regarded as major species requiring the testing of at least five randomly selected trees. The minor species were, in general, tested in the same way, but only three trees per species were tested. Much of the testing is now completed and it is expected that results will be published this year. The plywood manufacturing trials were regarded as particularly important and all timbers below approximately 45 lb/cu ft were peeled and tested.

Sawmilling and timber production

Work on the development of reliable methods for determining the production capacity of sawmilling and other conversion equipment and of relating this to production requirements is continuing. To date over 120 machines have been studied and some results published. A machine performance criterion, based on the average sawn area generated per unit time has been adopted, and a relationship established between the sawn area required to be developed per unit volume of log input and the average size of product intended.

Log grading

Log grading work is being intensified and will be dealt with more fully under Item 5(d).

Finger jointing

Our finger jointing program is at present concentrated on the evaluation of different techniques used in the production of waterproof joints. In the near future the Division is to install a Windsor finger jointing machine which will be used both for process development and also investigations on the production of finger jointed building components.

Sawing research

After a lapse, it is now proposed to take up sawing research on new lines.

(a) Tooth action. - By means of slow cutting experiments it is hoped to determine the forces on swage and off-set teeth, the cause of blunting (especially the importance of the outside corner of the tooth) and the initial form of the chip.

(b) Factors affecting sawing accuracy and surface finish. - For this work circular saws up to 48 in. diameter will be used, but the results should also have some relevance to band sawing. The basic thoughts are that circular sawing machines, being less expensive should be developed as far as possible for accurate sawing in deep cuts. It has become evident that a saw should not only rotate truly when turned slowly, but must be vibrationally stable when running and sawing. The latter depends (1) on the internal vibrational characteristics of the blade as affected by preparation, (2) on external restraints and (3) on sawing effects such as tooth loading, and heating.

Apparatus is being developed to study static and running behaviour of saws in the field and already this has indicated some errors that occur in flattening, tensioning and deciding the running speed. It is proposed to make an Australia-wide sampling of saw behaviour.

Saw preparation is to be investigated in an attempt to develop reliable tests for blades, and hence reliable preparation procedures. Rolling and heat tensioning methods are to be investigated. An experimental saw bench is to be installed for laboratory study of saw behaviour.

(c) Band saws. - It is evident that most people who have installed band saws in Australia have had a rather prolonged period of settling down. This has been due mostly to lack of trained or experienced saw doctors and engineers. However, it is felt that this period would be shortened if a comprehensive, systematic body of information - a trouble shooting manual - could be developed. It is therefore proposed to make a survey of band saw operations, and codify problems and cures. It is also intended to study their accuracy of cutting for comparison with that of refined circular sawing.

Industry service

At the request of industry, studies of the timber production problems endemic to various regions are being conducted. A follow-up investigation has recently been carried out in Western Australia and a study of the Fijian industry is to be commenced within the next few weeks.

Assistance with design work and/or the solving of operation and production problems for individual firms is continuing, and during the past 12 months some 30 companies have been assisted in this way.

Close liaison is maintained with machinery manufacturers and assistance given with the design and development of new equipment.

In the important field of information dissemination, we have conducted a number of 15-day courses for sawmill managers and executives on the latest developments in this field. Over 100 people have already attended and a new 10-day course is scheduled to be held in Western Australia next October.

Item 5(a) Research review (NSW)*

The major part of the Utilization Section's time is devoted to the technical problems of timber processors and users. Because of staff shortages it has not been possible to do much research. However, some aspects of our work may be of interest.

Low profile flooring. - Because of the increasing competition for the normal suspended timber floor from concrete slabs an attempt has been made to achieve the close-to-ground appearance possible with the slab while still retaining a timber bearer and joist system. Some years ago the National Lumber Manufacturers Association in the USA sponsored an investigation along these lines but they recommended the use of the method only in conjunction with forced air ventilation of the cavity and did not proceed further with the work.

The under-floor space within the peripheral walls is levelled to a comparatively smooth surface to help in preventing the puncturing of the waterproof membrane which is laid over the soil, previously proofed against termite attack by spraying with dieldrin. The bearers are then supported on bricks or concrete blocks laid on top of the membrane.

A number of types of membrane have been tried. The one found easiest to handle without puncturing readily was a hessian-backed 0.006" polythene. Even without any ventilation at all of the underfloor space, an equilibrium moisture content below 13% was maintained in the cavity for several months, then a period of wet weather caused water to flow under the membrane and it penetrated the taped joins in the membrane, leading to a very rapid rise in equilibrium moisture content in the underfloor space.

It would seem that such membranes can keep underfloor moisture contents at satisfactory levels, even without ventilators, if the joins remain waterproof, but that it is quite difficult to provide practicable joins that will prevent the entry of running water. They would require permanently well drained sites.

Traffic over the floor could in time lead to uneven settlement of footings because they just sit on top of the membrane and have not got a solid foundation.

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* Prepared by K Bootle

Any puncturing due to mechanical damage or termite attack could be difficult and expensive to locate and repair.

Paint testing. - The durability of the major brands of exterior gloss alkyd and gloss acrylic paints is being examined for the Timber Development Council of Australia. Some products, of both types, have been found to have an unsatisfactory service life. The dust retention of the acrylics is generally disappointing, especially in the initial stages of exposure. Blackbutt, Baltic pine and alpine ash were used as the testing substrates. Poor service has been obtained on blackbutt because of its susceptibility to surface checking.

Stain or 'natural' finishes. - Such finishes are becoming more and more popular and a wide variety of proprietary products is available, most of them based largely on the Madison formula though creosote based stains are also available. We have not observed much difference in durability between the two types; however, the creosote stains have the initial disadvantage of an unpleasant odour and slower drying.

The better stain finishes behave well on rough sawn surfaces of good paint-holding species such as brush box. Blackbutt is not a good substrate for stain finishes. Radiata pine holds the stain well but surface checking often occurs. A service life of up to 4 years is quite a possibility for brush box. Dressed surfaces are of course a different proposition; unless the timber is an absorbent one the stain finishes cannot be recommended for the smooth surface.

The use of water repellents. - Despite the advantages they undoubtedly have in stabilising joinery joints, etc., they have not made much headway commercially in New South Wales. One manufacturer tried to make them a more tempting proposition by claiming that they could take the place of the primer coat. We have found that the omission of the primer coat, at least on radiata pine, is fatal to the service life of the paint system.

Some work has been done on the effect of water repellents on actual paint performance as distinct from end stabilisation. So far little difference has shown up between controls and panels given 3 minutes of immersion in water repellents and treated with both opaque paint and stain finishes.

It may be of interest to note the marked improvement in behaviour of finishes adjacent to the end grain of radiata pine when such timber is pressure treated with CCA salts.

The painting of cypress pine cladding. - While there are very real advantages in using cypress pine in seasoned form for flooring

it does not follow that this is true for weatherboards. Because of its free splitting nature cypress pine does seem to benefit from the slow down in drying brought about by the application of paint to the green material. Possibly because of this species' low shrinkage the adhesion of the paint film on our test panel has not been affected by their originally unseasoned condition, while the appearance of these panels is better than those that had been seasoned beforehand, because of their freedom from checks extending through the paint film.

Acrylic primer v. 'pink' primer. - Water based primers have not been promoted commercially yet but an examination of one company's sample submitted for trial did show some tendency to lift the grain of brush box, the testing species, quite excessively.

Durability of radiata pine tile battens. - In New South Wales radiata pine is used without preservative treatment for tiling battens. We have taken both bright and sap-stained pine battens and fitted them under concrete and unglazed terra cotta tiles in a roof sarked with aluminium foil. The test site is a southerly well wooded suburban location. At the end of two years' exposure the material will be examined for signs of decay.

Softwood wall framing. - The combination of damp clay soils, absorbent brickwork and rather poor underfloor ventilation is a common one in the Sydney area and work is under way to examine the effect of these factors on the moisture content levels of structural timbers in a domestic type building. With the greater use of non-durable species for scantling such information should be of value. Moisture take-up in asbestos cement clad walls is also being investigated.

Item 5(a) Research review (g)*

Activities in this area have been largely in the field of extension work.

Items of interest include:

Species evaluation. - Methods for the rapid appraisal of the properties and utilization potential of lesser known or unknown species, on the basis of macroscopic anatomical features and a few simple tests, were examined in collaboration with the Division of Forest Products.

Fire damage effects. - In a study on 21-year old loblolly pine felled 13 years after a fire, the extent of externally visible evidence was positively relatable to the decrease in green-off-saw recovery due to fire injury. However, the percentage rejection due

* Prepared by W J Smith

to distortion in seasoning was negatively related to the extent of visible damage.

Conversion study. - In 26-year old loblolly pine, the effect of position in stem, end product (i.e. boards and scantling) and sawing method (through and taper sawing) on the extent of degrade in seasoning was studied. Results were generally as would be expected, in that conversion of a $4\frac{1}{4}$" central flitch to boards, rather than scantlings, with the outer wood being sawn to boards or scantlings, gave least degrade. However, among other interesting results, it was found that, in sawing scantling, through-sawing gave less degrade due to distortion in seasoning than taper sawing; and taper sawing for boards gave less degrade than taper sawing for scantlings.

Finger jointing and glulam. - Technical assistance has been given to industry in producing and testing finger jointed studs and glued, laminated scaffold planks from plantation grown pines. Accelerated "weathering" tests on the glulam planks are projected.

Some machining problems with exotics. - Observations on machining difficulties encountered with exotic conifers by some millers are reported in a separate paper.

Building experimentation. - The use of Departmental building projects to demonstrate the effective and wider application of plantation grown material has been continued.

In promotion of exotics by industry, their effective use for general framing (preferably housed to minimize twist as studs), and in larger solid sections (end jointed with gang nail plates where necessary) has been clearly demonstrated. Comparisons with the performance of imported conifers, including Douglas fir, have been more than favourable.

Hardwood pulping trials. - The results of pulping trials on a number of open forest hardwoods by a Japanese company show promise for some species, despite generally somewhat low unbleached yields.

Discussion

Hanson: Sawmill economy is affected by the method of operation, i.e. by family or outside workforce.

Page: Many small mills may be inefficient but the capital has been long written off and the men accept less than the standard pay, particularly when the mill is a family affair.

Colwell: There are 66 mills in the Territory with a throughput less than 5×10^6 su ft, and all are profitable, with a captive market and cheap labour. Of 11 mills producing more than 5×10^6 su ft, which have to export, three are profitable the others are not. These are not large enough to give a large enough return for the money invested.

Cokley: There is also the problem of multiple species, with insufficient quantity of any one species for industry to promulgate more than a group usage.

Colwell: The Territory has many species differing in density and other properties. A few can be segregated but most must be marketed mixed.

Item 5(a) Report of Austis Research Committee

Mr Brabin presented a report which included a list of research projects recommended by the committee. He stressed that the report and listing was subject to confirmation.*

List of research subjects

The Committee wishes to advise that whilst these are listed in approximate order of priority, it should be appreciated that a number may be implemented concurrently, as different research organizations may be involved, or different sections within one organization.

It will be noted that this list chiefly refers to applied research. It is not suggested that those organizations carrying out fundamental research should necessarily reduce such activity, although a review of the fundamental research being undertaken and its possible value as a basis for applied research may help in achieving maximum benefits to our forests, forest products industries and the community.

It should also be appreciated that the proposals set out below cover a very wide range of activities and, in most cases, deal with subjects on which a considerable amount of research has already been carried out. In view of this wide range, more specific definition - and possibly sub-division - will no doubt be required before some of the proposals can be implemented. The following are the industry

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* NOTE: Subsequent to the Conference, the subject of logging has been included at high priority (5) and Communications has been upgraded to No. 2 priority. Items 1, 2, 4 & 5 have been grouped as subsections of a new heading "Timber Structures - Domestic and other fields", which has been accorded No. 1 priority.

problems and suggested research subjects prepared by this Committee:

Stable timbers

(a) The problem: To produce economically stable large-section timbers.

(b) Application: This would include joinery, structural timbers, house frames, etc.

(c) Range: To cover the whole range of species and log qualities available from Australian forests, in sizes $1\frac{1}{2}$" thicker. Also to include problems of usage of stable timbers, such as nailing, gluing etc.

(d) Possible directions of research: These may possibly include lamination of seasoned and unseasoned timbers, and stabilization and/or seasoning of large sections.

(e) General comments: Markets are being lost to other materials due to difficulties in competitively supplying large sections and lengths in grades often demanded including timber used for structural and framing purposes. This has been accentuated by recent emphasis on "stability", increasing competition from concrete, steel, aluminium and plastics (in domestic, commercial and industrial buildings), combined with an increasing dependence by the sawmilling industry on the profitable use of short lengths and lower grades.

This project, in conjunction with the one below, should have highest priority.

Domestic building systems

(a) The problem: To critically study traditional methods of design and construction of timber-framed dwellings with the object of improving the competitive position of timber.

(b) Possible direction of research:

(i) Development of use grades and dimensions based on strength testing of composite structures rather than individual pieces.

(ii) Seeking the most effective jointing methods to produce the most economical structures - gluing, nailing, stapling, etc., etc.

(iii) Development of designs permitting maximum economy. For example, use of salvage sizes and grades, modular construction, easy erection, etc., etc.

(c) General comments: This project is, to some extent, a projection of Stable timbers - on page 122, and should share highest priority with that project. With manufacturers of competitive materials placing greater emphasis on factory assembly, modular systems and production of units (or products) rather than individual pieces for site assembly, research in this field is urgent.

Preservation

(a) The problem:

(i) Limitations on the life of marine piles, particularly in tropical waters.

(ii) The problem of producing fully impregnated indigenous hardwoods and softwoods at prices competitive with other timbers and materials.

(b) Application: Problems most urgently requiring solution include -

(i) preservation of marine piling,

(ii) " " softwood and hardwood truewoods including the heartwood of softwoods,

(iii) the "afterglow" problem with CCA treated timbers,

(iv) re-seasoning of CCA treated timber with respect to period of seasoning compared with unseasoned timbers,

(v) to produce more effective short term water repellents for protection of timber during transport and construction.

These projects, particularly that of marine piling, should be accorded a priority immediately following the two projects on page 122.

(c) Possible direction of research: In the case of marine piling testing could include determination of optimum conditions for attack, such as salinity, temperature, etc.

In general, fields of research could include all known methods of impregnation.

(d) General comments: With continual improvement being made in competitive materials, it is imperative that timber performance in areas of high hazard should be able to be guaranteed, at least to the limits attained by competitors, and at the same time be competitive.

With transport and handling playing an increasing part in our cost structure, processes suitable for application at initial points of production would be an advantage.

Jointing of timber:

(a) The problem: Expansion of the use of solid timber (sawn and veneered) and more effective use of timber's inherent (and added) properties requires effective jointing or bonding of individual pieces with one another or with other materials.

(b) Application: This could include -

(i) Gluing of both seasoned and unseasoned timber,

(ii) Development of inexpensive, easily handled and cured adhesives with particular emphasis on water-proof adhesives (e.g. produce an adhesive with Resorcinol's advantages and none of its disadvantages),

(iii) Development of glueless bonding,

(iv) " " more versatile, effective and economically - applied methods of jointing.

(c) General comments: This project has been accorded high priority, partly because of its relationship to the two projects on page 122. The replacement of nailed, bolted and screwed joints with glue, clamps or some other method of jointing could revolutionize domestic building methods and design.

Grading and timber usage

(a) The problem: The traditional patterns of timber grading and usage are too often unrelated. This does not always permit timber to be used most economically and effectively.

(b) General comments: This project involves a complete rethink of grading and timber designs, and seeks to more effectively relate the two. It has been given a fairly high priority because of its relationship to project - Domestic building systems - on page 122.

Sawmilling

(a) The problem: Australian producers are faced with the need to meet a more demanding market - both quality and price-wise - and at the same time utilize increasingly defective and smaller hardwood logs.

(b) Application: Specifically, this project should include -

(i) investigation of the problems and development of techniques for the sawing of small logs, with particular attention to spring and economics of handling and production.

(ii) investigation of the application operation and maintenance of bandsaws.

(iii) a study to determine the size of the most economic units applicable to each operation - logging, sawing and processing.

(c) General comments: This project has increasing importance as we move into utilization of second growth forests. If we are to produce timber of the right grade and dimension at competitive prices, it is important that operations be developed of a size to permit use of equipment and know-how aimed at doing this.

Plantation establishment

(a) The problem: Australia is spending increasing sums on the establishment of plantations - mostly softwoods. Are these plantations located to best advantage? Are the species the most desirable in relation to economics, wood properties and likely usage?

(b) Application: This is an extremely wide subject of very great importance. Possible lines of investigation could include -

(i) more reliable assessment of likely forest produce requirements,

(ii) investigation of plant species capable of most economically and safely (that is, in relation to fire, disease, insect attack, etc.) producing these requirements,

(iii) developing prescriptions for the growth of stress-reduced timbers - shrinkage, variations in cell size, reaction woods, etc., etc.

(iv) location and concentration of these forests in relation to minimum volumes required by raw material users, markets, effluent disposal, economic extraction, etc., etc.

(c) General comments: This investigation has a high priority. It is extremely wide in its ramifications, but of very great importance to the future of forest products industries.

External timber finishes

(a) The problem: To produce economically, long term maintenance free timbers for external use.

(b) Application: Investigations could include -

(i) use of facing materials,

(ii) modifications to wood surfaces - with and without impregnation,

(iii) surface coating, including stains - perhaps combined with preservatives or water repellents,

(iv) consideration of building designs aimed at achieving maximum life of exterior finishes.

(c) General comments: A contributing factor to the continual reduction in the use of timber as an external cladding is the problem of maintenance. Development of an economical long life (15-20 years) surface treatment sould assist in recovering this market.

Communications

(a) The problem: A gap exists between research and its application.

(b) Application: This could include -

(i) evaluation and prescribing the basis of report writing to permit easier interpretation and application by industry,

(ii) study of the most effective methods of dissemination of research results,

(iii) study of the most effective means of encouraging assimilation and application of research results.

(c) General comments: This is an urgent project. It is suggested that already a considerable store of knowledge remains unused.

Forest utilization

(a) The problem: If forest products industries are to make the most effective use of our forests, it is essential that usage of these forests be related to all factors including economics and marketing requirements.

(b) Application: This project could include -

(i) a study into the most economic use of saw logs, particularly with relation to species and defects.

(ii) a study of the problems related to achieving maximum economic utilization of the tree, including:

development of a log grading system for use in the forest determining the most profitable end use for the various sizes, qualities and species of logs,

chip production, storage and handling,

de-barking,

recovery of normally waste products, including lower grades.

(c) General comments: With the increasing diversity of usage of forest products, combined with greater economic pressure on traditional uses, it is desirable that the most effective use should be made of these products and by-products.

Item 5(b) What is the future of hardwood?*

For the purpose of this discussion "hardwood" refers to the Myrtaceous species, essentially eucalypts plus brush box and turpentine.

The native hardwood forests currently provide the major portion of Australian timber production; their contribution is about seven times that of exotic pine plantations but the position will change very much in the next 20 years. The total volume of logs available will increase by about 15% but all this increase will be due to the plantations. Indeed, Dr. Jacobs forecasts that by 1990 the production from the native forests will have declined by nearly 300 million su ft/year compared with present yields, so a lot of hardwood producers are in for troubled times.

By the early 1990's there will be as much pine softwood as native hardwood logs produced annually, and by the turn of the century softwood availability will be considerably in front of hardwood. In the meantime, the free trade agreement with New Zealand must mean that very large imports will be coming from there unless better prices are offered elsewhere; however, we cannot have any assurance of that.

These developments will inevitably lead to much greater accent by timber sales organizations on pine softwoods and their easier workability, lighter weight, availability in seasoned condition, advantages for prefabrication etc. This could easily lead to a snowballing rejection of hardwood which might only be held in check by a general shortage of wood.

Will there be a shortage of timber?

At the present time the demand for housing absorbs 30%–40% of sawn timber production, so the prosperity of the timber industry is very closely related to cottage construction. In the next decade the only increase in likely demand for timber is in this field. However, the changeover to multiple-occupancy brick and concrete structures in our main urban centres, brought about by the cities' ever increasing growth and hence the increased cost of land in the more attractive districts, must have a very considerable effect on all forecasts of future timber needs. Much has been made of the average Australian's desire for the single cottage on its quarter acre lot as a counter to the ever increasing proportion of flats, but it will need very active government support for decentralization to have much chance to stem the tide.

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* Prepared by K Bootle

The amount of timber needed to be imported to meet Australian requirements is expected to increase by a few percent to about 30% by 1975. This large import bill is some consolation to hardwood producers but its worth should not be over-estimated. Even if rising prices elsewhere cut off a lot of this supply, there is no certainty that hardwoods would benefit much. Already the steel manufacturers are having exhibition homes erected with steel studs and further timber price movements upwards might well give them some market acceptance. Also there are great timber resources as yet untapped in Papua New Guinea. When current problems of extraction are overcome, a floot of scantling could perhaps develop. Already enquiries as to acceptibility of species for scantling have been received.

Can something be done to improve hardwoods?

Let us consider the main hardwoods of New South Wales. The following list, in approximate order of abundance, gives current annual log production from the State Forests:-

	million su ft
blackbutt	75
tallowwood	39
brush box	38
Sydney blue gum	35
spotted gum	24
messmate stringybark	18
silvertop stringybark	18
river red gum	18
ironbarks (all species)	17
yellow stringybark	15
white mahogany	13
rose (flooded) gum	12
turpentine	11
brownbarrel	10
silvertop ash	8
New England blackbutt	7

The blackbutt forest is the most productive one we have in New South Wales but it represents only one-seventh of the 3.5 million acres of coastal hardwood forests and even then a lot of this so-called blackbutt forest may contain as true blackbutt only 20% of

the basal area of the existing forest growth. Blackbutt's annual increment can be as high as 150 cu ft/acre but the average is more like 45 cu ft. Even this very low figure (compared with 200-300 for exotic pine) is far in excess of the 5 to 10 cu ft/acre being produced by much of our hardwood forests.

Florence, in a contribution to the June 1968 issue of "Australian Forestry", examines the case for increasing the blackbutt component of east coast forests. He is doubtful of the success of such moves and feels that it may be undesirable to establish it in pure stands beyond the limits of its natural occurrence. If there were better prospects for small logs this conclusion might be varied.

Rose (flooded) gum is the only other major species with blackbutt's growth potential but it has rather special ecological needs. These two species are the only ones with any real potentialities for overcoming the compound interest hurdle but the quality of the young growth (to be discussed later in Mr Booth's paper) is not impressive.

The flooded gum is very susceptible to grub attack and gum vein formation while the sawn material from the young blackbutt has much more spring than that from mature logs and is somewhat subject to collapse. Blackbutt has a good reputation as a structural timber but because of its proneness to surface checking it is a very poor holder of paint; perhaps it is just as well that the main demand for hardwood will be as framing material.

It is virtually impossible to increase the productivity of the hardwood forests without a great deal of time and money. They are not stocked for optimum production for they generally have a wide range of age classes and contain many slow growing species which bar the regeneration of more desirable species. It seems certain that silvicultural treatment of hardwood areas will not increase sawlog production significantly above current levels.

In these circumstances, would the limited resources of men and money be better devoted during the next two decades to accelerating the softwood planting program? Yields of acceptable hardwood species are very small compared with softwoods. For example, in Queensland slash pine is 7 times as productive as spotted gum and hoop pine 5 times as productive as much of the better hardwood, over normal hardwood rotation periods. With large scale planting and integrated harvesting the rate of return from softwood plantations is considerably better than for hardwood, according to Mr A Trist's recent paper to sawmill managers at Maryborough, Queensland. The only factor where the hardwood forests seem to have some advantage is in resistance to fire, a far from negligible consideration in this country.

Turning to the end uses of hardwood, how will the main ones fare in the next decade or so?

Building scantling. - The trend in every State is to brick veneer construction, from all brick as well as weatherboard and asbestos cement. However, the price of hardwood will have to be lower than for softwood to attract builders, the majority of whom prefer softwood not only because of its greater ease of working but, more importantly perhaps, because of the fewer "call-backs" to remedy the cracked plaster joints. The feeling against hardwood is not so marked in regard to roof framing because it provides a safer support for the construction team and the extra shrinkage is not so important.

If the price of hardwood can be kept down at the same time as the product is made more stable it will maintain its share of this market, but is this asking the impossible?

Multi-storey construction. - Timber is being used less and less on such buildings. Concrete is now being poured onto steel supports, or at least sheet wood products. There have even been moves to replace the traditional timber boardings around construction sites with steel. The main use for timber in such structures seems to be only in panelling and decorative effects, a market in which the hardwood producers currently are not much interested.

Cladding. - The chance of regaining any considerable part of the market once held by weatherboards is very slight indeed. While the problem of paint retention has been an important factor in the loss of this market, the fact that the price of timber has gone up much more than that of bricks in recent years has reinforced people's desire to use the more permanent material.

We should be giving much greater attention to the stabilization of wood-based sheet materials that would lend themselves to pre-fabricated members with built in insulation and which could largely overcome the maintenance problem.

Flooring. - The demand for feature flooring (i.e. not to be covered with carpet etc.) is very limited and is unlikely to increase. In New South Wales, cypress pine has most of the cottage flooring market since the housewife wants to cover the timber floor as soon as she can afford to do so because she finds it noisy and not very easy to maintain. Multi-unit construction and concrete slabs for single storey dwellings are adding to the problem, while developments in fibreboard, particle board and structural plywood might conceivably make strip flooring obsolete in the years ahead. The flooring market is bleak.

Panelling. - At present there is a widespread renewal of interest among designers in decorative timber panelling, but hardwood producers have shown very little interest in this field, even though their species would provide a superior article to the softwoods currently used. Such panelling does not necessarily have to be free of blemish; there are many who would appreciate well-pinholed and stained silvertop ash or the travertine-like venation of red bloodwood. What is essential is seasoned timber accurately milled. Work on methods of fixing panelling without the disfigurement of face nailing would be well worthwhile.

The market is not a large one and needs careful servicing. Perhaps the present organization of the industry does not lend itself readily to such products.

Heavy engineering. - Prestressed concrete has taken over much of the bridge timber market and the relatively low price of structural steel has inhibited development of a local "glulam" industry. Major wharves are now constructed on solid fill held by concrete caissons. Railway goods and livestock waggons are still using some hardwood, but stainless steel, aluminium, and melamine sheets have almost replaced timber in the passenger cars.

Poles. - While pressure preservation has been accepted quite readily by the engineers of the PMG Department and electricity supply authorities, and will doubtless help to keep a market for poles in country areas, public pressure is increasing in built-up areas for the removal of the ugly clutter of poles and wires from the streets. Telephone lines have gone underground and many new subdivisions make a sales feature of their underground electricity supply. In another decade or so perhaps only rural supply lines will be renewed in timber poles?

Mining. - Five percent of present timber consumption goes into the mines, most of it hardwood and little change is expected.

Some mining companies are actively working on rock bolting and other methods to eliminate the use of timber underground.

Cases and crates. - Australia's total current annual consumption of timber for such packaging (which includes pallets) is about 250 million su ft, but ever increasing competition from fibreboard, paperboard and plastics as well as plantation pine must surely mean that the position of hardwood will diminish quite rapidly. The ANZ Bank survey of 1964 predicted a steady decline in hardwood use from 75 million su ft in 1964-5 to 60 million in 1974-75.

Railway sleepers. - Current Australian consumption is about 120 million su ft of hardwood but apart from the new developments in

West Australia and on the Perth-Broken Hill standard gauge link the demand is mainly arising from track maintenance and export orders are small and irregular.

Preservatised radiata pine has been shown to make quite an acceptable sleeper and may have an affect on hardwood use in New Zealand and perhaps South Australia in due course.

Hard fibreboard (hardboard). - Excess production capacity is present in this industry and unless exports can be built up, the increased use of hardwood by this industry will only be a couple of percent a year. Even then the industry relies on such waste timber and forest thinnings and will not have much effect on the sawlog market.

If hardboard could be stabilized dimensionally and made more uniform in strength its market acceptance would be much improved.

Paper and pulp. - Apart from newsprint, 85% of Australia's paper and paperboard requirements are met by local material, mainly the ash eucalypts. If overseas pulp prices increased considerably, greater use might be made of local hardwoods (note the considerable interest being shown by the Japanese in chipping our eucalypts). Here in New South Wales one paper company has purchased considerable areas of coastal forest, much of it capable of growing flooded gum, but has made no move to begin production.

One often hears the thought expressed that pine softwoods are the best for paper pulp, but the short fibred pulp from the eucalypts is a very desirable component in many types of paper and, in addition, it is more attractive economically, for much less weight of wood is required to make a ton of pulp. The pulping process is also cheaper with eucalypts.

To sum up. - The cottage construction industry represents the main outlet for hardwood and only a general shortage of timber will maintain this market for it. If hardwood production costs rise relative to other timbers (pine, New Guinea hardwoods) and steel, then the industry could be in very much more trouble than what is already inevitable with the falling off in log supplies and the necessity for many mills to cease operations.

To help in the vital reorganization of this industry we should be giving thought to such matters as:-

a) The optimum size of hardwood mills, number of shifts to be worked, and the most suitable equipment for scantling production.

b) Improved stability. Thinner sections are needed to enable reasonably rapid seasoning. If seasoning is going to make hardwood too dear can we improve fixing methods to mitigate the effect of the movement of the house frame? Can we do something to reduce the very high price of laminated beams for use over openings, where shrinkage cannot be tolerated?

c) Can we economically join end-to-end short pieces of unseasoned scantling to cut down on waste?

d) Difficulties of joining cladding and lining tend to hold back the reduction in size of structural members that seasoned hardwood would permit from considerations of strength. The greater use of adhesives for attachment of such panels should be investigated.

Discussion

Smith: The obvious answer is to direct more research attention to hardwoods.

Bootle: The real question is "Should not the forestry departments reconsider their expenditure on the production of hardwoods?"

Bryant: The producers of hardwoods are facing stiff competition and do not always help themselves by the way in which they present their product.

Vaile: In Western Australia, about 25% of floors are in concrete and the production of plywood floor panels 4 ft 6 in. wide is significant. Are the three grades of hardwood necessary and realistic in relation to industry's needs?

Huddleston: I believe that the real question facing the industry is not "What timber is best for flooring?" but rather "Is timber to be used at all for flooring?" Timber floors, sanded ready for carpet, cost $84 to $96 per 100 sq ft. "Bondek" (a steel and concrete combination) at the same stage costs only $60.60. Therefore, the real question facing the industry is "timber or some other material?"

Tamblyn: The Australian housewife is becoming less satisfied with houses of conventional design. If basement type houses become more popular, the market for wood floors might well improve.

Boyd: We must be realistic about comparisons. Who determines "trends"? The timber industry is not controlling "trends" because the timber industry's promotion is lagging so far behind that of the

"competitive" materials. This is, in fact, a problem for Austis.

Jones: I support that criticism of the timber industry. The industry should promote timber to extend the market. In Brisbane, the basement type house is being replaced by concrete slab construction. One reason for this is the irregular shrinkage which occurs with subfloor timbers sometimes 10 in. in depth. You will recall that the production of stabilized, distortion-free timber was placed high on the research priority list proposed by the Austis Committee. Greater emphasis must be given to the problem of eliminating shrinkage and distortion.

Martin: New systems of construction could be useful in extending the market for timber, e.g. platform construction.

Dale: Should we not look to the "homogenization" of components rather than to new systems of construction? The development of a continuous laminating machine to produce stock for recutting would have tremendous advantages.

Cokley: In selling timber the customer is usually told of the disadvantages of using timber rather than of its advantages. To whom should a prospective purchaser go in order to get a fair summary of the advantages of timber over other materials? The timber industry should aim to set a trend.

Colwell: Problems in the Territory of Papua and New Guinea are mainly centred around the stability of heavy sections; architects would like to have a stable product, uniform in design characteristics and which is available off the shelf, at the time they want it.

Huddleston: There is no distinction between this conference and industry. We are industry! We must govern our research program to give answers to questions which will be asked during the next 20 to 30 years.

Bootle: Users are generally more concerned with price than with stability. If the price of hardwoods exceeds or even comes close to that of softwoods they will lose markets.

Item 5(c) Rationalization of log grading in relation to industry integration*

The development of integrated forest industries would be facilitated and utilization of the forest resources improved if it were possible to grade logs visually according to their most profitable end use. Consequently the Division, as was reported at the previous

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* Prepared by M W Page

Conference, is endeavouring to develop workable log grading rules. Regrowth Eucalyptus obliqua has been studied in Tasmania and currently we are working with regrowth Victorian E. regnans, in a program which combines log grading with a study of growth stresses; our aim in this latter regard being two-fold:-

to study several methods of reducing growth stress intensity before conversion

to develop methods for determining growth stress intensity both in the standing tree and in felled logs.

In the first investigation the following systems of reducing growth stress intensity are being studied:-

The sap ringing of standing trees some time prior to felling,

The holding of both bush logs and mill logs under water sprays for some period prior to conversion,

The sap ringing of mill logs at appropriate intervals along their length prior to conversion.

This latter system has been suggested by Barnacle's work on the problem of end popping during the cross cutting of immature logs.

In the second part of the study an attempt is being made to grade both logs and trees according to the extent to which they contain growth stresses, in order that those likely to pop and spring during conversion can be segregated.

A simple, portable instrument is being developed with which we are endeavouring to measure growth stress intensity and variation, not only in mill logs but also in standing trees. Some visual observations have suggested that growth stress intensity may vary with time or perhaps with season and our aim is to be able to predict likely behaviour before felling. While still in its infancy, this project is already yielding very interesting results.

Item 5(d) Developments in sawmilling machinery

Under this heading Mr G Conaway listed, illustrated and discussed various items of sawmilling machinery now in use in New South Wales.

The following machines were covered, but owing to lack of

space it is possible to list them only in these Proceedings. Further information, if required, may be obtained from Mr Conaway at DWT:

McKee twin saw re-saw
Dolmar portable salvage mill
Loroch equalizing grinding machine
Isles multi-edger control unit
Isles hydraulic feedworks
Twin hob radial arm band re-saw
Nicholas one-man bench
Isles 6 x 54" multi saw edger
Isles overhead beam edger
Metal cutting rescue saw
Chain saw-wood auger attachment
Four head moulder with gang rip saw
Briggs automatic No. 1 sawbench
McKee travelling line bar double cutting re-saw
Vollmer hardening machine
Gray 30" power feed saw bench.

Item 5(e) Some machining problems in woods of non-uniform texture*

Machining problems associated with the textural variation of timbers with distinct growth rings are not new, but have been highlighted in Queensland recently by the difficulty reported by some millers in machining exotic pines to a consistently smooth surface.

Attention has probably been focussed on these problems by the increasing availability from older pruned stems of wide clear boards suitable for broader application. The related defects have been observed to a variable degree in slash and loblolly pines and other local exotics, and in radiata pine, Douglas fir, western red cedar and redwood. They also occur in many ring-porous hardwoods.

Their absence from the remarkably uniformly textured indigenous softwoods such as hoop pine has undoubtedly made local processors more conscious of previously rarely encountered defects, which are so common in more temperate regions as to be permitted even in grades for high appearance uses.

Defects. - Two defects relatable to variability in properties of the alternating earlywood and latewood zones in each growth ring in such material are raised grain and loosened grain.

Raised grain as referred to in North America, is an

* Prepared by W J Smith and D K Gough

unevenness between earlywood and latewood on the surface of dressed timber and this definition is more specifically applicable to the present discussion than the local one, which has a broader interpretation. A new term, "ridged grain", proposed here, is considered more descriptive.

Loosened grain is a grain separation between earlywood and latewood without displacement. Again the American definition is more pertinent than our own, but a new term, "shelled grain", is preferred.

These two defects generally do not appear immediately after machining, but from several hours to a few days later.

Moisture effects. - Processing at too high or too low a moisture content can be a causal factor. In the former case, the higher density latewood would shrink more than the earlywood laterally, leaving the earlywood elevated. In the latter case, the latewood would swell above the earlywood in attaining equilibrium moisture content. The ridges are generally relatively uniform across each zone in these cases, the cause is readily recognizable, and the remedy obvious. The real problem here lies not in the nature of the material nor the machining, but in inadequate moisture control.

However, ridged and shelled grain commonly occur independently of or only partially due to moisture variational effects.

Machining effects. - In machining, hard latewood on the surface is pressed into the softer earlywood beneath it by the knives and/or feed rollers. The crushed earlywood cells slowly recover their shape and the latewood is pushed into a ridge above the surface.

Ridged grain due solely or largely to machining rather than moisture effects can be recognized by (a) the protrusion of the last-formed latewood on the pith side of a board (where this zone has been pushed up by recovery of the crushed first-formed earlywood of the subsequent ring beneath); and (b) protrusion of the first-formed latewood on the bark side of the same board, due to recovery of the crushed last-formed earlywood of the same ring.

If the knife impact has been severe enough, failure of the earlywood cells beneath surface latewood may occur, to cause separation or "shelling" at the latewood/earlywood interface. This tendency is accentuated by stresses developed in seasoning, due to the differential lateral and longitudinal shrinkage of the two zones.

Structural and physical factors. - Because of the more gradual transition in cell dimensions, density and hardness from earlywood to latewood of the one ring than from latewood of one ring to earlywood of the next, the incidence and severity of ridged and shelled grain are greater on the pith than the bark side of boards.

Mechanically caused ridged and shelled grain becomes worse as the angle made by the growth rings with the board surface decreases, due to the greater "springboard" effect of the surface latewood when pressed into supporting earlywood. Thus, back-sawn boards are most and quarter-sawn material least affected.

Incidence and severity can be expected to increase as the difference in density and hardness between the two growth zones increases. From our observations on slash pine, this differential varies greatly, but is greater within than between trees.

The basic density of the earlywood varies from 14 to 23 lb/cu ft and the latewood from 27 to 44 lb/cu ft within individual rings.

While the earlywood density remains relatively constant, fluctuating around approximately 19 lb/cu ft, that of the latewood increases to a variable age, from about 31 lb/cu ft to around 40 lb/cu ft on the average. Percent latewood also increases with age, from about 6% in the first ring to as high as 85% further out.

The variations in basic density differential and in proportions of the two types of tissue are probably responsible for the tendency towards increased severity of ridged grain with age observed in recent work on slash pine. However, it seems that orientation of the rings in relation to the surface may be a more important factor.

Machining factors. - Limited preliminary trials on slash pine indicated that blunt cutters and faster feed rates were associated with increased incidence and severity of the defects, and that cutter speed and cutting angle were likely contributory factors.

Work on this and other species elsewhere reveals general agreement that attention to the following machine-related factors can minimise ridged and shelled grain:-

(a) Cutter sharpness - Knives must be sharp. Pounding by blunt knives increases the crushing effect and subsequent defect development. Heavy jointing between grindings should be avoided, since it has been found that quality deteriorates once the flat or "land" so produced exceeds 1/32".

(b) Cutting angle - Species vary markedly in their response to variation in this factor. In general, decreased angle was beneficial and the slash and loblolly pine group respond well.

(c) Knife cuts per inch, feed rate and cutter speed - There is apparently an optimum number of knife cuts per inch, which also varies with species. In one study, it was found to be around 12 for the slash pine group, less for the softer ponderosa pine, and higher for ring porous hardwoods of variable density. Feed rate and cutter head speed are apparently only important as determinants of cuts per inch. They have been reported as having little effect on surface finish, provided the number of cuts per inch is constant. This apparent contradiction of our own observed improvement with reduction in feed speed can be explained by our inability to vary cutterhead speed on the equipment used. The slower feed obviously increased the number of cuts per inch to a more desirable level.

Apparently, once the optimum cuts/inch for a species has been determined, if the required feed rate/cutter speed ratio is maintained, the feed rate may be as high as practicable.

(d) Depth of cut - Decreased depth of cut gives a progressive decrease in ridging, with between species effects again reported. No such effect was observed in our trials, probably because of the failure to keep other factors constant. Double dressing, with a shallow final "skim", could be worth considering for certain applications.

(e) Knife type - High speed steel knives are apparently considered superior to carbide knives in minimising finishing defects in conifers but no real difference was found for certain ring-porous hardwoods.

These comparisons apply to knives kept sharp and the much better wearing properties of carbide tipped knives could make them more acceptable where other factors can be adjusted to give a finish satisfactory for the desired end use.

(f) Feed roll and pressure bar pressure may be minor factors and should not be excessive.

Defects in diffuse-porous hardwoods. - Marked textural variation can occur in some species without distinct growth rings, due to the presence of fairly broad bands of softer parenchymatous tissue as rays and/or circumferential bands, with dense zones of fibres between them. The tulip oaks exemplify this type of structural variation, and slight ridged and shelled grain has been observed at times in this genus and other diffuse-porous species with wide parenchymatous zones.

Experimental work needed. - The remedies for machine related ridged and shelled grain appear self evident, but it is considered the adequately designed and controlled experimentation necessary for a really satisfactory solution to the problem would be unattainable or at least impracticable in normal commercial practice.

Immediate improvements could certainly be effected by keeping cutters sharp and minimising roll pressure, but trial and error adjustments of the other factors by individual processors would probably be of limited value and the benefit restricted.

Because of (a) the number of variables involved, (b) the variable effect of several of them on different species, and (c) the adverse effect of ridged and shelled grain in certain glued and appearance applications, it is suggested there is a need for detailed work on local species, particularly the exotic conifers. The objective should be to specify optimum machine conditions for the reduction of these and other surface imperfections in each species. Our present equipment is inadequate for such work and it is hoped the Division of Forest Products may consider work in this area.

Discussion

McKenzie (DFP per M Page): The principles of successful dressing of wild grain surfaces are well known and set out in publications such as those of Davis from the Madison Laboratory, Monnett (Dependable Machine Co. North Carolina), the Reprint from our Forest Products Newsletters Nos. 293-4.

The major requirements are reduced rake angle, a small feed per knife and a small depth of cut. These should be taken in the context of a good machine and good setting up, including knife jointing, for otherwise the through-put is much reduced.

The optimum conditions vary with the material being machined. Research on species could provide guide lines only because source and drying are important, and dictate the optimum conditions for each individual run. Thus the operator must know the principles.

Huddleston: NSW is well experienced in dressing Douglas fir. Let us not waste research on this, industry can tell us all we want to know.

Moglia: Unfortunately you will probably get 3 different theories from 3 different machinists.

Item 5(f) Noise in woodworking plants*

The problem

Exposure to noise at a high enough level such as occurs in many industries including the timber industry, for even short periods, will often cause temporary impairment of hearing. However, if the noise is repeated continually over a period of years, it is likely to cause physical damage to the nerve cells of the inner ear which often results in permanent deafness.

Industrial deafness, as it is known, is a compensatable injury under the Workers Compensation Acts of the Commonwealth, New South Wales, Victoria and Queensland. At the present time arguments on the scales to be used in measuring industrial deafness are being tested in the courts.

The unions, who have been watching the position very closely are prevented from making claims on behalf of their members until the problem is solved and it is anticipated that there will be large payouts in compensation following the court ruling.

Statistics from various organizations concerned with this problem are not readily available or dissected into the various industries but some idea of the rising costs to industry can be obtained from the following:-

A Sydney Insurance Co.

Claims paid to 30th June 1968.

Year	Number of Claims	Amount
1965	34	$ 27,000
1966	55	38,000
1967	165	104,000
1968	249	117,000
	503	$286,000

These figures are for payouts only and do not include legal and court fees which have to be borne by the insurance company in addition.

Figures supplied from the Financial Review Tuesday 8th April, 1969 reveal that the "Total payout of compensation to sufferers of industrial deafness in Victoria in 1968 probably amounted to more than $200,000. The New South Wales Railways report that "claims for industrial deafness have already cost the department $1,000,000 and claims run into hundreds and hundreds annually".

* Prepared by G Canaway

Whilst the figures mentioned on the previous page are for claims by the metal trades, tradesmen in the noisy sections of the timber trade will soon become aware of their rights under the various Acts and the Timber Industry could be called upon to bear the burden of yet another cost unless steps are taken to quieten sawmills, joinery shops and forestry operations.

To sum up the future position, a leading legal authority described the industrial deafness as "big business with damages claims running into millions of dollars".

As a guide, in this country a sound level "A" figure of 90 dBA has now been suggested as a low risk criterion or Hearing Conservation Level for industry.

This figure gave similar results to the criterion previously used which was based on a figure of 85 dB in the critical octaves from 300 cps to 4800 cps.

Following a complaint by the Commission's carpenters of excessive noise from woodworkin machines, tests were conducted by the Division of Occupational Health, NSW Dept. of Health.

The results shown in the Table (Before soundproofing) indicated that noise levels were well above the Hearing Conservation Level (HCL) and could damage the hearing of the operatives.

Acting on advice from the above mentioned Division a project to soundproof the Robinson Thicknesser only was undertaken to check the efficacy of the methods used. The Table (after soundproofing) shows the difference in the noise levels.

These figures indicate a worthwhile improvement. The important factor when idling is a pure tone in the frequency band 300-600 Hz. In addition to the risk of impairment of hearing a tone of this character is likely to produce annoyance. This was reduced 8dB. When cutting, the higher octaves are more important: these were reduced by 17dB in 2 octaves.

Recommendations

From the above it is clear that within a short time the Timber Industry will be faced with the problem of coping with noise induced loss of hearing.

To meet this need it will be necessary to study the legal and engineering aspects of the problem within the framework of local Compensation Acts.

It is therefore recommended to Conference that discussions be held with State authorities concerned with noise prevention with a view to:-

(a) Obtaining the cooperation of the Timber Industry for a survey of the problem.

(b) Instituting an educational campaign to acquaint the industry leaders with the need to take preventative measures in the form of efficient ear protection where necessary.

(c) To supply plans and specifications of typical soundproofing units to assist the industry.

Discussion

Muncey: How do you propose to deal with this? If you cannot talk to a man 1 ft away, noise is a problem.

Canaway: I suggest that we set up a committee to discuss this problem with the State Health Departments.

Cheal: We have done much investigation in PWD shops. We located the worst areas in three shops and tested earmuffs on the operators. If they use them their hearing remains, otherwise they risk losing it. It would cost up to $10,000 per machine to install any effective soundproofing covers.

Page: Dr Sunderland of Western Australia has investigated this problem. He found that it is dangerous if the operator cannot detect a change of pitch. He can do this through earmuffs.

FREQUENCY DISTRIBUTION IN DECIBELS IN OCTAVE BANDS

FORESTRY COMMISSION - DIVISION OF WOOD TECHNOLOGY

No.	Particulars	Overall 20-9.6 KC	1 37.5 75	2 75 150	3 150 300	4 300 600	5 600 1200	6 1200 2400	7 2400 4800	8 4800 9600	HCL	ENE*	d BA
1	Robinson Thicknesser Idling 4 ft from feed-in side												
	(a)Without cover 22.11.67 (before soundproofing)	104	86	93	98	101	86	81	75	75		+16	98
	(b)With cover 15.5.69 (after soundproofing)	101	86	87	95	93	82	73	67	63		+ 8	95
	(c)With cover, doors open 15.5.69	108	91	97	103	101	91	89	84	75		+16	100
2	Cutting softwood 4 ft												
	(a)Without cover 22.11.67 (before soundproofing)	109	85	92	92	100	101	104	100	90		+19	
	(b)With cover 15.5.69 (after soundproofing)	100	86	84	93	91	88	87	83	80		+ 6	

* ENE = Excessive noise exposure

Item 5(g) Some timber problems associated with current building trends*

Changing constructional trends, whether motivated by utilitarian, economic or aesthetic reasons, have brought with them a variety of problems affecting the satisfactory utilization of timber.

These problems must be minimised if further inroads into the constructional field by substitute materials are to be avoided.

Excessive shrinkage and distortion of major structural members. - The increasing demand for larger sub floor utility and recreational areas, uncluttered by supporting columns, has necessitated an increase in sub floor framing sizes. This and the wider use of vermin-plate construction, in which the external wall studs are housed into floor plates on top of sub floor framing and floor, rather than into bottom plates, can result in the post-installation transverse shrinkage of up to 17" of timber below sill level. With unseasoned mixed hardwoods commonly used in Queensland, shrinkage of this depth of timber in drying to 12% moisture content could possibly vary from $\frac{1}{4}$" to over $2\frac{1}{4}$" in the one house, since the predominantly backsawn framing generally contains some which is quarter sawn. While these extremes are unlikely to occur in any one building, shrinkage effects such as jammed doors and windows, cracked plaster and uneven floors have been serious. With brick veneer construction and aluminium framed windows, sub-sill movement has been especially troublesome. Restorative maintenance can be costly and, for best effect, has to be left for 18 months or more, which makes matters worse.

Similar problems are being experienced due to the shrinkage of larger superstructural members required by a trend towards pier and beam construction. To allow greater flexibility in locating internal partitions, better through ventilation, larger glazed areas, or simply to economise, 8" or deeper top plates and ridge beams are being used in conjunction with well spaced 4" x 4" piers, raked ceilings and low level internal partitions. Cracked plaster and irregular ceiling and roof lines have resulted, and problems in storm water disposal due to uneven gutter fall seem likely.

Greater differential shrinkage within these larger members causes distortion affecting true seating and bearing areas. A contributory factor has been the reduction in average size and age of hardwood logs available. These smaller logs are generally sounder and, paradoxically, likely to yield a higher proportion of troublesome material unless due care is exercised in conversion. Millers are tempted to cut closer to or include heart.

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* Prepared by W J Smith

Such timber, especially in larger sizes, may distort more, and its apparent soundness can be misleading in that incipient decay and/or brittle heart could be present. Pipe and other obvious defects in older logs previously minimized material from the troublesome central core.

Some architects, builders and millers tend to blame reduced log size and/or the species involved for excessive shrinkage. This ignores the facts that -

(a) shrinkage is proportional to dimensions, and

(b) apart from some changes in proportions, the species mix is essentially the same as usual.

Conversion of a 4" central square to 1" stock for seasoned boards has been strongly advocated in the conversion of all species.

Some reduction in cross section could be effected at bearing points without adverse affect on bending strength of the member, but this would add to labour costs, and shrinkage of the remaining timber would still be serious.

The obvious solution to the major problems of excessive shrinkage is the use of seasoned material. This is impractical for most of the dense, slow drying hardwoods now used. They would probably be uneconomic to season and stock in the sizes under consideration and certainly difficult to work when dry.

However, the use of lower density species for seasoned solid sections, and almost any species for laminated material is quite practicable. Although not widely applied in Queensland as yet, interest is being exhibited in marketing both types of material.

The conifers, including hoop, slash, loblolly, caribbean, patula, radiata, and cypress pines and kauri provide ideal material which shrinks less, dries more quickly, works easily when dry and, except for cypress, glues well. Sizes to 9" x 3" can be sawn in very limited quantity from plantation grown stems, but those generally available at present would be more suitable for lighter solid framing and ideal for laminated members of almost any size.

There are a large number of brushwoods between about 30 and 45 lb/cu ft at 12% moisture content, suitable and available in reasonable quantity for seasoned large section framing, both solid and laminated.

Very few open forest hardwoods could be seriously considered for seasoning in large sizes here. Rose gum (Eucalyptus grandis) could be an exception.

Some experimental work has been done in the past on the seasoning of thicker stock of a limited number of species, but satisfactory kiln schedules for at least 2" and 3" stock of quite a number of the more readily available timbers likely to be used are needed.

If seasoned members are to be available when required, builders must order as far ahead as practicable. At the same time, larger millers could be expected to carry reasonable stocks without disadvantage, since thicknesses could readily be resawn as standard widths if necessary.

Most conifers, brushwoods and open forest hardwoods, regardless of density, can be used in the fabrication of laminated members from seasoned thinner stock. Brush box (Tristania conferta) is well established for custom engineered laminated beams mainly exposed as a design feature. It is the only species used in any quantity here for this purpose.

Mass produced, "pre-shrunk" laminated building members in standard sizes to, say, 8" x 3", should find ready acceptance, especially if less emphasis is placed on appearance to reduce costs. A utility, rather than a prestige product, should be the aim, especially since present laminated beams are considerably more expensive than encased steel beams, even allowing for increased on-site labor costs in the latter case.

Where required sizes are available in seasoned solid material, this should provide the lowest cost member and that most acceptable aesthetically. W here lower density species are used, their generally lower strength would necessitate an increase in designed section, compensated for to some extent by the 25% increase in working stress allowable for seasoned timber. This represents an elevation of one strength class for dry material.

An additional increase of 25% in unit stress is allowable for glued laminated members in which the number of laminates exceeds four, due to dispersion of defects throughout the piece.

Further economies in size and cost could be effected by the judicious use of a proportion of higher strength laminates in the more highly stressed zones outside the central three-fifths of the depth. While grade mixes of the same species are primarily envisaged, particularly from plantation grown conifers, species mixes from different strength groups are also being considered for investigation. Exploratory work in this field is being planned in collaboration with industry.

Because of the limited use of laminated material in Queensland and the general reliance of architects and builders on accepted practice and published sizes for standard conditions, rather than calculation in

specifying framing dimensions, wider application and acceptance of laminated framing would be greatly facilitated by, and possibly even largely dependent on the early publications of tabulated data presented in a form similar to the Division of Forest Products' pamphlet No. 112 on "Building Frames - Timbers and sizes".

The present publication could be used for members with no more than four laminae, to which solid timber data apply but would require modification above this. Data is needed for both glulam and solid material for spans longer than those now covered.

No undue complexity should be involved, since it is understood the dimensions of members with a strength group or grade mix would be determinable within reason by reference to data for the species and grade classification of laminae in the outer one-fifth of the depth.

A plea is made for the Division to undertake this extension of their original work.

Standard specifications for structural glued laminated timber (combining tabulated working stresses for compositional and use condition variations), similar to those issued by the Southern Pine Inspection Bureau, should also be made available.

Grading deficiencies highlighted by improved jointing systems. - A recent isolated in-service failure in the bottom chord of a gang nail roof truss has drawn attention to the need for greater care in quality control in the components of prefabricated structural units, despite the quite high standards currently operative.

With less efficient jointing methods (e.g. bolts), a margin of safety over and above the designed factor may operate, due to the larger timber sections sometimes used to compensate for joint inadequacy in load distribution.

More efficiently engineered roofing systems, with their improved jointing and economies in timber, still have the designed factor of safety, but no additional margin. More importantly, the isolated failure of such a unit is subject to more critical appraisal, simply because it is marketed as an engineering unit.

To foster confidence in prefabricated structural assemblies, the timber must be carefully graded. This is a field in which a special case can be made for the use of mechanically stress rated material for more predictable performance. Mechanized grading equipment can also be used to improve the confidence limits on visually graded stress ratings for such purposes.

Flooring problems. - The strong trend towards vermin-plate construction has been accompanied by the undesirable practice, adopted by many builders, of permanently fixing a seasoned floor immediately the joists are in position and using it as a working platform for completion of the building. Several weeks may elapse before the roofing, external sheeting, doors and windows are fixed to provide the protection normally recommended.

Where protection against the elements is provided, this consists of the superficial application of a water repellent preparation (usually containing tung oil, linseed oil or even sump oil), or alternatively, plastic or bitumenized paper sheeting, sometimes taped at the joints.

No method used can be regarded as satisfactory for general application. Where roof and wall protection are provided within a matter of days under fairly favourable weather conditions, and even with very short term exposure to unfavourable conditions, adverse effects may be negligible.

However, such circumstances do not often prevail. Moisture repellent preparations are not completely effective, especially against prolonged or repeated wetting. Neither these nor plastic sheeting protect the timber adequately from temperature effects, particularly severe when exposed to the sun. Sheeting materials invariably tear to admit and hold, rather than repel moisture.

In all cases, the upper surface film makes for unbalanced movement in response to any changes in flooring moisture content.

Checking, gaps between boards, buckling and cupping (either concave or convex) result from this practice, as would be expected. Heavy sanding is generally accepted as necessary but checking often remains, and an uneven surface may reappear due to movement after sanding. Oil spots persist around nail heads, at joints and between boards in some cases, to mar a polished floor.

After a lengthy trial, the local Housing Authority has found the practice generally unsatisfactory. They have restricted and will probably discontinue its use.

No seasoned flooring should be installed until adequate permanent protection has been provided. To meet the builders' apparent need for a working platform, reuseable plywood, particle board or solid timber decking panels, tacked or cleated to joists, is suggested.

Mechanized nailing, when first introduced, left a clearance between floor boards and joists, due to the impact being solely on the

nail head, rather than on head and board as in the final stage of hand driving. Reduction of the number of boards cramped at a time and nailing a few spaced "anchor" boards by hand solved the problem.

Shrinkage of joinery, furniture and parquetry in air conditioned buildings. - Air conditioning of large buildings is now regular practice, but designers, builders, joinery and furniture manufacturers has not yet become properly adjusted to modifications necessary in normal procedures.

Timber moisture content is more usually between 12% and 15% when processed and installed as interior finishing and furnishing, invariably before the air conditioning unit is in operation.

The usual drop to 8–12% and resultant shrinkage under normal controlled settings often causes unsightly joint failure, gapping and, with parquetry flooring, lifting and distortion of fingers. Solid counter tops installed at 15% may shrink as much as $\frac{3}{4}$" in drying to 8%, and cup in the process.

Specifications should be framed and constructional schedules arranged so that joinery, flooring and other finishing timbers can be allowed to attain in-service equilibrium moisture content on the site, with the air conditioning in operation well before fixing. Prefabrication of fixtures, with final assembly after on-site stabilization, might be practicable in some cases. Alternatively, since manufacturers rarely operate and store in controlled conditions, fixtures and furniture should be made up from timber towards the lower, rather than the upper limit of the normal 10–15% range, and delivered as soon as possible for retention under service conditions.

Maintenance of unpainted exterior timber. - Oiled, stained and/or preservative treated, but otherwise unfinished timber is sometimes featured externally for cladding, joinery and other applications. Although durable material is generally used, service life and performance must be inferior to that of material protected against checking, cupping, end splitting and joint separation by a more effective moisture repellent and often heat reflecting surface film such as paint.

It is doubtful if the joints in "natural finished" material are always adequately waterproofed.

Where its use is desired, joint sealing, the use of species which move least, such as the pines (suitably preservatised), and regularly maintained moisture repellents, are recommended.

Item 5(g) Problems associated with timber use in regard to current building trends (New Zealand)

(i) Centrally heated and air conditioned buildings.

The increasing use of central heating and air conditioning units in both commercial and non commercial buildings is causing an increasing number of timber movement and distortion problems. It is fairly well appreciated that moisture contents lower than emc must be used when being installed in heated buildings but the practical problems associated with maintaining timber at the service moisture content throughout the construction phase often appear insurmountable. While it should be possible to overcome many of the problems in larger commercial buildings by copying overseas practice the smaller heated buildings and private homes still constitute problem areas which at the moment do not appear to have practical solutions.

Every opportunity is taken - at courses of instruction, symposia etc - to sound appropriate warnings to pertinent sectors of the timber and building industries. Special mention is made of the importance of proper specification and programming of construction.

(ii) Prelaying of floors.

This practice is still growing amongst builders and now includes particle board and strip flooring. A study carried out on the efficacy of 6 commercial and 2 non commercial water repellents used as sealers on prelaid floors showed that none of the preparations are effective sealers against moisture pick up (liquid phase). The appearance and performance of defective prelaid floors is not likely to be enhanced by central heating.

The prelaying of particle board floors has only been approved by S A C when used with a water repellent and it is as yet too early to judge the long term performance of particle board floors laid under these circumstances.

Discussion

Brabin: Stabilized dimensioned framing is now available and is being used in Victoria. It includes finger jointed short length material. The price is up to 37/100 su ft more than green framing, in Melbourne to a builder it is $4.50 more. The builders are paying this extra for the advantages offered. Dry framing is needed because:

Victorian timbers have higher shrinkage than many other hardwoods; house frames are no longer left to dry before being completed; dry

softwood framing is on the market; it provides an outlet for shorts.

Smith: Can DFP provide or develop recommended drying schedules for framing sizes?

Muncey: We will recommend the seasoning of 2 and 3 in. timber when it has been proved that this is the best thing to do. We are at present looking at the question of laminating as against drying thick stock, the economics of the whole question must be carefully assessed.

Item 5(h) Utilization of small diameter, fast growing eucalypts*

In the economic management of both natural regeneration and plantation eucalypts forests it is necessary to find uses for the huge volume of small diameter thinnings which are produced. Although pulp is a potential outlet for much of this timber, it would be of great immediate advantage if it were possible to saw more of it.

The purpose of this report is to make known the results of experimental work carried out by the New South Wales Forestry Commission to reduce degrade due to spring of this material when it is sawn.

The possibility of reducing spring in sawing small diameter eucalypts was first drawn to our attention by a sawmiller, Mr J Croll of Dungog, who observed that Eucalyptus saligna logs of small diameter showed reduced spring when stored in the mill yard for 3 to 6 months prior to sawing.

In view of the possible economic importance of this, an experiment was organized by the Division whereby fast grown young blackbutt (E. pilularis) logs from Whian Whian State Forest were given the following four treatments before sawing:-

Sawn immediately after felling

Stored under water for 4.5 months

Stored in bush, end coated, for 4.5 months

Stored in mill yard, end coated for 4.5 months.

After sawing and air/kiln seasoning the material was graded in accordance with SAA rules, ignoring the spring and bow. The spring and bow was also carefully measured and this effect was considered separately. The best overall results, ignoring the spring and bow, were obtained from the logs stored in water.

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* Prepared by H E Booth

Briefly the results obtained were as follows:-

Yield % sawn-volume SF log volume hf	Logs sawn immediately on felling	Logs sawn after 4.5 months in water	Logs sawn after 4.5 months in bush	Logs sawn after 4.5 months in yard
% Select	10	18	7	6
% Standard	29	23	27	30
% Total	39	41	34	36

The above results do not include any degrade due to spring or bow. Degrade was principally due to collapse in heartwood and checking. It will be seen that the yield of select material and the overall yield is higher for the logs stored under water. As would be expected the overall yield from fresh sawn logs when bow and spring is disregarded is higher than logs stored dry, mainly due to reduced checking and splitting in the logs.

Spring and bow. - It is difficult to make an exact meaningful comparison between treatments for spring and bow. One reason for this is that the measured spring or bow is a function of the length squared. Also even severe spring can usually be tolerated in short lengths and narrow widths since its absolute magnitude and the force needed to eliminate it in a structure, are small. When compared for spring alone and ignoring bow as a defect of minor importance, the reduction caused by log storage is surprising. When comparisons are made between equal lengths and cross sections the value of spring for the stored logs averages about 40% of the spring for fresh logs. For wide boards the reduction is higher, in small sections the reduction is less than average. The experiment clearly shows the reduction in spring and bow caused by log storage.

Best results are obtained by storage under water since this reduces total log degrade and if wide boards are to be sawn the process is economically sound. If flooring only is to be sawn, the spring produced in sawing fresh logs can be tolerated as cramping will cope with spring except in very severe cases.

The above results have been confirmed by the author in similar experiments made with plantation grown E. saligna in South America. It is interesting to note that the practice of storing in water, logs of native hardwoods having a high internal stress, is also carried out in South America in some regions and the results are regarded as well worthwhile. Storage periods range from 6 to 12 months.

It would appear that the practice of storing logs, preferably under wet conditions to relieve growth stresses is worthwhile and represents a genuine contribution to overcoming this troublesome problem.

Item 5(h) Problems of fast grown eucalypts*

Extensive studies at the Division of Forest Products over the past few years have shown that poles from fast grown "ash" eucalypts rarely degrade beyond acceptable limits while air drying. In most cases, the end splitting that does occur in poles is due to the relief of growth stresses developed in the growing stem, but splitting can be accentuated by drying stresses particularly in the first weeks after felling.

In sawlogs, however, growth stresses can cause some boards to spring as they are sawn, especially those out from small, fast-grown logs. Increasing use of such material at some mills and the consequent risk of losses in recovery because of spring are the main reasons for the Division's interest in the problem of removing spring from sawn boards, and for its plans to look at the rheological behaviour of boards with spring.

While it is possible to tackle this problem at various stages in drying, it has been shown that spring can be removed by restacking and restraining sprung boards in a special frame before reconditioning and redrying.

Item 5(i) Compliance with the clean air act (NSW)**

With the growth of country towns in New South Wales containing sawmills and joinery works in or on their outskirts, the burning of wood waste frequently results in air pollution. Emission of smoke, the deposition of large particles of fly ash, unburned and partially burned wood from incinerators are a constant source of complaint to the local authorities by residents within a radius of half a mile of the incinerators.

As a result of public pressure, regulations under the New South Wales Clean Air Act have been promulgated which have set limits on the density of smoke and the concentration of solid matter that can be emitted from any industrial plant. The relevant regulation is Regulation 17 (ii) which states:-

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* Prepared by F J Christensen

** " " G Canaway

"any boilers or incinerators emitting dust, fly ash, soot or other solid particles in each cu ft of residual gas adjusted to a basis of 12% CO_2 shall be such that the total mass of such solid particles does not exceed 0.2 grains".

The adjustment to a basis of 12% CO_2 came as a result of tests made by the Department of Health, New South Wales on wood waste incinerators, in which it was found that in many cases 4-5 times the normal amount of air was present at the point of sampling and this dilution frequently reduced smoke emission below the statutory minimum but still left the problem of the deposition.

Results of investigations

Although there are many types of wood waste burning "appliances" throughout this State, there are possibly only two for which there are design figures, viz:-

The McCashney burner

The Teepee type burner

The McCashney type has a limited application for the average Australian sawmill cutting faulty hardwood in which it is necessary to deal with large hearts, slabs edgings etc. in addition to wet sawdust and shavings. This is shown by the preference of sawmillers for the teepee unit and it is this unit that is causing the trouble in most country towns.

Following requests for permission to use the teepee unit in Sydney the New South Wales Department of Health carried out tests on smoke emission and solid particle emission from these incinerators.

Smoke emission. - Smoke emission from wood waste is usually a combustion problem. At low loads, emissions were found to be due to large quantities of excess air passing through the furnace which cooled it below the level required for proper combustion giving the smoke a blue grey color. Insufficient air at high load causes black smoke and the most satisfactory method of controlling this appears to be the installation of a storage hopper and method of controlling the feed to enable the incinerator to operate at its designed load.

Solid particle emission. - Tests were conducted on two burners at Dorrigo on the north coast of New South Wales, one 39' dia and the other 19', the larger one being equipped with forced primary air and both were fed by a scraper conveyor.

The load on the larger unit was 65,000 lb/8 hr whilst the smaller was 8,000 lb/day.

Deposition readings downwind of the units ranged from 136 tons/sq mile/month to 207 tons/sq mile/month for the 39' dia unit depending on the reduction of the tangential air through the side ventilators and floor ports. However, at 136 tons/month the combustion rate was below the required level.

The 19' dia burner recorded a deposition of from 85 to 125 tons/sq mile/month.

As this fallout appeared to be excessive isokinetic sampling tests were carried out by Murphy and the results were as follows:-

Emission of solid particles from Teepee Incinerator 19' base diameter burning hardwood off-cuts and sawdust

Test number	1	2	3	4
Feed rates lb/hr	622	805	1320	2105
Flue gas flow rate cu ft at S T P	8610	11700	10700	13380
Average flue gas temperature °F	258	377	462	509
Average CO_2 in flue gas %	1.4	1.5	2.5	3.1
Fly ash concentration grains/cu ft at S T P - 12% CO_2	.20	.43	.43	.45
Percentage emission - %	.28	.68	.62	.64

These results show that the emission of solid particles is higher than the acceptable levels and is probably indicative of most teepee type burners.

From the above it can be seen that teepee incinerators in their present form are not capable of meeting the standards of emission of solid particles throughout their normal load range. It is suggested by Murphy that there is no technical reason why burners could not be fitted with dust collectors and that smoke emission control would depend on storage hoppers and feeding mechanisms.

Control developments in New South Wales

Two firms associated with the timber industry are investigating the problem in this State, namely N P Engineering Co., Taren Point ("Aircool") and Isles Forge and Engineering Co. Ltd., Coffs Harbour ("Rees").

N P Engineering are interested in the development of a water curtain scrubber and are preparing drawings to fit this unit to their burners. As yet no prices are available for the installation and supply of equipment.

Isles Forge who make and distribute the Rees burner under licence from the parent company Rees Burner and Blow Pipe Co. USA, have access to research figures made available by the Oregon State University and associated bodies after extensive research programs.

They offer a hydro wash unit with or without a forced draft system and surge bin to suit the load and size of burner. Prices quoted for the hydro wash assembly varies from $14,000-$35,000, surge bin and forced draft are extra.

Is there a need for further investigation?

The purpose of this paper is:-

To state the problem and highlight the need for investigation

To show what is being done to overcome the problem and if possible -

To promote discussion between interested groups in an effort to assist the industry in dealing with the problem.

From overseas and Australian investigations it would appear that the answer lies in one or all of the following:-

Control of the burner load

Air control

The use of a hydro wash to filter the solid particles.

Is it possible that the research information available from Oregon State University could be used in an attempt to find a solution to the proper operation of the teepee burner under Australian conditions?

Item 5(i) Air pollution and effluent disposal* (DFP)

The Division receives relatively few reports of problems with McCashney incinerators although it is possible that more problems could be met and overcome without our knowledge.

It is our impression that the McCashney incinerator is a generally satisfactory incinerator for the disposal of wood wastes provided,

(i) it is correctly sized to handle the load involved,

(ii) it is not subject to wide load fluctuations,

(iii) it has been constructed to specification and is well maintained,

(iv) the air volume is as specified for the particular size.

Problems related to (ii) and sometimes to (i) can usually be overcome by regulated feeding from a storage hopper and to (iv) by suitable adjustment or the provision of a small auxiliary blower.

Fluctuating loads, underloading, or gross excess air are the major causes of operational problems with McCashney incinerators.

For optimum performance a regulated feed from a storage hopper is recommended and indeed this statement could apply to all types of incinerators. Furthermore, the attainment of suitable temperatures by initial preheating before commencement of operations is important.

We have not measured particulate emission from McCashney incinerators and cannot comment on this aspect. Generally, however, with suitable adjustment smoke-free performance can be obtained, particularly with dry wastes.

Spark arrestors have not been considered necessary on correctly sized and properly operated units, However, a water spray fitted to one McCashney burning cypress pine was effective in reducing the ejection of a light white flaky ash which was formed with this particular species, and some of which drifted out with the flue gases.

It has been our opinion that smoking and particle ejection is more likely with "teepee" burners although we have not been actively engaged with problems encountered with these burners. Here again, however, experimental results from USA suggest that significant

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* Prepared by R M Liversidge

improvements in performance can be achieved by suitable sizing, control and operation. The importance of correct sizing of the "teepee" burner is emphasized as is the control of air volumes and the provision of adequate maintenance.

We have had no practical experience with multi compartment type incinerators and cannot comment on these.

Discussion

Page: A fire pit has been devised in Victoria which emits only a small amount of smoke and which has been approved by the CFA. The pit is 30 ft wide and 20 ft deep and is surrounded by a 12 ft high wire mesh fence on which are mounted water sprays draining into a channel below the fence.

Wickett: This is a nationwide problem. However, some of the figures quoted by Murphy at the Auckland conference are not as frightening as may seem at first, e.g. 100 ton/s mile/month is actually only approximately 3 g/s ft/month.

Burners should not be overloaded as this is one of the main causes of increasing smoke. A McCashney burner will not handle large sized sawmill waste and, since it is uneconomical to reduce large pieces to a small size, the McCashney is not as good as the large conical burner. I would like to see the Division of Forest Products relate the work done in Oregon to Australian conditions.

Bryant: I would like to see the pit burner mentioned by Mr Page publicised. (Muncey agreed this would be done.)

Item 5(j) Minor forest products*

In this short review of the present position of the minor forest products industry, anything from the forest which yields a useful product has been included, with the exception of products made from timber.

Charcoal

This industry has remained essentially stagnant over the past ten years, there being no new developments to change the position. By far the greatest production of charcoal is at Wundowie in Western Australia, and this is almost entirely consumed by the associated steel plant. About 300–400 tons/year have been produced in the Murray Valley

* Prepared by F R Humphreys

to cater for the needs of the large metropolitan areas, steel case hardening activities, CS_2 manufacture, and domestic charcoal burners. There has been a small export trade in charcoal to New Zealand but recently extra freight charges have placed this in jeopardy. Various attempts to make activated charcoal from Australian wood have all come to nothing because users of such a product require above all, guaranteed uniform and known activity. Any change in their processing procedures would require expensive readjustments which the total cost of activated charcoal does not justify. In any case there is little doubt that it would be difficult to produce a suitable activated charcoal because of raw material variability. The overall production of charcoal outside the Wundowie complex is so low that it has not been possible to obtain sufficient surplus from any of the operations to finance the promotion necessary to make any real inroads on the domestic market. On the other hand, those who have used finance obtained elsewhere to promote charcoal have come up against the primitive nature of production units and their inability to handle a highly seasonable and fickle market situation. The main industrial use, CS_2 manufacture, has not expanded because its outlet, rayon manufacture, has not expanded.

Essential oils

Cineole oils continue to hold a reasonable place on the world market, 51 tons being exported last year worth about $80,000. This is mostly produced from the mallees and ironbarks with some from Eucalyptus australiana and E. dives var C.

It is almost impossible to arrive at any meaningful figure about production for local consumption.

E. dives piperitone oils are produced at a reasonably regular rate of about 65 tons/year for the manufacture of menthol and thymol.

On the other hand, the position with phellandrene oils is completely hopeless. Virtually none is now produced because it must compete with either pine oil at 17¢/lb or phellandrene oils produced as a by-product from camphor production.

It is interesting to note that steady market for Melaleuca alternifolia oil amounting to 6 to 7 tons/year has been developed at the very reasonable price of $2.50/lb. This small industry has recommenced after many years of stagnation. Production is being carried out in two small plants using modern concepts and there is every possibility that it will continue and even grow a little. The product is being sold to the US almost entirely and is being used in antiseptics and flavouring materials.

Eucalyptus camaldulensis kino

A small but very consistent market for E. camaldulensis kino of about 700 lb/annum, worth about $10/kilo, has existed for many years and continues. Not many people realise that this material is listed in the British Pharmaceutical Codex for use both as an astringent and for the treatment of minor gastric illness. An incision is made in suitable trees where pockets of kino are thought to exist. Skilled operators seldom fail to find these when they select a tree for tapping. The kino is allowed to dry and the powder exported to Canada.

Sandarac resin

Some years ago a small export industry was commenced collecting sandarac resin from the stumps of fallen Callitris trees and exporting to the UK. This has been built up to almost 4 tons/annum and is worth about $4/kilo, some of this going to USA and some to France.

Tannin

The wattle bark industry in Australia is almost dead. The only meaningful production of tannin is that which is carried on in Western Australian where tannin is produced from the wood of E. redunca and E. accidens and perhaps other species. About 5000 tons/annum are produced of this material, all of which is exported. There is very little future for further tannin production in Australia for use in the leather industry unless trading and other conditions change drastically for some reason. The use of sole leather is on the decline and other and more specific tanning agents are used for soft leathers.

The possibilities of using tannins as phenolic adhesives is the most promising avenue of expansion but it is probable that even here South African wattle tannin will be the material of choice.

Hyoscine and Hyoscyamine

There is still no industrial extraction of either hyscine or hyoscyamine in Australia, although it has been, and is being, seriously contemplated by at least two companies. The industry has continued to export the dried leaves from the northern coastal areas, both grown in plantations (Duboisia leichhardtii) in Queensland and naturally (Duboisia myoporoides). There is only one processor of the corkwood leaves left in production, whereas at the height of the North Coast corkwood boom there were at least four. The total output is in the vicinity of 100 tons/annum and is worth about $350,000.

Efforts to improve the alkaloid content both in quantity and quality by selection have met with only limited technical success and not a great deal of economic incentive from the main purchaser.

It has been shown that vegetative propagation of trees which produce high yields of hyoscine only, is feasible and it does not seem unreasonable to imagine that this could present the purchaser with a substantial saving in processing costs. However, because large quantities of mixed material must be processed whatever happens, a special lot of leaves would only present him with the impossible problems of special processing. This would not be the case however if a small extraction plant started operation in Australia. Clones of suitable material exist and it is not difficult to separate the good plants, for breeding purposes, by paper chromatography. But whether such a producer could produce cheaper and whether he could break into the hyscine market is quite another question.

Rutin

There are now three rutin extraction plants producing more than 200 tons of rutin/annum worth more than $A1,000,000 entirely for export.

The industry employs directly and indirectly about 140 people. Two plants (one at Orange, New South Wales and the other in Melbourne) use E. macrorhyncha leaves collected in the Central and Southern Tablelands as raw material. The other plant uses mainly E. youmanii gathered from the Northern Tablelands. Some attempts have been made to use other species such as E. delegatensis and a variety of E. lindleana, but these have met with only limited success. E. delegatensis contains insufficient rutin to make it an attractive raw material. The extraction process used (water at or above 100°C as the extractant) has a yield which is a function of the rutin/leaf ratio - the more inherently inefficient the extraction, the more important this ratio becomes. The problem with E. lindleana is the fact that this species does not always contain rutin. Collectors must resort to field testing each tree. All collectors have to grapple with the very real problem of species selection, particularly on the Northern Tablelands, and the associated problem of hybridization. Despite its higher yield, E. youmanii collection costs are considerably greater than E. macrorhyncha because of the more scattered nature of its occurrence and the freedom with which it hybridizes. It also occurs in association with morphologically similar stringybark species.

The requirements of the main purchaser are quite stringent, a material which contains greater than 96% rutin virtually free of iron and other inorganic material and quercetin being required. Water

purity and materials of construction are therefore very important. These impurities once they are incorporated into the product are very difficult and expensive to remove, if they can be removed at all.

There is keen competition amongst the producers and the quality of the product has continued to improve. All plants use some degree of technical product control and have laboratories attached. This industry undoubtedly represents the most technically advanced and controlled minor forest product industry in the east of Australia, being on much the same plane as the tannin extraction industry in Western Australia.

Furfural

Lastly there is a promising development in the field of bark utilization, in the manufacture of furfural using waste material from chipping plants.

Promising yields have been obtained using the dry distillation process, and it is feasible that this development may eventuate.

Discussion

Colwell: Minor products are important in New Guinea; these include resins, gum and rattan, 2 tons/month of the latter being produced.

Foxton: Some 500 tons/year of crude eucalyptus oil is being processed for use in mineral flotation.

Woodhead: Trials of pine bark for separating oil pollution in seawater are being carried out.

Threader: Charcoal, woodwool and woodflour are being produced from radiata pine.

ITEM 6 TIMBER SEASONING

Item 6(a) Review of research activities (DFP)

In summary, we are continuing to concentrate on techniques and processes which give better control of dried quality and minimize the cost of the seasoning process.

The cost structure of the whole drying procedure from the green to the dry condition is being examined in detail to determine the

effect of the various contributing factors. This examination is being integrated into other related processes such as log procurement, grading and conversion, material handling and end use requirements.

Moisture movement. - With the recent appointment of Dr J F G Mackay, work on moisture movement in wood has been resumed with an investigation of the water vapour diffusion characteristics of certain hardwood heartwoods particularly in reference to the relationship between drying properties and anatomical features. Research has also commenced on drying and storage effects on radial permeability, the main interest lying in the physiology and function of medullary ray parenchyma.

Drying of sawn timber. - Considerable attention has been given to drying radiata pine in respect of moisture content uniformity, drying rate and distortion. Some of this work will be reported under separate items. Work in this field is being continued and extended.

Special consideration is being given to the problems of drying stud sizes obtained from young conifer stands in which drying problems associated with spiral grain are being experienced. Initial laboratory trials have given encouraging results.

Attention has also been given to the drying of "ash" eucalypts using pretreatments that included surface coatings, prefreezing, precompression, preheating and presteaming as well as by schedule control. The effects of method of sawing have also been studied. Detailed results are given in separate submissions.

Experimental work on the control of shrinkage by certain bulking agents at various concentrations was completed and the first report issued. It was found that treated material required longer drying times under standard drying conditions, and that glycerol, with the lowest molecular weight of the materials tested, proved to be the best dimensional stabilizer.

Developments in dryer design have included a low cost, screen kiln reconditioner and two laboratory units - a low temperature forced air dryer and a high temperature, high flow dryer - both of which are nearly completed. Some details are given in Item 6(b).

Air drying. - Work has continued on the use of model stacks in the laboratory wind tunnel to predict air flow behaviour in commercial air drying yards. The scope of the study has been extended by using models of a smaller scale to allow larger stack layouts to be tested.

Recent work has shown that under experimental conditions, a steady wind direction gives model stack evaporation rates (with para-dichlorbenzene) similar to that found when the wind direction was varied quite widely about a prevailing direction. This removes one of the uncertainties regarding the application of laboratory results to commercial conditions.

While correlations with industrial installations have not been fully established, recommendations for layouts at several drying plants have been based on experimental data obtained; results achieved have been very satisfactory.

Drying of round timbers. - Experimental studies on the boultonizing of poles has now been completed with the work on small diameter karri and jarrah poles. The project has shown that boultonizing can be applied very successfully to a number of the denser eucalypt species. Results of our pilot plant studies on boultonizing are now being applied at several commercial preservation plants. Further details of this work are given in Item 4(c).

Training and technical assistance. - The Section has continued with the training of overseas students together with a number of short term trainees from the Australian industry. There has been a strong demand for the Kiln Operator's Course which has been continued.

At the 9th Commonwealth Forestry Conference in 1968, Australia accepted Convenership for the Timber Seasoning Corresponding Sub-Committee, and Mr J E Barnacle was subsequently appointed Convener. Work is very active and involves many countries. The Madison Forest Products Laboratory has been of considerable help in supplying publications and some technical assistance. It is hoped that information exchanged will prove of considerable benefit to the less developed countries.

In collaboration with the Division of Mathematical Statistics and the W A Forest Department, an analysis of the drying performance of Phytophthora affected jarrah has been carried out.

Technical service to the Australian industry has been continued with kiln designs, layouts and waste disposal. Advice has also been given to a number of overseas countries by way of correspondence and discussions with visitors, and, in particular to New Guinea and the B S I P with the setting up of facilities for seasoning research.

Item 6(a) Research review (NZ)*

In the absence of research scientists seasoning research has been confined to generalised studies of drying schedules and the effects of seasoning methods on wood properties.

Kiln drying

Comparative drying rates of 4 x 2 in. and 6 x 1 in. radiata pine for a range of kiln schedules

Comparison of drying rates of compression wood and non-compression wood in radiata pine revealed only minor differences which can be ignored for practical purposes

Species trials

Podocarpus spicatus dried without degrade but black surface staining occurred above 160°F.
Litsaea calicaris showed gross distortion and collapse in all heartwood boards

Cupressus macrocarpa has proved surprisingly difficult so far : internal checking even on mild schedules

Equilibrium moisture content of kiln dried radiata pine. 4 x 1 in. flat-sawn sapwood, air dried, oven-dried, and kiln dried with 20°F wet bulb depression at dry bulb temperatures 130°, 150°, 170° and 190°F (six treatments in all). Exposed outside under cover and weighed weekly for one year, showed increasingly lower emc's with higher drying temperatures (air dried 19.1%, oven dried 16.2%); and also slower rates of change of moisture content for samples dried at the higher temperatures

Pinus strobus has been dipped in sodium fluorate as a prophylactic in the prevention of brown enzymatic staining during kiln drying. A 0.4% solution (wt/wt) has a definite inhibiting effect.

Shrinkage and distortion

Examination of the oft-repeated claim that, in practice, considerable shrinkage occurs in sawn radiata pine at moisture contents above fibre saturation proved it to be groundless. Less than 1% shrinkage occurred before the average moisture

* Prepared by D H Williams

content reached fibre saturation.

A comparison of distortion between matched air dried and kiln dried boards (6 x 1 in. flat sawn radiata sapwood dried without restraint). Distortion was measured after drying, and after allowing boards to equalise for six months on racks under cover outdoors. Both showed considerable reduction in all forms of distortion even though moisture content of air dried boards was the same at the end of the six month period as at the beginning.

Air drying

Reports have been prepared on air drying of:
1 in. and 2 in. Dacrydium cupressinum : slow drying; covering stacks did not improve drying rates greatly, but largely prevented degrade.

Pseudotsuga menziesii. Covers aided drying in winter but not in summer. Their chief value was in minimising surface checking to which this species is particularly prone

Air drying trials with radiata pine posts have recently been carried out in Auckland to evaluate the effectiveness of a commercial water repellent additive in preventing the development of internal decay and in accelerating drying. The additive was added to a standard prophylactic solution of borax plus sodium pentachlorophenate according to manufacturer's instructions. It was found that the additive failed to accelerate drying, and did not prevent the development of internal decay in uncovered posts put into stack at the least favourable period of the year (March - July). The amount of external staining was reduced however.

Item 6(b) Developments in timber seasoning (NSW)*

Gradient drying

The development of the technique of "Gradient drying" was reported at the last Conference. This consists of measuring timber moisture contents and temperatures during drying by means of electrodes embedded in the timber connected to a moisture meter and potentiometer in the control room. This method is gaining commercial acceptance and there are now three plants in Sydney using it. It is anticipated

* Prepared by J Hartley

that the instrumentation and wiring will be installed in at least one other plant in New South Wales in the near future.

Considerable experience has been gained by the operators, and moisture meter correction figures at elevated temperatures have been determined for a number of species, including oregon, radiata pine (New Zealand), western hemlock, western red cedar, meranti and brush box. One point worth noting is the operators' satisfaction with the method, and their claims that they dry faster with less degrade than when using set schedules and sample boards. The knowledge and ability of the people operating these plants at present is considerably above average, and problems may arise in the future if relatively unskilled operators try to determine correction figures, and control their kiln runs from the figures they obtain. For this reason there is a need to standardize, as far as possible, the practical details that could affect the results, and to obtain and collate all the available correction figures.

Surface coatings

The tulip oaks (Heritiera spp.) are rainforest timbers that are available in reasonable quantities, but are not fully utilized due to their proneness to face checking, particularly on the back sawn faces. Approaches to the solution of this problem were reported to the last Conference. Since then this work has continued, concentrating on dipping green boards in a solution of sodium alginate, either alone or extended with woodflour, before stripping and air-drying. The results have been very promising, with a marked reduction of checking, and timber that has been accepted for cabinet work has been produced in semi commercial pilot trials. Details of the method used were published in a paper by J Harrison in the Australian Timber Journal (Vol. 34, No. 7, August 1968).

Since that was written it has been demonstrated that whole stripped slings can be dipped and drained, rather than the dipping of individual boards used in the trials. This will reduce the handling costs considerably.

This method has also produced a marked reduction of checking in trials with other low-collapse species, but results with collapse-susceptible species are not as promising, although some reduction in checking has been observed.

An associated problem arises from the need to immunise many of the species most suitable for this treatment. Attempts to obtain adequate diffusion of preserving chemicals incorporated in the dip, without a period of retarded drying (e.g. by block stacking) have given patchy and generally unsatisfactory results. Further work

will be undertaken to develop commercially applicable methods that will give adequate immunisation, together with the protection against early severe case drying afforded by the alginate coating.

Cypress pine

The investigation into the drying and milling of cypress pine flooring was reported in some detail at the last Conference. The results have now been collated and will be published shortly. The main conclusions are that cypress can be rapidly air-dried west of the Dividing Range, and can be milled with little degrade at moisture contents down to about 15%. Where a seasoned end product is to be used it will be more economical to dry at the mill, and machine after drying, rather than the present practice of sending green, milled boards to the coast, where they are then dried, usually in comparatively slow air-drying conditions.

Brush box

The economical utilization of this species, particularly the "curly-grained" material, is a problem facing the New South Wales industry. Following enquiries from one miller, trials will be conducted aimed at producing feature panelling, and large sizes, seasoned and free of checks and collapse distortion. The former should be quite possible with good drying practice and control, but the latter will be more difficult, and the trial will include chemical seasoning with urea. This has been used successfully in previously reported trials to produce material for turnery and window sills. We hope to be able to report results before the next Conference.

Utilization of low quality eucalypts for scantling

A number of New South Wales millers are interested in producing dressed, size-matched, seasoned scantling from the stringybark and ash type Eucalypts. It should be possible to do this without excessive degrade by either air, or combined air and kiln drying, plus reconditioning, followed by docking out reject material and finger-jointing the resulting shorts. This is obviously expensive, and the millers will have to compete against imported softwoods. Can it be done economically? Where are the economical limits? We have heard that at least part of this process is being done in Victoria, and this is primarily a request for information.

Forced-air driers

There is a growing interest in this type of drier. We have inspected one installation, but have not yet carried out a detailed

test. It appears to be quite suitable for drying relatively easily dried species down to moisture contents somewhat above equilibrium moisture content, but we doubt if the humidity control and rate of heat input are adequate for the successful and economical drying of refractory species, or for producing a fully seasoned end product. We are interested in any information about the limitations and economics of this type of drier that any delegates may have.

Miscellaneous

There are two other seasoning problems of immediate importance in New South Wales:

(i) Developing satisfactory drying schedules for negrohead beech. This rain forest timber is relatively abundant, but its drying is slow and difficult, due primarily to the large variations in green moisture contents, the tendency for "wet spots" to develop, and its proneness to internal checking

(ii) Millers are experiencing trouble from large gross shrinkage and severe checking in manna gum, white gum, and similar species from the Dorrigo area.

We will be working on both of these problems in the near future, and will report any developments of importance.

Item 6(b) Developments in timber seasoning (DFP)*

The increasing use of radiata pine in structural sizes has led to an extensive program to determine optimum drying procedures. Some studies on high temperature drying of stud material have recently been completed and a report is given under the next item. This work will proceed further with the construction of a drying tunnel capable of temperatures up to 250°F and air speeds up to 2000 ft/min. The unit is almost complete and drying tests on 1 in. radiata pine boards will commence shortly.

The economic feasibility of non-critical drying under very mild conditions such as 100-120°F is to be examined in a laboratory drier now under construction. This is a multi-pack unit which can be operated as a progressive drier with open circuit or closed circuit air flow. The unit will also be used to determine the conditions

* Prepared by R Finighan

under which heated or unheated forced air driers can be operated economically and to determine drying costs using various fuels and heating systems.

A recently designed low cost screen kiln has now satisfactorily completed proving trials at a commercial plant. It incorporates a simplified heating and circulating system in which a single fan is mounted at floor level in the rear and uniform air distribution is obtained by using a plenum screen. Reconditioning in the drying chamber has not presented serious corrosion problems.

Discussion

Threader: In Victoria, the price of finger-jointed framing products is $5 to $7 above that of green scantlings. There is only one plant "buying-in" shorts for finger-jointing.

Booth: Because urea glues may become "fatigued" in scantlings, the South Africans have abandoned the use of urea glues and now prefer resorcinols.

Page: The chances of failure are very low once framing is in place. In flooring, finger-jointing without gluing meets CEBS specification and urea glues have been used overseas for many years for this purpose with no trouble.

Cokley: Gradient drying is very successful in Queensland and forced air drying is satisfactory for some low density species, but the Intertherm drier has given trouble with humidity control. This aspect requires further study but modification should be possible.

Hartley: I have tested only one "Intertherm" installation. They do not appear to be able to give a wet bulb depression of less than 15-20°F.

Christensen: Relative humidity control of "Intertherm" driers at present is not good enough for critical applications.

Item 6(c) High temperature drying of radiata pine*

As the use of seasoned radiata pine in structural sizes increases, the necessity for increased plant capacity will also arise. The answer could well lie in the use of kiln drying temperatures above 212°F for accelerating drying rate.

The economics of faster drying have recently been examined at the Division in terms of drying time and the effect on dried quality.

Of particular interest is a comparison between three runs, run 1 being kiln dried under a conventional schedule commencing at 150°F DBT, 145°F WBT, finishing at 160°F DBT, 130°F WBT, and runs 2 and 3 at 240°F DBT, 212°F WBT (i.e. under superheated steam conditions) throughout. For runs 1 and 2, the average rate of air speed through the stacks was 350 ft/min and for run 3 it was 650 ft/min.

A comparison of drying characteristics of the three runs is given below:

Run No.	Moisture C.% Green	Final	Drying time Days	Hrs	Shrinkage % Width	Thickness	Remarks
1	108	12	4	12	3.5	2.4	Slight to severe checks in several boards. Average amount of twist after KD 1° (meas. over 18").
2	118	12	1	12	4.2	5.3	Slight to moderate checks in several boards. Average amount of twist after KD 0.5°
3	116	12	0	21	3.1	3.6	Minor checking only in a few boards. Average amount of twist after KD 0.5°.

Although the tests involved only a few boards the appearance of run 3 after kiln drying indicates that there may be less drying degrade with high temperature drying than with the drying under conventional kiln schedules. The drying rate of run 2 was three times as fast as that of run 1 and run 3 was five times as fast: the faster rate in run 3 being due to the fact that the rate of air speed was almost twice as fast as in run 2. However, moisture gradients were steeper in run 3 after kiln drying than in run 2.

Moisture gradients tend to be steeper in the high temperature dried material than in conventionally dried material, but this is not a serious problem and is easily corrected by a conditioning and stress relieving treatment given at the end of kiln drying.

Huddleston: Has the effect of high temperature drying on strength been examined?

Christensen: It is not significant except for impact strength where there could be a marked reduction.

Cokley: In general, drying temperatures in New Zealand are higher than in Australia. The high temperature drying of high moisture content boron treated material has caused marked corrosion of kiln vents due to boron compounds in steam. This is eliminated by a preliminary air drying.

Cheal: Redrying of 1½ and 2 in. thick treated radiata pine boards 4–10 in. wide gives trouble in summer at Mt Gambier because of surface checking, particularly in boards at the outside and top of stacks. Can this be avoided?

Christensen: Boards containing some heartwood could develop compression set during treatment, and then shrink more than usual on redrying. Covering the tops of air drying stacks would help to reduce checking in the outer layers, but redrying in the kiln at high temperature would probably eliminate the trouble if the expense is justified. The latter is based on results obtained with radiata pine poles, which took longer to redry because of higher than "green" moisture content after treatment.

Item 6(d) The reduction of distortion in sawn material particularly from small diameter stems*

The reduction of distortion in sawn material from small diameter stems is a utilization problem particularly where plantation timbers are being cut as thinnings from relatively young plantation areas, and where it is desirable to mill the logs to a top end diameter in the region of 4 in. under bark.

By distortion is inferred mainly twist and two approaches to this problem have been investigated:

(i) Drying of small plantation logs of hoop pine prior to sawing and (ii) the elimination of twist from rejected exotic scantlings using hot water treatment and reconditioning.

An investigation into the drying of small plantation logs of hoop pine was prompted by one of our pine plantation sawmillers reporting that he had obtained distortion-free 3" x 2" stud material by drying the logs before sawing.

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* Prepared by D K Gough

The following points are relevant:

The necessity to utilize small logs for purposes other than for pulp. (By small is meant top logs with a small end diameter of 4" under bark).

The desirability of channelling this product into 3" x 2" stud material, because of the strong possibility of any product from these top logs containing pith and a large number of small knots.

The realization that unless most elaborate precautions are taken in drying this material, it is virtually impossible to produce material of acceptable grade. This is due to the inherent property of high angle spiral grain around the region of the pith, and it is apparent that this is responsible for severe twisting during drying.

It was considered that in drying a small log an amount of twisting would occur in the same manner that a piece of lumber would twist when dried from green.

An experiment designed to determine the moisture content level and the time required for air drying top logs before sawing in order to obtain 3" x 2" stud material of acceptable grade was initiated in January of this year. The experiment is not as yet completed, however some interesting results have already been observed. The species being used is hoop pine which is normally barked at the stump.

(a) A control replication of 24 pieces of 3" x 2" cut from green logs, has dried to a core moisture of 18% for the highest piece to 16% for the lowest (corrected moisture meter readings) in three months. Twist recorded in this time, each piece being 8 ft in length, ranges from 8° to 20° with an average of 14.3°. Approximately 5° in this length is the maximum twist allowable for building grade and utility grade under the draft grading rules for Australian Grown Conifers. The pack of controls was weighted with about 75 lbs weight to the square foot.

(b) A replication of 24 logs stripped under cover has dried in three months to a core moisture of 23% for the highest to 18% for the lowest. In this time twist recorded, each piece being 12 ft long, has ranged from 2° to 16° with an average of 7°.

(c) A replication of 24 logs stripped in the open has dried in three months to a core moisture of 23% for the highest to 16% for the lowest. In this time twist recorded over 12 ft lengths has ranged from 3° to 20° with an average of 9.5°.

A replication of block stacked logs has been installed however, this has only been installed for one month and so far readings have not been taken.

At this stage and in the absence of statistical information there is an indication that stripping logs in the open could be the best means of drying and relieving twist. Rain wetting of these logs dried in the open could be a means of obtaining additional twist relief.

It is intended to experiment with kiln drying and steaming treatments in order to obtain a combination of the best methods of drying and the most effective method of obtaining twist relief.

Even at this stage there is an apparent correlation between twist recorded in the logs as they dry and measurements of spiral grain taken along the diametral cross section of the logs when they are green.

A method for obtaining spiral grain readings across a log was adapted from a method used by P L Northcott of the Forest Products Laboratory of Canada and described in his publication "Is Spiral Grain the Normal Growth Pattern".

Briefly the method involves splitting a 3 in. long cross-sectional disc along a diameter through the pith and measuring this resulting profile in terms of degrees of deviation from the stem axis.

An attempt to eliminate twist from rejected exotic scantlings was initiated, when, after grading air dried stacks of 4" x 2" exotic pine material it was found that under the Draft ASA Grading Rules for Australian Grown Conifers, approximately half of the slash pine and 70% of the loblolly pine was reject mainly due to twist. G B H O B of the stems ranged from 26" to 54" with an average of 36" for the slash and from 24" to 45" with an average of 33" for the loblolly.

Two methods of eliminating twist were attempted.

Reconditioning (steam treatment). - The material was stripped, weighted to approximately 50 lb weight/sq ft and reconditioned for five hrs at 180°F. The doors of the chamber were opened the next morning when the temperature then was 120°. At this stage the material had straightened out and the charge was left to air dry to emc and was then regraded. Results are as follows in number of pieces of lumber:-

Grade	I	II	III	IV	Reject
Slash pine	-	-	2	7	36 pieces
Loblolly pine	-	-	-	-	46 "

The steaming and weighting had the initial effect of straightening the material, however, once it had dried out to the lower moisture content levels (below fibre saturation point) twisting began against the force of the weights.

Hot water treatment. - This treatment involved heating the timber in water at 200°F for six hrs. The timber was allowed to air dry to emc, more than adequately weighted under packs of hardwood. Results are as follows:-

Grade	I	II	III	IV	Reject
Slash pine	-	-	2	7	36 pieces
Loblolly pine	-	-	-	-	46 "

as with the steam treatment, the material straightened under the hot water treatments but distortion took place again when the lower levels of moisture content were reached.

It is obvious that neither of these methods could provide an effective means of relieving twist from previously distorted dried material of slash and loblolly pine.

There is a likelihood that steam or hot water treatments, applied to green off saw material could be of benefit in preventing twist. In fact one of our millers of hoop pine thinnings is at present using a hot water treatment green off saw as part of his routine procedure for preventing twist.

Discussion

Christensen: Normally, twist is important only below a moisture content of about 15%. I have induced reverse twist in 2½ in. thick material dried to about 5% moisture content. The problem of twist is most serious between 5% and 15% moisture content.

Huddleston: Young pine can be dried straight by weighting the stacks but the timber is likely to twist in service.

Christensen: That is the reason for inducing a reverse twist, so that the dry wood remains more or less straight at the average emc conditions.

Cokley: In order to overcome the problem of twist, one Queensland miller is cutting his timber into short lengths and finger-jointing his finished product, which is of very acceptable quality.

Smith: Would DFP comment on the feasibility of drying logs to reduce the twist problem by milling timber from dry logs?

Christensen: This would probably be an expensive process particularly if done in dilns. There is no guarantee that material will remain untwisted after sawing - subsequent changes in both stress and moisture distributions could produce twist.

Item 6(e) The control of surface checking in backsawn collapse susceptible eucalypts*

The seasoning behaviour of the ash type eucalypts varies widely from the mild, easy drying, slightly collapsing material of north-eastern Victoria to the difficult, slow drying, surface checking, severely collapsing material found in parts of Tasmania. In some areas mild and difficult material can occur in the same locality and this increases the utilization problems. Attempts to sort the logs before milling have not been successful to date.

Where difficult material is being milled it is customary to quarter-cut boards to minimize the face checking which occurs during drying. However, the Tasmanian lumber industry believes that back sawing would result in increased productivity and lower production costs if the surface checking problems could be solved.

A considerable amount of experimental work has been carried out over the last two years to examine possible means of controlling surface checking and this report gives the results of four lines of attack.

These were (a) surface coatings, (b) chemical seasoning, (c) control of drying conditions and (d) sawing at various angles to the growth rings.

(a) Surface coatings

Neither the microcrystalline wax emulsions nor sodium alginate solutions were successful in controlling checking in "difficult" material. Both were messy to handle and the microwax treated boards dried slowly. In some instances, the presence of the wax appeared to inhibit removal of collapse.

(b) Chemical seasoning

A wide range of chemicals was examined, but the two most promising were sodium chloride and calcium chloride. Samples soaked for 16 hr in a 25% solution of sodium chloride generally dried with

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* Prepared by G S Campbell

little checking except in samples with pronounced tension wood, provided mild initial drying conditions were used. A considerable penetration of salt into the wood occurs and this presents a serious corrosion problem when treated wood comes in contact with ferrous fastenings, etc. Compounds such as di-sodium hydrogen phosphate and boric acid added to the salt solution proved ineffective as corrosion inhibitors.

Samples soaked for 6 hr in a 20% solution of calcium chloride also dried comparatively free of checking provided mild initial drying conditions were used. However, in some highly collapse susceptible trees, checking occurred while the samples were in the solution. This salt did not penetrate into the wood to the same extent as the sodium chloride and most of the treated material is removed during machining.

(c) Control of drying conditions

On the basis of experimental work carried out at the Division, it appears there are no drying conditions available to a kiln operator within the scope of conventional kiln or air drying practice that would enable him to dry all fully back sawn stock without the checking problems inherent in sawn material of this type. However, it is possible to obtain good results with timber from the "milder" trees by kiln drying from the green commencing with the very mild conditions of a dry bulb temperature of 90°F or lower if possible with a 2-3°F wet bulb depression held for the first 3-4 days. Once the check-susceptible period has passed, the conditions can be progressively increased. Results were unsatisfactory for highly collapse-susceptible back sawn stock or where tension wood was present.

(d) Grain orientation

Inspection of a large number of samples that had been air or kiln dried without any special control measures showed that under normal drying conditions, face checking is largely eliminated provided the angle of the direction of the growth rings to the board face is greater than 30° or conversely, that the angle of the medullary rays to the board face is less than 60°.

General

A dryer designed to operate on the progressive principle is at present being developed at the Division and from data already obtained, it would appear that this type of drying operation would be most suitable for controlling the surface checking that frequently occurs in joinery stock, particularly that of Tasmanian origin. The expected increase in demand for seasoned framing timbers and other heavy sizes suggests a further use for a dryer of this type.

Discussion

Hartley: We have had difficulty in maintaining a wet bulb depression below about 5°F.

Christensen: This is certainly difficult at high temperatures because of the enormous increase in the moisture holding capacity of air but is not so difficult at low temperatures when temperature control is good.

Cokley: We have had some unfortunate experiences in Queensland due to surface crystals affecting the cutters.

Christensen: We have not had enough experience to know.

Item 6(f) Surface treatments to protect timber on the construction site

Cheal: This is a major problem in South Australia, where packages of seasoned framing and flooring are often not protected at all on site, or if sisalkraft or plastic sheets are used they are often torn or misplaced. In the latter cases, water could easily enter and the damage would then often be worse than on the uncovered stacks. Woodzone has been used as a protection for laminated beams, but it was found that this interfered with subsequent finishing operations.

Christensen: For timber where a clear finish is not required, probably the best temporary protection is obtained by using a cheap pink primer which costs about 1.5¢/s ft of surface, but obviously this could not be used for all timbers, only joinery and assemblies. For timber to be clear finished a primer of a clear finish system, e.g. a urethane modified alkyd, would also give about 3 months' protection but would cost about 3¢/s ft. This could be more than justified for members such as laminated beams where appearance is important.

Jones: In respect to transport of dried timber in Queensland the practice is developing of block stacking, strapping and spraying the strapped bundle with a proprietary water repellent.

Item 6(g) Monitoring of drying in kilns (DFP)*

Papers were presented at the last Conference on (1) determining the moisture content of selected samples in a kiln with a moisture meter connected to electrodes embedded in boards, and (2) factors that may

* Prepared by F J Christensen

limit the accuracy of moisture content measurements made on commercial sized stacks dried in kilns. Previously, tests had been made with electrodes left in material for subsequent measurements, after it was noted that apparent reductions in moisture meter readings of up to 15% occurred in the sapwood of green poles within a few days of inserting them. Results indicated that the principal factors responsible for these abnormally low values were electrode pressure, contact area and contact resistance.

Because of its economic importance to industry, the Division has now resumed active work on the remote measurement of moisture content during kiln drying, with the aim of assessing accurately when stacks are dry without using traditional sample boards. Initially, investigations have been made on 1 in. thick Pinus radiata boards, but will be extended to slow drying hardwoods.

Measurements made include electrical resistance, board temperature, temperature differences and moisture gradients under several drying conditions. Readings have been obtained with a 50 channel datalogger, and recorded on punched paper tape. Data is processed by a CD3200 computer.

Item 6(h) Moisture movement inhibitors to improve stability of joinery

Cheal: While there are a number of proprietary lines on the market which repel moisture from items of joinery and like products during construction work on building sites, these can assist only in a very limited way. The basic problem is, of course, movement in the timber due to "take-up" and "loss" of moisture which affects:

a) movement of sliding and/or hinged sections etc.,

b) relationship with the adjoining materials, and

c) finishes - opening up of joints, etc.

In attempting to find and use a "cure" for the problem consideration has to be given to the effect of such a treatment on the actual finish of the product, i.e. paint, stain, or any other alternative.

Item 6(i) Prefreezing as an alternative to reconditioning*

Reconditioning of many hardwoods after drying is sound practice in regard to improving recovery and relaxing drying stresses,

* Prepared by F J Christensen

but dried quality can be adversely affected by the reopening of closed surface checks or the occurrence of fresh ones. While this is not usually a problem for quartersawn flooring and boards where checking is largely confined to edges and would generally be hidden from sight, such degrade may not be acceptable on the faces of backsawn boards and on both the edges and faces of joinery sized timbers.

Some laboratory studies have suggested that shrinkage and collapse are less in green boards subjected to freezing temperatures before drying and the Division has collaborated with a Tasmanian timber firm in an experiment on the effect of prefreezing 1½ in. thick Eucalyptus obliqua boards as an acceptable alternative to reconditioning. In the field study, boards were strip stacked in a freezing chamber operated at -15°F. They were removed after 16 hr when the temperature registered by thermocouples inside boards was about -5°F. After preliminary air drying, material was predried to 20% moisture content and finally kiln dried; the controls were then reconditioned. Detailed cost analysis of recovery from the 1500 su ft of timber used in this study showed the commercial value of the control material to be 71% of its theoretical value, while that of the prefrozen material was 84%. In the laboratory study with matched 2 ft long specimens, differences were not so apparent: shrinkage in prefrozen specimens averaged about 2% less than in the controls before reconditioning, but about 3% more when the controls were reconditioned.

Generally, while shrinkage in not-reconditioned, prefrozen material was greater than in matched material after reconditioning, its dried quality was better and less of it was downgraded for this reason.

Comparison of reconditioned and not-reconditioned laboratory material suggests that where absence of checking is of prime importance e.g. joinery and similar material, the simplest solution may be to saw slightly oversize and refrain from reconditioning. Repeated cycling at conditions ranging beyond extremes likely to be encountered in service produced negligible collapse recovery in not-reconditioned test sections.

Item 6(j) Surface treatment of Pinus radiata flooring boards to improve surface crushing strength and resistance to abrasion

Cheal: Radiata pine flooring does not, in its comparatively unprotected state, stand up kindly to traffic of any density. While various types of "finishes" are available the surface is quickly marked by normal footwear with particular emphasis on female fashions. Examples

of this are readily available in exhibition homes etc. Also in many instances, particularly with young people, the outlay of savings to buy a home generally means that purchase of furnishing items such as floor coverings etc. must, of necessity, be delayed. The wear and tear on "clear finishes" or stain floors during this period can be quite heavy. What is required is virtually an "armour plating" clear finish at an economic cost.

Discussion

Huddleston: In USA they solve the problem by placing cheap carpet over the flooring boards. This may need renewing within a short time.

Page: Rolling the surface to increase density could be beneficial.

Dale: If there was sufficient demand, the possibility of precompression and impregnation of polyester resin into the surface would be worth looking into.

Jones: Is not this a case of using the wrong species in the wrong place?

Plomley: The "Arboneeld" process, based on the use of dimethylol-urea, has been used for surface hardening and a second process in which the wood is passed between heated compression rollers has recently been resurrected (see "Wood", March 1969).

Lamb: In other words, monomer impregnation offers some possibilities.

Item 6(k) Control of end splitting in round timber*

A simple method of limiting the extent of end checks and splits in round timber has been tested and its effectiveness demonstrated in some reputedly fissile timbers namely Eucalyptus regnans, E. cypellocarpa, E. obliqua, E. sieberi, E. fastigata and E. nitens.

Where it is required to control splitting at only one of the end faces produced by cross cutting, such as when heading-off a pole the technique only requires a saw cut (groove cut) to be made around the log to approximately half the depth of the radius prior to cross cutting at a point 6-8 in. away from the groove cut. However, when the cross cut is made at the centre of a long log,

* Prepared by J E Barnacle

a groove cut is, of course, required on either side of the proposed cross cut in order to stress relieve each fresh cut end.

Theoretically, the groove cutting technique has an advantage over other end restraint methods, in that it reduces the magnitude of longitudinal compressive and tensile stresses before cross cutting and thereby positively reduces the amount of longitudinal strain energy (and hence the amount of end checking and splitting) which takes place when the cross cut is subsequently made. It also has the advantage that it can be carried out at stump using only a chain saw i.e. provided that the log is well supported to prevent sagging, and headed off to preclude springing, during sawing.

It must be pointed out however, that the technique is, by its nature, designed to limit growth stresses only; it cannot be expected to prevent or control every form of fracture such as those due to either falling stresses or bending stresses during cross cutting. In this respect, however, the groove cutting method does appear to be a prespective diagnostic tool to differentiate between the various causes of end fracture and work is already planned in this area.

A brief description of the technique has been printed in the Division of Forest Products' Technical Note No. 4, and this has aroused interest in a number of countries. We are interested to see this method of growth stress split control tested wherever forestry authorities or users claim their timber to be free splitting or highly stressed. In this regard we have been advised that the technique will be tested on fissile material (including plantation grown eucalypts) in Malagasy, Uruguay, Italy, Germany, Hawaii and New Guinea, and we anticipate hearing results of these tests in the near future.

Discussion

Colwell:- We have tried the DFP method with mixed success in TPNG, but we made the mistake of carrying out some tests in the middle of the wet season. We have high hopes but the process is not as easy as it seems.

Item 4(i) (to be read in conjunction with the discussion on Item 4(i) on page 85. Omission from its correct correct place is regretted).

QUARANTINE: Preservative treatments for containers

From time to time the Commonwealth Division of Plant Quarantine has asked the Division of Forest Products to calculate the loading of commercial preservative necessary to give a certain arsenical retention in treated wood. A list of acceptable commercial preservatives has been published by Quarantine in a brochure labelled CARGO CONTAINERS AND UNIT LOADS. This publication contains much other useful information of interest to importers using timber for packaging their goods.

Quarantine requirements for preservative treatment of timber components in containers has had the effect of excluding the greater part of the Australian hardwood milling industry from competing for this developing market. Sections of the Industry are concerned that the use of naturally durable species is not acceptable to Quarantine and that diffusion treatments have not been "approved".

QUARANTINE: New Zealand

(i) Timber treatment requirements (New Zealand)

In general sawn timber and wood packing may be freely imported into New Zealand provided that timber is free from bark and from visible signs of infection. The only treatment requirement specified in the Forest Produce Import and Export Regulations 1966 is in respect to wooden cable drums, and regulation 8 requires that:-

No person shall import into New Zealand any wooden cable drum unless -

(a) It is completely free from bark and has been certified by a government authority in the country of export or by the exporting manufacturer, or by the treatment agency employed by the manufacturer, as having been treated in accordance with any of the specifications prescribed in the Second Schedule.

(b) A certificate of treatment accompanies the shipping documents relating to the consignment.

Specifications for treatment of cable drums are:-

(1) Preservative treatment of all wood components - with a preservative treatment against attack by insects and fungi; that is, a method and with a preservative

acceptable to a Quarantine Officer, being a preservative treatment that conforms to a specification that is authorised or approved by the British Wood Preservers Association, the American Wood Preservers Association, the New Zealand Timber Preservation Authority, or any similar national body; or

(2) Fumigation of all wood materials with methyl bromide gas at a concentration of 6 lb/1000 cu ft (96 Mg/L) for 24 hr duration, and a minimum temperature of 10°C or 50°F; or

(3) Heat treatment (or kiln sterilisation) - where wood is heated in a kiln to a temperature of not less than 160°F or 71°C under conditions of maximum humidity (steam atmosphere) and held at that temperature for two hr duration.

(ii) Pest hazard

New Zealand like Australia has been concerned over possible pest hazards with the introduction on an international basis of shipping containers and palletised cargoes, but no requirements for permanent treatment of wooden components have yet been issued.

Recommendations for the permanent treatment of timber components of shipping containers and pallets have been issued by the Commonwealth Division of Plant Quarantine, Department of Health, Canberra, and in dealing with enquiries from overseas shipping companies and exporting agencies as to New Zealand requirements for treatment of wooden components of containers and pallets, we have indicated that components treated in accordance with the Australian recommendations would have free entry into New Zealand. New Zealand Forest Service recommendations to other enquirers seeking guidance on preservative treatment of wooden components of containers and pallets have been;

Tanalith NCA - 0.20 lb/cu ft nett retention

Boliden K33 - 0.18 lb/cu ft " "

Celcure AN - 0.20 lb/cu ft.