CSIRO
Forest Products Newsletter
FOREST PRODUCTS LABORATORY, CSIRO, P.O. BOX 310, SOUTH MELBOURNE, VICTORIA 3205

NUMBER 391 MAY 1973

1973##391

# Tannin Adhesives for Glued Laminated Timber

By K. F. Plomley, P. J. Collins, and R. E. Palmer,
Forest Conversion Science Group

The use of certain kinds of tannins as adhesives for bonding wood has been studied at the Forest Products Laboratory for a number of years. In 1957 the development of adhesives based on commercial mangrove and wattle tannins for the manufacture of exterior grade plywood was reported, and at the same time it was suggested that tannin-based adhesives might also be suitable for bonding other wood products, including solid timber, laminates, and particle board.

Following this report a number of factory trials were carried out with the wattle tannin formulations and the process was successfully taken up by a plywood manufacturer. Since that time plywood adhesives based on wattle tannin have been used in increasing quantities.

In 1969 this Laboratory reported the application of tannin adhesives (based on commercial wattle and quebracho tannins) to the manufacture of particle board. As a result of this work, particle board bonded with wattle tannin adhesives and possessing improved water resistance compared to the normal urea–formaldehyde bonded board is now manufactured in Australia.

The suitability of tannin adhesives for making glued laminated structural timber is now being investigated.

Adhesives based on commercial wattle tannin and laboratory prepared extracts of *Pinus radiata* bark were used to bond assemblies of 2–4-in.-wide, 1-in.-thick *Pinus radiata*, using radio frequency to cure the adhesive. Some results of the laboratory tests are shown in the table.

The results indicate that tannin-based adhesives, in particular wattle and *P. radiata* tannins, show promise as low-cost adhesives for laminating timber when using radio frequency heating.

| Adhesive | Tested dry* Failing load ($lb/in^2$) | Tested dry* Wood failure (%) | Vacuum pressure soak cycle† Delamination (%) |
|---|---|---|---|
| Wattle tannin (1) | 1546 | 95 | 0 |
| Wattle tannin (2) | 1513 | 86 | 1·0 |
| Radiata tannin | 1512 | 86 | 0 |
| Radiata–wattle tannin blend | 1525 | 94 | 0 |

* Means of 30 specimens.

† Australian Standard 1328–1972. For *P. radiata*, delamination should not exceed 10% of the total length of all glue lines on the two end-grain surfaces.

The studies will be extended to include laminating with other tannins and wood species and to scarf jointing. A detailed report of the work will be published as results become available.

# WHAT'S IN A (METRIC) NAME?

By W. G. Keating, Timber Structures Group

## Timber Stress Grades

The metric era has arrived and the timber designer is already using strange sounding names such as megapascals or meganewtons per square metre instead of the familiar pounds per square inch. A *newton* is the force required to produce an acceleration of 1 m/sec$^2$ in a body of 1 kilogramme mass and, coincidentally, it is also a measure of the gravitational pull on the apple (4½ to the pound) which so startled Sir Isaac Newton. The unit of stress is the newton per square metre or *pascal*, an extremely small value for most engineering applications. In practice the term recommended is the megapascal (MPa), i.e. 1 million pascals. One megapascal is the equivalent of 145 lbf/in$^2$ which is approximately the stress in the stalk that held the apple!

The stress grade nomenclature adopted in Australia has followed the pattern 630f, 800f, 1000f, 1250f ..., such that the ratio between successive numbers is approximately 1·25. This has proved to be most convenient, dovetailing in with established visual grading rules (see Newsletter No. 371). As a bonus the system gave an indication of the working stress values for the material in the stress grade. For example, 1000f indicates that for such a grade of material the basic working stress in bending is 1000 lbf/in$^2$.

| Present stress grade name | Basic working stress in bending (lbf/in$^2$) | (MPa) | Metric stress grade name |
|---|---|---|---|
| 400f | 400 | 2·8 | F2 |
| 500f | 500 | 3·4 | F3 |
| 630f | 630 | 4·3 | F4 |
| 800f | 800 | 5·5 | F5 |
| 1000f | 1000 | 6·9 | F7 |
| 1250f | 1250 | 8·6 | F8 |
| 1600f | 1600 | 11·0 | F11 |
| 2000f | 2000 | 14·0 | F14 |
| 2500f | 2500 | 17·0 | F17 |
| 3200f | 3200 | 22·0 | F22 |
| 4000f | 4000 | 27·5 | F27 |

However, stiffness and the other strength properties which are often critical are only implied. The designer must still refer to an appropriate text such as CA65–1972, SAA Timber Engineering Code, for all of the other working stresses.

With metrication the stress grades will not change only their numerical reference. A rounding off process has been developed to simplify the names as indicated in the table.

The metric nomenclature still indicates bending strength but not with quite the same precision as before. However, this is not crucial, as mentioned previously. A nicely rounded set of numbers could have been produced in the megapascal column but would have meant a complete revision of all the visual grading rules in time for the metric change-over—a formidable task.

Therefore, to give two examples, in the next few months standard building grade radiata pine will be called F5 instead of 800f and building grade messmate will be F11 instead of 1600f. Changes such as these should not cause more than interim inconvenience.

## 1973 FOREST PRODUCTS RESEARCH CONFERENCE

The 16th Forest Products Research Conference will be held at the Forest Products Laboratory, South Melbourne, from 28 May to 1 June 1973, and will be sponsored jointly by the CSIRO Divisions of Building Research and Applied Chemistry. The main topics to be covered are (1) Wood quality assessment; (2) Utilization of small hardwood logs; (3) Timber for construction (divided into subtopics (*a*) Structures, (*b*) Wood preservation, (*c*) Biodeterioration); (4) Residue disposal and utilization; and (5) Whole tree—any tree utilization.

Delegates will include representatives from State Forest Services, Forest Products Research Centres, and various branches of the timber and construction industries. Overseas representation is expected from Papua New Guinea and New Zealand.

Organization of the conference is in the hands of a committee consisting of C. D. Howick (Chairman), Mrs. E. Bolza (Executive Officer), D. E. Bland and J. Nicholson (committee men). Further information may be obtained from any of these members.

# Improving Conversion Efficiency in Eucalypt Timber with Variable Seasoning Characteristics

**By J. E. Nicholson, Forest Conversion Engineering Group**

Mill-run eucalypt boards often vary considerably in seasoning characteristics. Some boards will dry rapidly and shrink slightly, whereas others will dry slowly and shrink more severely. These variations are a result of differences in the microstructure and composition of wood, and while they will at times result from natural differences between trees they are also known to occur frequently *within* trees.

This variability in seasoning characteristics affects conversion efficiency in various ways. For instance, board "over-cut" is generally adjusted to match the maximum shrinkage expected, and as a result many boards are sawn thicker than necessary. In seasoning, yard or kiln schedules are set to accommodate the slowest, most dense material, whereas savings would accrue if the lighter material could be separated and dried more rapidly. On the other hand, the tendency towards surface checking also varies with wood density and rate of drying. For these reasons, considerable effort has been spent over the years in an attempt to find an effective means of identifying timber having different seasoning characteristics.

Some recent work at the Forest Products Laboratory has been aimed at a better understanding of the relationships between tree growth and wood properties. Leaning trees, in particular, have been found to contain wood with a wide range in properties between the upper and lower side of the bole. Invariably wood from the upper side is more dense, seasons more slowly, and shrinks more than wood from the lower side. This is a result of structural changes that occur in new growth as the tree responds to the problem of supporting itself in an inclined position. In this situation the tree will generally develop high levels of longitudinal growth stress on the upper side and below normal levels on the lower. Wood shrinkage follows the same pattern, with material from the upper side shrinking more than that from the lower.

Results from the recent studies suggest it may be possible to separate material of higher or lower than average density by segregating logs from severely leaning trees. For example, all trees of this type would be marked on the top face prior to felling with identifying chain saw cuts. In the mill yard the top half of the end faces of such logs would be painted red to signify material of above average density and shrinkage, and the lower half green to signify material of low density and shrinkage. Unpainted logs would represent average material. Each of the three classifications would be sawn and seasoned according to predetermined requirements. In this way boards would not be sawn thicker than necessary to produce a particular seasoned dimension, and mill recovery would probably improve. In the same way, boards would not be seasoned longer than necessary, which could result in lower seasoning costs. Hopefully, the more ideal seasoning schedules would result in less face checking, but this would remain to be seen.

The potential savings that could accrue from material separation seem to warrant the slightly increased effort required to achieve it. Companies concerned with this problem, and interested in attempting material separation on this basis, should contact the Forest Products Laboratory for further information.

# In Memory of

## STANLEY A. CLARKE, 1900–1973

Australia's forest products community is mourning the loss of Stanley A. Clarke, a symbol of life-long service to the advancement of timber and its products and Chief of the Division of Forest Products from 1944 to 1960, who passed away unexpectedly and peacefully on 25 March.

Stanley Clarke was born in 1900 in Perth, where he completed his schooling and university education as a mechanical engineer. He joined the Western Australian Forests Department in 1919 as a seasoning officer. In 1924 he was appointed Officer-in-Charge of Wood Technology Investigations and quickly showed his remarkable ability for extracting results of practical industrial significance from research on timber processing.

In 1929 he was seconded to the newly created CSIR Division of Forest Products and the following year became a member of the permanent staff. His appointment in 1931 as Deputy Chief under I. H. Boas, the Division's first Chief, led to the formation of the closely knit, brilliant, and highly productive team that was to have such a decisive influence in the creation and development of a national forest products industry which today has an annual output of over 1500 million dollars and employs over 150,000 people. The research to uncover and consolidate the knowledge required to make this industry operational and competitive placed the Division of Forest Products high on the list of similar institutions around the world, and its research team was widely respected.

Stan Clarke's succession to Mr. Boas as Chief in 1944 confirmed the high esteem in which he was held by CSIR, by his staff, and by the forest products industry in Australia. Under his leadership, the Division grew in strength, stature, and wisdom and became a byword in forest products and wood science everywhere. To everyone associated with the Division in those days, it was clear that these successes were to a very large degree a result of Mr. Clarke's devoted and inspired leadership. He became personally an authority on the conversion of trees to pulp and paper, particle board, fibre board, and other new products, in addition to his encyclopaedic knowledge of mechanical conversion and general engineering. After his retirement in 1960, he continued to be active in the industry as a director of several important forest products companies.

His services were widely sought: he was Chairman of the Timber Industry Committee of the Australian Standards Association from 1944 to 1960; Chairman of the Asia–Pacific Regional Committee of Forest Products Research; a permanent member of the FAO Technical Panel on Wood Technology. Indeed, his advice was constantly in demand in the international field and was freely given on the many occasions when he visited FAO. Just prior to the 1939–45 war, and in 1958, he was asked to advise the United Kingdom Department of Scientific and Industrial Research on timber problems, and in 1945 he visited India at the request of the Government of Bengal to investigate the manufacture of building boards. He was also instrumental in the foundation of the International Wood Research Society, the forerunner of the present Institute of Wood Science.

Stanley A. Clarke's achievements are far too numerous to be given full due in any short obituary or to be represented by any single monument. To his former staff, he remains as the figure of a true leader who cared for every one of them, who knew what everyone was doing even to the most junior laboratory assistant and maintenance worker, and who was like a second father to many of the younger ones. Today, Australia is reaping the benefits of his untiring efforts to create a group of forest products research workers who would make it their mission to serve the nation through technical assistance to the industry and consumers of forest products, and the work he helped to set in motion is carried on by more than 230 persons, including 86 professional scientists and engineers, in the Divisions of Applied Chemistry and Building Research of CSIRO.

Mr. Clarke is survived by his widow and son.



Printed by CSIRO, Melbourne

CSIRO
Forest Products Newsletter
FOREST PRODUCTS LABORATORY, CSIRO, P.O. BOX 310, SOUTH MELBOURNE, VICTORIA 3205

NUMBER 392 JUNE—JULY 1973

1973##392

# INSTITUTE OF WOOD SCIENCE

## Australian Branch Formed

**By W. G. Keating, Branch Secretary**

An Australian branch of the London-based Institute of Wood Science has recently been formed. This Institute, established in 1955, aims to advance the scientific, technical, practical, and general knowledge of persons interested in the study of wood and allied subjects. Since the early formative years of the Institute, a small group of Australian members has maintained a rather tenuous link with others around the world with a similar interest in wood science. For its population, Australia, over the last 40 years, has had a significant number of wood scientists, largely based at the CSIRO Forest Products Laboratory. With the spread of the wood science profession into industry, there has been a growing need for some cohesive group to provide a suitable forum and, as with other professional groups, to forge a bond of common interest. It was felt that the Institute of Wood Science would admirably serve these purposes.

Preliminary discussions in London during 1968 with officers of the Institute were the first move in the formation of a local branch. The proposal was nurtured for some time, and culminated in formal approval being granted for the formation of the Australian branch in December 1970. A talk by Dr. E. J. Gibson, vice-president of the Institute and Director of the Princes Risborough Forest Products Laboratory, given in Melbourne in August 1971, provided the further impetus necessary to form an ad hoc committee. During 1972, 54 applications for membership were forwarded to London and the inaugural branch meeting was held in November of that year. The Committee elected then served until March 1973 and subsequently became the permanent Committee, with Dr. W. E. Hillis of the Forest Products Laboratory as Chairman.

Some of the activities of the Institute in England include publication of a journal which has established a high international reputation, the holding of meetings and symposia, and visits to relevant scientific and industrial concerns. In Britain, the Institute is actively involved in the education sphere and is the examining body for approved courses in timber technology and timber economics at the technical college level. It is expected that the local branch will progressively follow a similar pattern in its activities, with the addition of a local newsletter for its members to supplement the Institute's journal.

The first function organized by the Australian branch was a dinner and talk held on 10 April 1973 at Clunies Ross House, Melbourne, at which Professor J. D. Ovington, Head of the Department of Forestry, Australian National University, Canberra, was the guest speaker. In introducing Professor Ovington, the Chairman, Dr. Hillis, explained the aims of the Institute and its particular relevance to local conditions. He pointed out that in these times of energy crises it is worth remembering that Australia has more solar energy than practically any other country and photosynthesis through forest trees is the best means of accumulating and storing this form of energy. He listed the advantages of timber when compared with some other materials in the areas of energy required per unit production, by-product formation, disposal costs, and environment restoration. He suggested that from a social viewpoint we should be asking whether forest products, from multiple use forests, should not be penetrating the field occupied by other products, particularly those from non-renewable resources.

Professor Ovington in his address entitled "The Increasing Need for Wood Science in the Forest Products Industry", explained how increasing population, environmental problems, disparity in living standards, and the influence of informed public opinion were all modifying the magnitude and pattern of wood production around the world. He saw the role of the wood scientist as one aimed at improving efficiency, lowering costs, and developing new products. He emphasized that there must be a significant improvement in communication, not only with the general public but also between the relevant specialist fields, of which wood science is but one.

The Institute will reprint Professor Ovington's address and make it available to those interested in the subject.

The branch is currently planning two other functions for 1973. The first of these is a panel discussion on the topic "Wood Science and Industry: the need for two-way communication". The three speakers on this panel, Messrs. Lindsay Bryant, Norton Ladkin, and John Stokes, who are all Institute members, are well known and highly respected within the timber industry. This discussion will probably be held in late July or early August. For the second function, on 17 October, the Institute has been most fortunate in obtaining the promises of addresses by two world-renowned wood scientists. They are Prof. Dr. W. Liese, Research Institute for Forestry and Timber Industries, Republic of West Germany, and Dr. H. O. Fleischer, Director of the Forest Products Laboratory, Madison, Wisconsin, U.S.A.

Enthusiasm in the Australian branch is high and there are excellent prospects for the future. Industry support will be welcomed and membership enquiries can be directed to either the Chairman or Secretary, C/-Forest Products Laboratory, CSIRO, P.O. Box 310, South Melbourne, Vic. 3205.

## Notes on Wood Residue Utilization

# Oil Collection — a Potential Use for Small-particle Wood Residue

By R. M. Liversidge, Forest Conversion Engineering Section

It has been reported from overseas sources that bark can be used to collect oil from water surfaces or to filter it from oil/water mixtures.

Tests carried out at the Forest Products Laboratory over the past year have confirmed the potential of bark for oil collection and, in addition, have shown that dry sawdust and shavings are also a potentially useful medium for oil collection or oil/water separation.

Many materials can be used to collect oil from water but probably few possess the extremely advantageous features of sawdust and shavings, ready availability and low cost. In addition, wood is a biodegradable material, so any particles not recovered after removal of the oil-soaked residue following an oil collection operation are unlikely to create any significant problem.

Tests carried out to date in this laboratory suggest that wood residues could be effectively used to pick up or filter various grades of oil ranging from light machine oil to bunker fuel.

In tests using bunker fuel on a water surface, the ratio of the weight of oil collected to the weight of dry (approx. 12% moisture content) residue used ranged from approx. 2 : 1 to 6 : 1. The highest ratio was obtained with milled bark from fibrous-barked eucalypts, although all types of wood residue tested proved satisfactory. When applied to an oil slick the wood residue quickly forms a matt of oil-soaked material which can then be scooped or skimmed from the water's surface.

Further laboratory tests on oil collection or filtering are planned and it is hoped that these can be followed by trials on actual oil spillages.

It is reported that a proprietary oil-slick absorbent made from specially treated wood fibre will soon be manufactured in Australia under licence from a company in the U.S.A., and will be available in loose shredded form, panels, or in the form of a "sausage" for use in booms.

# Problems Associated with Resin in Pines

By P. J. Nelson, Division of Applied Chemistry

When pulp is manufactured from pinewood under neutral conditions as in the refiner groundwood process or under acid conditions as in the bisulphite process, a sticky material is often deposited in the pulp mill and on the paper machine. "Resin" is the general term for this material which is not a simple substance but a mixture of a large number of compounds. The two main classes of compounds are the resin acids and the esterified fatty acids. These two groups are concentrated at different locations within the tree. The resin acids are found in the resin canals of the wood, and it is a solution of these components that oozes from a tree when it is mechanically damaged. On the other hand, the esterified fatty acids are present in the ray parenchyma cells and form part of the food storage for the tree.

The main problems caused by resin in industry stem from its hydrophobic nature and its insolubility in water. Its ability to repel water can impart undesirable properties to paper products such as absorbent tissues and towelling. Problems due to resin are rarely experienced when an alkaline process such as the kraft process is used because the acidic material is removed in solution as sodium salts and the esterified fatty acids are saponified. The problem is most severe when acidic pulping procedures are used, and for this reason many of the *Pinus* species with higher resin contents cannot be satisfactorily pulped by an acid process.

The amount of resin present in a sample of wood is dependent on factors such as the species, age of the tree, and the location of the wood in the tree. The principal *Pinus* species throughout southern Australia is *P. radiata*, with smaller amounts of *P. pinaster* in Western Australia and South Australia particularly and *P. elliottii*, *P. taeda*, and *P. caribaea* located in Queensland. It is fortunate for the Australian industry that *P. radiata* is one of the lower resin-containing *Pinus* species. The amount of resin in trees increases with their age, e.g. 36-yr-old *P. radiata* or *P. pinaster* trees contain twice as much resin as 16-yr-old trees. The heartwood of pine trees is much richer in resin than the sapwood.

A research programme was carried out at the Forest Products Laboratory aimed at finding ways of overcoming the problems caused by resin during the manufacture of bisulphite pulp. An examination was made, in collaboration with Dr. R. W. Hemingway, of the resin content of the pulp at various stages in its manufacture and of the accompanying changes in the composition of the resin. The results showed that the washing and screening steps lowered the amount of resin in the pulp and that this decrease was principally due to loss of the resin acid fraction from the resin. In the pulping process the resin acids are released from the wood and adhere to the outside of the fibres and form a suspension in the water. For this reason they are more easily removed by washing than the esterified fatty acids which are largely retained within the ray parenchyma cells.

Three methods for reducing the amount of resin in bisulphite pulp were investigated. The first involved heating pine chips in a current of air prior to pulping. This treatment oxidizes many of the resin components and substantially reduces the resin content of the wood. The oxidized resin is much more soluble in the pulping solution and is removed from the pulp in this way. The advantage of this method is that a large proportion of the esterified fatty acids which are difficult to remove by other methods is oxidized and eliminated.

In the second method, bisulphite pulp was treated under mild conditions with a dilute caustic soda solution. Analysis of the resin from the pulp before and after alkali treatment showed that the acidic components were selectively removed while the neutral material was not appreciably affected. The extent of de-resination achieved by this method is dependent on the amount of non-acidic material present in the pulp; for example, the minimum resin content attainable for *P. radiata* bisulphite pulps is about half that for *P. pinaster* pulps.

The third procedure investigated was the treatment of wood chips with caustic soda before the pulping stage. The reduction in resin by this method is not as large as that achieved by treating pulp with alkali, but there is an important advantage in that retention of hemicellulose in the pulp leads to an increase in yield in the overall pulping process.

These three methods offer a wide variety of procedures for removal of resin. The one most suitable for a particular bisulphite pulp mill will depend on the facilities available there.

## PERSONAL

His many friends in the timber industry will be interested to learn that the degree of Doctor of Applied Science was conferred by Melbourne University on Jack D. Boyd, of the Forest Products Laboratory, late last year for his thesis entitled "Aspects of Wood Science and Applications in Building Construction and Engineering".

The citation pointed out that he has been a leading national and international figure in the study of wood science and its application to building construction and engineering in Australia. His research and developmental work have contributed much to the efficiency and economy of use of local materials.

# Publication on African Timbers

The Division of Building Research, Forest Products Laboratory, has issued a useful publication for those with an interest in African timbers. The title, "The Properties, Uses, and Characteristics of 700 African Species", gives some indication of both its content and scope. Authors are E. Bolza and W. G. Keating.

This book is particularly comprehensive even though only one page has been allocated to each species, but by the use of coding techniques wherever possible a large amount of information has been conveniently provided in the available space. Data are presented on growth characteristics, timber appearance, working properties, seasoning, insect susceptibility, permeability, strength, density, shrinkage, durability, and uses. A detailed index lists, as well as the latest botanical name, several common names for each species. The work is a collation extracted from 140 listed references which has enabled, for the first time, data on a large number of little-known African species to be presented in one volume. Previous publications of this nature have tended to concentrate on the same well-known species.

The initiative for the project arose from a request made at the FAO conference on "Man-made Forests", held in Canberra in 1967, for as much information as possible on African timbers, particularly the lesser-known species. The Forest Products Laboratory agreed to undertake the work.

The first edition was limited in number, but a reprinting may be undertaken once an assessment of the demand has been made. It is also possible that at some future date other regions will be covered in a similar fashion.



Printed by CSIRO, Melbourne

CSIRO
Forest Products Newsletter
FOREST PRODUCTS LABORATORY, CSIRO, P.O. BOX 310, SOUTH MELBOURNE, VICTORIA 3205

NUMBER 393 AUGUST 1973

1973##393

# SLEEPERS AWAKE!

**By F. A. Dale, Preservation Section**

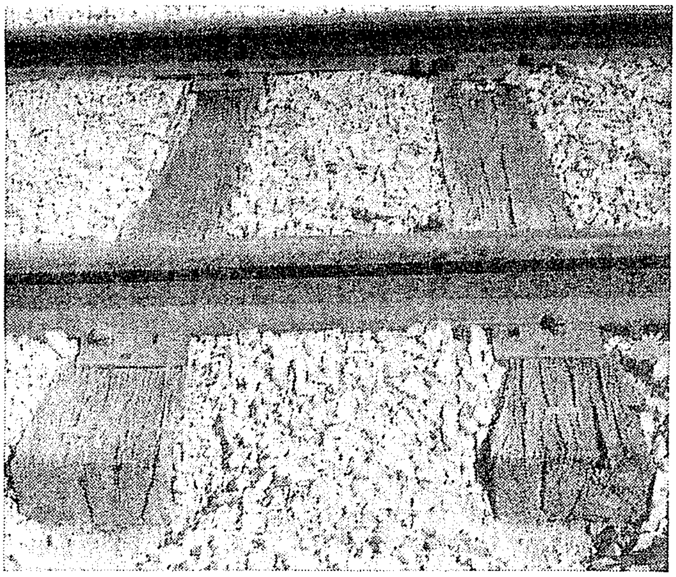
Current propaganda in some circles would have us believe that wooden railway sleepers are on their way out. So are motor-cars, but both will be with us for a long time before better alternatives are found. Over 75 million wooden sleepers are used to support Australian rail tracks and to replace them requires $2\frac{1}{2}$–3 million sleepers annually. Demand is increasing for both renewal and new construction, particularly on lines carrying heavy mineral traffic in Western Australia and Queensland where timber still supplies the best combination of properties for this very severe task.

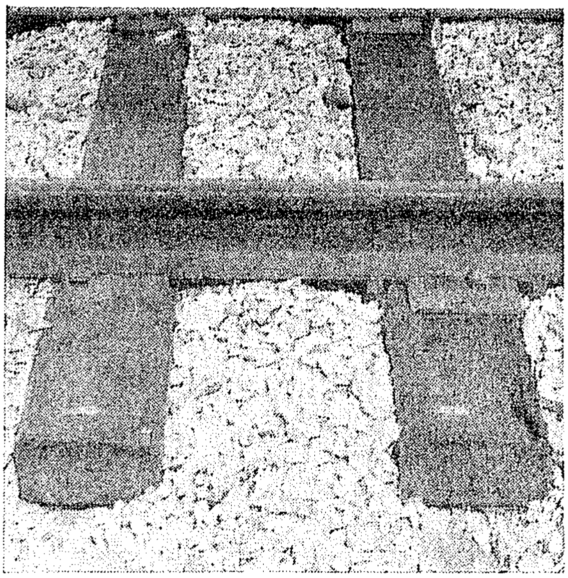
Although many alternatives to the steel wheel on steel rails fixed to individual supports have been suggested, it remains the cheapest and most effective means of moving heavy loads at high speeds. Materials other than wood are used in some countries, but wood has advantages in cost, ease of laying and repair of damaged lines, and versatility for re-use and ready final disposal without damage to the environment.

Most rail sleepers in Australia fail from mechanical causes such as end splitting, rail cut, and spike kill. After World War II it was apparent that supplies of heavy durable timbers were declining and that lighter less durable timbers would require preservative treatment to give the same service. Our experiments showed that high pressures up to 1000 lb/in$^2$ were needed to obtain satisfactory penetration into the dense heartwood of most of the suitable eucalypts, and overseas experience had shown that a preservative oil such as coal-tar creosote gave the best mechanical protection as well as preventing decay and insect attack.

Starting in 1952, a series of tests comprising over 4000 sleepers treated in this Division was installed over a period of 9 years in conjunction with every public rail system in Australia. The timbers treated were jarrah, karri, and marri in Western Australia and the Trans-Australian Railway; messmate, mountain ash, peppermint, and white stringybark in Victoria; messmate, alpine ash, and silvertop ash in Tasmania; messmate, mountain grey gum, silvertop ash, and brush box in New South Wales; and rose gum, satinay, turpentine, and brush box in Queensland. No treated hardwoods have been used in the tests in South Australia but two most valuable test items of *Pinus radiata* sleepers were installed there in 1936 and 1956. Durable controls of wandoo, grey box, red gum, and ironbark were installed as well as untreated controls of the timbers treated. The preservatives used were mostly creosote, creosote/furnace oil mixtures, and pentachlorphenol in furnace oil. Treatments were designed to give overall preservative retentions of 80 kg/m$^3$ (5 lb/ft$^3$) or more, but some refractory timbers such as brush box with retentions of as low as 32 kg/m$^3$ were used in the tests.

These tests have shown that, in the main, low-durability timbers properly treated with preservative oil will resist both mechanical





*Jarrah* (E. marginata) *untreated.*

*Karri* (E. diversicolor) *treated with 5 lb/ft*$^3$. 30/70 *creosote/diesel oil.*

*Sleepers after* 18 *years' service in the Trans-Australian Railway.*

and biological deterioration for at least as long as the durable species. The average life of untreated local timbers in Tasmania is just over 10 years, but more than 90% of the treated sleepers are still in service after 19 years and an average life of at least 25 years can be expected. In the Trans-Australian Railway, all 48 treated karri sleepers installed in 1952 are still in the test. In Western Australia, an average life of 20 years can be expected from treated karri and marri laid in 1955 in gravel ballast, while jarrah treated with furnace oil alone should last for 30 years. Additional protection against termites would be needed for karri and marri to approach this performance.

In Victoria, at least 25 years' service can be expected from timbers which wouldn't last 15 years without treatment; even mountain ash, the lightest and most prone to split timber tested, should last more than 20 years. In New South Wales, because of the greater weathering hazard and very heavy traffic at the two test sites, a service life of over 20 years can only be expected from the three heavier species, but messmate may prove less satisfactory because of splitting and rail cut. However, the heavier timbers are performing at least as well as untreated grey box and ironbark. The Queensland sleepers installed in 1961 have yet to be fully inspected, but none have been removed to date.

The building of 800 miles of new lines to carry very heavy iron-ore traffic in the Pilbara region of Western Australia has brought special problems. Very high temperatures and summer rainfall together with very heavy traffic loading have reduced the life of untreated jarrah to as little as seven years in the worst situations. Also, widespread attack by *Mastotermes darwiniensis* in this usually termite-resistant timber will require special protective measures.

The tests have shown that treatment with heavy preservative oil is a practical and economic means of extending sleeper life. The particular preservative and type of treatment must be chosen to suit the available timbers and conditions of service for each application.

Commercial application of the test results is already well under way. In Victoria, 10,000 yellow and white stringybark sleepers have been high-pressure-treated with 40/60 creosote/furnace oil and another 40,000 are to be treated. In other States, treatment of green sleepers is being carried out by boultonizing (boiling under vacuum) followed by 200 lb/in$^2$ treatment, which gives a satisfactory penetration pattern if the sleepers are incised beforehand. In Tasmania, 110,000 sleepers have been boultonized with 3% pentachlorphenol in oil, and in New South Wales some thousands of sleepers of blackbutt and

Sydney blue gum have been boultonized with creosote and put into service. Successful treatments of incised spotted gum and red stringybark have also been made.

In Western Australia, about 8000 karri treated at high pressure with 3% pentachlorphenol in furnace oil were put into service about 10 years ago. The W.A. Government Railways took 50,000 boultonized jarrah sleepers in 1972 and will take more this year. The Commonwealth Railways have also called tenders for treated sleepers for the Trans-Australian Railway. In the iron-ore lines, all sleepers for replacement or new work will be pressure-treated; either West Australian jarrah and karri or kempas and keruing from Malaysia will be used, over 150,000 of which have already been put into service.

The experience gained in the last decade has also shown the need for suitable anti-splitting devices and improved fastenings if maximum benefit is to be obtained from preservative oil treatment. Future service tests using commercially treated sleepers will be concentrated on these aspects, supplemented by high-speed simulated load tests in the laboratory. Much still remains to be done, also, towards devising and implementing suitable methods of quality control for treated sleepers, particularly boultonized sleepers to which established methods do not apply.

An international rail sleeper conference, sponsored by the major supplier of creosote in Australia, will be held in Sydney from 13 to 17 August. Past experience, present needs, and future work will be discussed in detail, and three papers prepared by the officers of the Preservation Group of this Division will be presented. Delegates will include railway engineers, foresters, rail sleeper suppliers, timber treaters, and the chief engineer of a major railroad in the U.S.A., as well as representatives of the Deutsche Bundesbahn, the Indian State Railways, and other overseas rail systems.

Sleeper production is very important, although it represents only a small part of the total timber output. Australian hardwoods are among the best sleeper timbers in the world and the potential export market is considerable, especially as better treatments are developed. Sleeper cutting helps to support many small sawmills and country towns and so assists decentralization. It could also play an important part in forest conservation and recreation as pulp and reconstituted wood production turns more and more to fast-grown plantation timber.

These are all good reasons for those concerned with the production, treatment, installation, and use of wooden sleepers to exert the maximum effort to improve their performance.

# NAIL LAMINATING

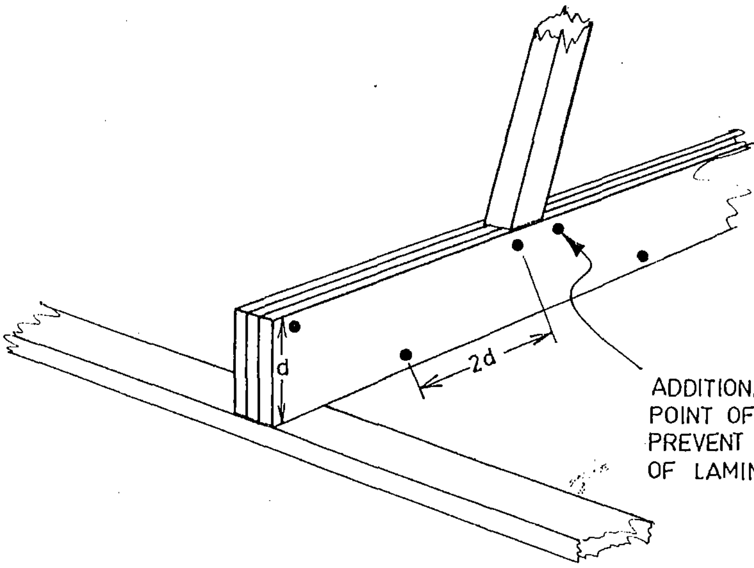
**By W. G. Keating, Domestic Structures Group**

"For the want of a nail a kingdom was lost." This well-known saying reminds us that the common nail also plays a vital role in the use of timber. It is familiar, cheap, efficient, readily available, and easy to use, factors not always matched by more modern means of fastening.

However, one application of nails that has received only scant attention in the past is their usefulness in laminating relatively thin boards to form structural members of substantial dimensions. In the particular case of house framing there are several situations where nail laminating would constitute not only an improved building practice but also a more efficient use of timber. The larger members such as lintels, strutting, and hanging beams come immediately to mind, but under certain circumstances bearers, joists, studs, rafters, and stumps could also be nail laminated.

To laminate satisfactorily by any method it is desirable to use dry timber, and this immediately attracts some important advantages over the use of green material. Shrinkage problems which are often serious in large initially green hardwood sections are eliminated, higher working stresses are applicable, and the creep (deflection under long-term loading) characteristics are much improved.

*Typical use of vertical lamination as a strutting beam—nail spacing should not exceed twice depth of beam.*




Drying of structural timber is often uneconomic, but when laminations of approximately 25 mm (1 in.) thickness are used in combination the cost structure is much more acceptable.

Nail laminating is most efficient when the member is used on edge and loaded in a direction parallel to the laminations (as pictured). The system, although theoretically feasible for horizontal laminations, is more costly and generally impracticable due to the larger number of nails required.

For vertically laminated members it is not necessary for the wide faces of each board to be dressed. It is, however, advisable to ensure that the edge of the assembled beam is uniformly flat so that the applied loads are shared equally by all laminations.

The nailing pattern used is important, with nail spacing confined to definite limits. It is recommended that nails be spaced no further apart than twice the depth of the member and staggered, as illustrated. It is important to recognize that the function of the nails in this form of construction is to prevent the laminations from spreading apart from one another. Ideally, nailing should be done from both faces of the laminated beam and if appearance is of no consequence clinching of the nails is an advantage, although not essential. At present, definite recommendations enabling the use of butt joints within laminations cannot be given but with further research work it is expected that some definite guidelines in this area will be forthcoming.

The current shortage of imported softwood timber such as oregon, often used in large sizes, may well be the trigger necessary to start a serious industry study of the possibilities of using this economical method of providing large-size structural timber members.



Printed by CSIRO, Melbourne

CSIRO

# Forest Products Newsletter

FOREST PRODUCTS LABORATORY, CSIRO, P.O. BOX 310, SOUTH MELBOURNE, VICTORIA 3205

NUMBER 394 SEPTEMBER–OCTOBER 1973

1973##394

# The Strength Group and Stress Grade Systems

By H. Kloot, Division of Building Research

The strength grouping system, as applied to structural timbers, has been accepted practice in Australia for many years and, more recently, the concept of a stress grading system has been introduced. The purpose of this paper is to consolidate the explanations of these systems given previously (Newsletters Nos. 324, 329, 371, and 391), to present these systems in metric units, and to introduce systems of strength grouping and stress grading specifically designed to apply to seasoned timber.

## Background to Strength Grouping

The species in common use in Australia for structural purposes are numerous, vary considerably in their strength characteristics, and are frequently difficult to identify when sawn. To minimize commercial difficulties in marketing these timbers, it is generally very convenient and technically not unduly inefficient to group species of similar properties and regard those in each group as being, for design purposes, identical or, for commercial purposes, equivalent. This was done some 30 years ago when four strength groups called A, B, C, and D were established, the four hypothetical species A, B, C, and D replacing the multitude of actual species. A species was allocated to a group if its bending strength (modulus of rupture), stiffness (modulus of elasticity), compression strength, and shear strength were similar to those of the hypothetical species representing the group. It must be emphasized that all the strength properties used in grouping are calculated from laboratory tests on small clear specimens and are not the strength properties to be assumed for usual commercial timbers of structural sizes as used under service conditions. Neither the working stresses for structural design nor the quality of material are considered in grouping a species.

A major difficulty with the system used until 1965 was that the four strength groups as originally defined did not cover the full range of properties for all the species in use. The plantation-grown pines in particular could not be fitted into the scheme. In addition, much more information had been gathered about Australian species since the four strength groups were first established. Consequently, the properties for the hypothetical species representative of the groups could be determined more precisely for Australian timbers.

The main impetus for a revision arose from investigations on structural timbers that had been carried out both here and overseas. These had led to a complete change in outlook about the effect of the type and size of the defects in a timber member, i.e. its grade, on its stiffness. Previously, grade was believed to have no close relationship with stiffness, and so all grades of a given species or strength group were assumed to have the same modulus of elasticity. Stiffness as well as strength is now known to vary with grade. The resulting relationships are the basis of machine grading which is being rapidly developed in several countries including Australia. As a corollary, working stresses based on earlier assumptions had to be

**Table 1**

**Minimum Standard Test Values for Strength Groups for Green Timber**

| Property | Strength group S1 | S2 | S3 | S4 | S5 | S6 | S7 |
|---|---|---|---|---|---|---|---|
| Density* (kg/m³) | 900 | 760 | 640 | 540 | 450 | 375 | 320 |
| Modulus of rupture (MPa) | 103 | 86 | 73 | 62 | 52 | 43 | 36 |
| Modulus of elasticity (MPa) | 16300 | 14200 | 12400 | 10700 | 9100 | 7900 | 6900 |
| Maximum crushing strength (MPa) | 52 | 43 | 36 | 31 | 26 | 22 | 18 |
| Maximum shear strength (MPa) | 13·1 | 11·0 | 9·1 | 7·7 | 6·6 | 5·5 | 4·6 |

* Values are for basic density, which is oven-dry weight/green volume.

amended to take account of this variation of stiffness with grade.

Although the grouping of species and the derivation of working stresses are separate operations, the working stresses for each group depend on the properties of the hypothetical species representative of the group. As indicated, changes and extensions to the strength groups and the working stresses became necessary, so the time seemed opportune to introduce a rationalized system based on the latest information and also more convenient and flexible than the previous system.

Additionally, it was obviously desirable that working stresses for visually graded material should be compatible with those for mechanically graded timber.

## Strength Grouping and Stress Grades for Green Timber

(i) *Strength Groups.*—The system developed to supersede the A, B, C, D groupings introduced seven strength groups S1, S2, S3, S4, S5, S6, and S7. This new system provided ample scope for the grouping of a number of species, including some of the plantation-grown exotic species, which previously could not be satisfactorily classified in the old system. Another important feature of the new grouping was that the working stresses for the groups formed a rational series that dovetailed with the timber grades select, standard, and building as applied generally to hardwoods and other grades for timbers such as Douglas fir, radiata pine, etc. With this system, only 11 sets of working stresses instead of 28, were necessary to cover the seven strength groups and four grades in each group.

The limiting average values for classifying a species into one of the strength groups S1 to S7, as applied to timber in the green condition, are given in Table 1, and the strength grouping of a number of timbers is given in Table 5.

(ii) *Stress Grades.*—Although stress grade is a term relatively recently introduced into Australian timber standards, it is rapidly increasing in importance. Generally, it is a grading index of the ability of a piece of timber to perform satisfactorily in a structural capacity in a building. More precisely, it would be defined as "the classification of a piece of timber for structural purposes, by means of either visual or mechanical grading, to indicate primarily the basic working stress in bending for purposes of design and, by implication, the basic working stresses for other properties normally used in engineering or building design". The stress grade is designated in a form such as "F14", which indicates that for such a grade of material the basic working stress in bending is approximately "14 megapascals (MPa)" (see Table 4).

**Table 2**

**Interlocking Strength Groups and Stress Grades**

| Grade (as in AS 081, 082, 084) | Stress grade appropriate to timber of strength group S1 | S2 | S3 | S4 | S5 | S6 | S7 |
|---|---|---|---|---|---|---|---|
| Select | F27 | F22 | F17 | F14 | F11 | F8 | F7 |
| Standard | F22 | F17 | F14 | F11 | F8 | F7 | F5 |
| Building | F17 | F14 | F11 | F8 | F7 | F5 | F4 |

The advantages of the term "stress grade" are twofold. Firstly, by its use the descriptive terms for structural timber, i.e. Select, Standard, etc., can be largely avoided. This will help the timber industry by preventing an obvious confusion with appearance grades which also carry the same classification names, e.g. select and standard grade lining.

**Table 3**

**Minimum Standard Test Values for Strength Groups for Seasoned* Timber**

| Property | Strength group | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | SD1 | SD2 | SD3 | SD4 | SD5 | SD6 | SD7 | SD8 |
| Density (kg/m³) | 980 | 865 | 770 | 680 | 590 | 520 | 465 | 390 |
| Modulus of rupture (MPa) | 150 | 130 | 110 | 94 | 78 | 65 | 55 | 45 |
| Modulus of elasticity (MPa) | 21500 | 18500 | 16000 | 14000 | 12500 | 10500 | 9100 | 7900 |
| Maximum crushing strength (MPa) | 80 | 70 | 61 | 54 | 47 | 41 | 36 | 30 |
| Maximum shear strength (MPa) | 16·7 | 14·8 | 13·2 | 11·7 | 10·3 | 9·0 | 8·0 | 6·9 |

* As measured or estimated at a moisture content of 12%.

It also helps the buyer or specifier to whom terms such as Select, Select Merchantable, and Select Engineering Grade tell little of the structural adequacy of the timber and which are capable of conveying incorrect impressions of the suitability of timber being ordered or specified for specific structural purposes.

The second advantage stems from the interlocking of stress grades, visual grades, and strength groups (Table 2). A similar picture applies to grades of other names such as Merchantable, Select Merchantable, Standard Building, and so on, as defined in standards for other timbers such as Douglas fir, radiata pine, etc.

**Strength Groups and Stress Grading for Seasoned Timbers**

(i) *Strength Groups.*—The current strength grouping and stress grade systems were developed primarily for green timber because until now the vast proportion of timber has been used in the green condition for structural purposes in Australia. The notable exception is radiata pine which, in accordance with AS 1490, is required to be seasoned.

Structural design in seasoned timber other than radiata pine has been dealt with to some extent in AS CA38, Light Timber Framing Code, and in greater measure in AS CA65, Timber Engineering Code. However, both these documents have a makeshift approach and are not entirely satisfactory on either technical or practical grounds.

With the increasing interest in glulam manufacture, in the potential of seasoned framing, and the use of machine grading, it is clearly desirable that the strength grouping and stress grades of seasoned timbers should be placed on a sounder footing. To achieve this, the information available on the properties as determined at 12% moisture content has been analysed on its own merits without reference to species properties in the green condition. Normally, the properties for both green and dry material are determined when a species is subjected to standard testing.

It is important to realize that the term "seasoned" as defined in AS CA65–1971, Timber Engineering Code, means the condition of a piece of wood when the maximum moisture content anywhere within it does not exceed 15%. It should be noted that this definition does not specify how the timber is seasoned, whether by air drying, kiln drying, or other means, but only its moisture content when seasoned.

Using the procedures applied by Pearson in D.F.P. Technol. Pap. No. 35 (1965) to formulate the groupings for green timber, eight strength groups, SD1 to SD8, have been defined for seasoned timber. The minimum strength properties for each group are shown in Table 3. These differ from those used for classifying green timber because of the different relationships between the properties in the dry condition. Although strength groups beyond SD8 are theoretically possible to define, timbers with densities below 390 kg/m³ are generally too soft for normal structural use.

Table 5 gives the strength grouping of a number of timbers in both the green and seasoned condition. The fact that any given timber has two strength groups, one in the green and one in the seasoned condition, should not present any significant practical difficulties.

(ii) *Stress Grades.*—As a result of the technique used in deriving the values in Table 3, a precisely similar set of stress grades to that presently applied to green timber can be used for seasoned timber.

There are obvious advantages in this. Not only does it avoid the need for a separate set of stress grade numbers but also it obviates the need for different settings of a machine grader to cope with green and seasoned timber. Furthermore, the table of basic working stresses is exactly the same for seasoned as for green timber.

One not quite so obvious advantage is that by considering the properties of seasoned timbers on their own merits a number of species whose properties improve far more than average when the timbers are seasoned can now be utilized more efficiently. Also under this scheme, radiata pine as seasoned timber is no longer an oddity amongst exclusively green timbers.

At this juncture, the only grading rules prepared specifically for seasoned timber are those, as mentioned, for radiata pine. In developing the stress grading system for seasoned timbers generally, it has been assumed that the grading rules formulated for green timber will be applied to the timber *after seasoning*. It is highly likely that, for technical reasons, this is the procedure that will be adopted when grading rules are prepared for seasoned material.

**Table 4**

**Basic Working Stresses for Structural Timbers**

(*a*) Basic working stresses and modulus of elasticity (MPa)

| Stress grade | Type of stress | | | | Modulus of elasticity |
|---|---|---|---|---|---|
| | Bending $F'_b$ | Tension parallel to grain $F'_t$ | Shear in beams $F'_s$ | Compression parallel to grain $F'_c$ | $E$ |
| F34 | 34·5 | 27·5 | 2·45 | 26·0 | 21500 |
| F27 | 27·5 | 22·0 | 2·05 | 20·5 | 18500 |
| F22 | 22·0 | 17·0 | 1·70 | 16·5 | 16000 |
| F17 | 17·0 | 14·0 | 1·45 | 13·0 | 14000 |
| F14 | 14·0 | 11·0 | 1·25 | 10·5 | 12500 |
| F11 | 11·0 | 8·6 | 1·05 | 8·3 | 10500 |
| F8 | 8·6 | 6·9 | 0·86 | 6·6 | 9100 |
| F7 | 6·9 | 5·5 | 0·72 | 5·2 | 7900 |
| F5 | 5·5 | 4·3 | 0·62 | 4·1 | 6900 |
| F4 | 4·3 | 3·4 | 0·52 | 3·3 | 6100 |
| F3 | 3·4 | 2·8 | 0·43 | 2·6 | 5200 |
| F2 | 2·8 | 2·2 | 0·36 | 2·1 | 4500 |

(*b*) Basic working stresses (MPa) for compression perpendicular to grain and shear at joints

| Strength group | | Compression perpendicular to grain | Shear at joint details |
|---|---|---|---|
| Green | Seasoned | $F'_p$ | $F'_{sj}$ |
| | SD1 | 10·4 | 4·15 |
| | SD2 | 9·0 | 3·45 |
| | SD3 | 7·8 | 2·95 |
| S1 | SD4 | 6·6 | 2·45 |
| S2 | SD5 | 5·2 | 2·05 |
| S3 | SD6 | 4·1 | 1·70 |
| S4 | SD7 | 3·3 | 1·45 |
| S5 | SD8 | 2·6 | 1·25 |
| S6 | | 2·1 | 1·05 |
| S7 | | 1·7 | 0·86 |

## Basic Working Stresses

As already mentioned, the proposed scheme for seasoned timber has been tailored in such a way that the same set of stress grades is generated and, therefore, the same set of basic working stresses applies to both green and dry timber (Table 4).

However, the designer must know whether the timber is green or seasoned. Firstly, the basic stresses for bearing perpendicular to the grain and for shear (Table 4(*b*)) depend on strength group not stress grade and, secondly, the creep factor for seasoned timber is only two-thirds of that for green timber.

Table 5 shows the relationship of visual grades to stress grades for the most common structural timbers (both green and seasoned).

## Conclusion

It should be noted that for a number of species listed in Table 5 the strength grouping in the green and for the seasoned condition is, to a degree, tentative. When, for lack of adequate technical data, some doubt arises as to the appropriate strength group in which a species should be classified, the choice is made usually on the conservative side.

It is hoped that the proposed system will provide not only a sounder and more rational basis for the use of seasoned timber in construction but will avoid the difficulties which now arise and which will become more critical as more seasoned timber is marketed and greater use is made of machine grading. If this system finds general acceptance, the conversion soon to metric units of both the Light Timber Framing and the Timber Engineering Codes will provide an opportunity to incorporate the scheme and eliminate the present procedures introduced into each of these codes as a matter of expediency.

**Table 5**

**Relationship of Visual Structural Grades to Stress Grades for Green and Seasoned Timber**

| Species | Aust. Standard | Strength group Green | Strength group Seasoned | Stress grade F4 | F5 | F7 | F8 | F11 | F14 | F17 | F22 | F27 | F34 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Australian-grown timbers | | | | | | | | | | | | | |
| Unidentified hardwoods from | | | | | | | | | | | | | |
| New South Wales | | | | | | | | | | | | | |
| Highlands | | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Elsewhere | | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Queensland | | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| South Australia | 082 | S4 | | | | | Bldg | Std | Sel | | | | |
| | and | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Tasmania | 083 | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Victoria | | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Western Australia | | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Unknown | | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Unidentified softwoods | | | | | | | | | | | | | |
| *Pinus* spp.* | | | *SD7* | | *Std* | *Sel* | *Std* | *Sel* | | | | | |
| | | | | | *Bldg* | *Bldg* | *Eng* | *Eng* | | | | | |
| Imported | | S6 | | | Sel | Std | Sel | | | | | | |
| | | | | Merch | Merch | Eng | Eng | | | | | | |
| | | | *SD7* | | | *Sel* | *Std* | *Sel* | | | | | |
| | | | | | *Merch* | *Merch* | *Eng* | *Eng* | | | | | |
| Alder, brown | 084 | S5 | | | | Bldg | Std | Sel | | | | | |
| | | | *SD6* | | | | *Bldg* | *Std* | *Sel* | | | | |
| Alder, rose | 084 | S6 | | | Bldg | Std | Sel | | | | | | |
| | | | *SD7* | | | *Bldg* | *Std* | *Sel* | | | | | |

**Table 5** (*Continued*)

**Relationship of Visual Structural Grades to Stress Grades for Green and Seasoned Timber**

| Species | Aust. Standard | Strength group Green | Strength group Seasoned | F4 | F5 | F7 | F8 | F11 | F14 | F17 | F22 | F27 | F34 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ash, alpine | 083 | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Ash, Crow's | 084 | S2 | | | | | | | Bldg | Std | Sel | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Ash, hickory | 084 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Ash, mountain | 083 | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Ash, silvertop | 083 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Ash, silver, northern | 084 | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD5* | | | | | *Bldg* | *Std* | *Sel* | | | |
| Ash, silver, southern | 084 | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD5* | | | | | *Bldg* | *Std* | *Sel* | | | |
| Ash, white | 082 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Blackbutt | 082 | S2 | | | | | | | Bldg | Std | Sel | | |
| | | | *SD2* | | | | | | | | *Bldg* | *Std* | *Sel* |
| Blackbutt, Western Australian | 1483 | S4 | | | | | | Str2 | Strl | | | | |
| | | | *SD5* | | | | | | *Str2* | *Str1* | | | |
| Bloodwood, brown | 082 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Bloodwood, red | 082 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Bloodwood, yellow | 082 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Box, black | 082 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Box, brush | 082 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Box, grey | 082 | S2 | | | | | | | Bldg | Std | Sel | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Box, grey, coast | 082 | S2 | | | | Bldg | Std | Sel | | |
| | | *SD2* | | | | | | *Bldg* | *Std* | *Sel* |
| Box, red | 082 | S3 | | | Bldg | Std | Sel | | | |
| | | *SD4* | | | | *Bldg* | *Std* | *Sel* | | |
| Box, white | 081 | S2 | | | | Bldg | Std | Sel | | |
| | | *SD2* | | | | | | *Bldg* | *Std* | *Sel* |
| Box, white-topped | 082 | S2 | | | | Bldg | Std | Sel | | |
| | | *SD2* | | | | | | *Bldg* | *Std* | *Sel* |
| Box, yellow | 082 | S3 | | | Bldg | Std | Sel | | | |
| | | *SD4* | | | | *Bldg* | *Std* | *Sel* | | |
| Brownbarrel | 082 | S4 | | Bldg | Std | Sel | | | | |
| | | *SD4* | | | | *Bldg* | *Std* | *Sel* | | |
| Cadaga | 082 | S4 | | Bldg | Std | Sel | | | | |
| | | *SD5* | | | *Bldg* | *Std* | *Sel* | | | |
| Candlebark | 082 | S5 | Bldg | Std | Sel | | | | | |
| | | *SD5* | | | *Bldg* | *Std* | *Sel* | | | |
| Carbeen | 082 | S1 | | | | | Bldg | Std | Sel | |
| | | *SD2* | | | | | | *Bldg* | *Std* | *Sel* |
| Gum, blue, southern | 083 | S3 | | | Bldg | Std | Sel | | | |
| | | *SD2* | | | | | | *Bldg* | *Std* | *Sel* |
| Gum, blue, Sydney | 082 | S3 | | | Bldg | Std | Sel | | | |
| | | *SD4* | | | | *Bldg* | *Std* | *Sel* | | |
| Gum, blue, Tasmanian | 083 | S3 | | | Bldg | Std | Sel | | | |
| | | *SD4* | | | | *Bldg* | *Std* | *Sel* | | |
| Gum, grey | 082 | S2 | | | | Bldg | Std | Sel | | |
| | | *SD2* | | | | | | *Bldg* | *Std* | *Sel* |
| Gum, grey, mountain | 082 | S3 | | | Bldg | Std | Sel | | | |
| | | *SD2* | | | | | | *Bldg* | *Std* | *Sel* |
| Gum, Maiden's | 081 | S3 | | | Bldg | Std | Sel | | | |
| | | *SD2* | | | | | | *Bldg* | *Std* | *Sel* |
| Gum, manna | 083 | S4 | | Bldg | Std | Sel | | | | |
| | | *SD4* | | | | *Bldg* | *Std* | *Sel* | | |
| Gum, mountain | 081 | S4 | | Bldg | Std | Sel | | | | |
| | | *SD5* | | | *Bldg* | *Std* | *Sel* | | | |
| Gum, pink | 081 | S3 | | | Bldg | Std | Sel | | | |
| | | *SD4* | | | | *Bldg* | *Std* | *Sel* | | |
| Gum, red, forest | 082 | S3 | | | Bldg | Std | Sel | | | |
| | | *SD4* | | | | *Bldg* | *Std* | *Sel* | | |

**Table 5** (*Continued*)

**Relationship of Visual Structural Grades to Stress Grades for Green and Seasoned Timber**

| Species | Aust. Standard | Strength group Green | Strength group Seasoned | F4 | F5 | F7 | F8 | F11 | F14 | F17 | F22 | F27 | F34 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gum, red, river | 081 | S5 | | | | Bldg | Std | Sel | | | | | |
| | | | *SD6* | | | | *Bldg* | *Std* | *Sel* | | | | |
| Gum, rose | 082 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Gum, salmon | 082 | S2 | | | | | | | Bldg | Std | Sel | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Gum, scribbly | 082 | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD5* | | | | | *Bldg* | *Std* | *Sel* | | | |
| Gum, shining | 082 | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD5* | | | | | *Bldg* | *Std* | *Sel* | | | |
| Gum, spotted | 082 | S2 | | | | | | | Bldg | Std | Sel | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Gum, sugar | 081 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Gum, swamp | 081 | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Gum, yellow | 081 | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD5* | | | | | *Bldg* | *Std* | *Sel* | | | |
| Hardwood, Johnstone River | 081 | S2 | | | | | | | Bldg | Std | Sel | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Ironbark, grey | 082 | S1 | | | | | | | | Bldg | Std | Sel | |
| | | | *SD1* | | | | | | | | | *Bldg* | *Std* |
| Ironbark, red | 082 | S2 | | | | | | | Bldg | Std | Sel | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Ironbark, red, narrow-leaved | 082 | S2 | | | | | | | Bldg | Std | Sel | | |
| | | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Jarrah | 1483 | S4 | | | | | | Str2 | Str1 | | | | |
| | | | *SD4* | | | | | | | *Str2* | *Str1* | | |
| Karri | 1483 | S3 | | | | | | | Str2 | Str1 | | | |
| | | | *SD2* | | | | | | | | | *Str2* | *Str1* |
| Mahogany, red | 082 | S2 | | | | | | | Bldg | Std | Sel | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Mahogany, southern | 081 | S2 | | | | | | | Bldg | Std | Sel | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mahogany, white | 082 | S2 | | | | | | | Bldg | Std | Sel | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Maple, Queensland | 084 | S6 | | | Bldg | Std | Sel | | | | | | |
| | | | *SD6* | | | | *Bldg* | *Std* | *Sel* | | | | |
| Maple, scented | 084 | S5 | | | | Bldg | Std | Sel | | | | | |
| | | | *SD5* | | | | | *Bldg* | *Std* | *Sel* | | | |
| Marri | 1483 | S3 | | | | | | | Str2 | Str1 | | | |
| | | | *SD3* | | | | | | | | *Str2* | *Str1* | |
| Messmate | 082 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Messmate, Gympie | 082 | S2 | | | | | | | Bldg | Std | Sel | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Oak, silky, northern | 084 | S6 | | | Bldg | Std | Sel | | | | | | |
| | | | *SD7* | | | *Bldg* | *Std* | *Sel* | | | | | |
| Oak, tulip, brown | 084 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Oak, tulip, red | 084 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Penda, brown | 082 | S2 | | | | | | | Bldg | Std | Sel | | |
| | | | *SD2* | | | | | | | | *Bldg* | *Std* | *Sel* |
| Penda, red | 082 | S2 | | | | | | | Bldg | Std | Sel | | |
| | | | *SD2* | | | | | | | | *Bldg* | *Std* | *Sel* |
| Peppermints (var.) | 083 | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Pine, bunya | 0107 | S6 | | | Bldg | Std | Sel | | | | | | |
| | | | *SD5* | | | | | *Bldg* | *Std* | *Sel* | | | |
| Pine, celery-top | 084 | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD5* | | | | | *Bldg* | *Std* | *Sel* | | | |
| Pine, cypress, northern | 095 | S4 | | | Light Scant | | | | | | | | |
| | | | *SD6* | | | *Light Scant* | | | | | | | |
| Pine, cypress, white | 095 | S6 | | Light Scant | | | | | | | | | |
| | | | *SD7* | | *Light Scant* | | | | | | | | |
| Pine, hoop | 0107 | S6 | | | Bldg | Std | Sel | | | | | | |
| | | | *SD5* | | | | | *Bldg* | *Std* | *Sel* | | | |

**Table 5** (*Continued*)

**Relationship of Visual Structural Grades to Stress Grades for Green and Seasoned Timber**

| Species | Aust. Standard | Strength group Green | Strength group Seasoned | Stress grade F4 | F5 | F7 | F8 | F11 | F14 | F17 | F22 | F27 | F34 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pine, loblolly† | 0107 | | | | | | | | | | | | |
| | | | *SD6* | | | | *Bldg* | *Std* | *Sel* | | | | |
| Pine, radiata* | 1490 | | | | | | | | | | | | |
| | | | *SD7* | | *Std* | *Sel* | *Std* | *Sel* | | | | | |
| | | | | | *Bldg* | *Bldg* | *Eng* | *Eng* | | | | | |
| Pine, slash† | 0107 | | | | | | | | | | | | |
| | | | *SD5* | | | | | *Bldg* | *Std* | *Sel* | | | |
| Satinash, grey | 084 | S5 | | | | Bldg | Std | Sel | | | | | |
| | | | *SD6* | | | | *Bldg* | *Std* | *Sel* | | | | |
| Satinay | 082 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Stringybark, brown | 082 | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Stringybark, red | 082 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Stringybark, white | 082 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Stringybark, yellow | 082 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Tallowwood | 082 | S2 | | | | | | | Bldg | Std | Sel | | |
| | | | *SD2* | | | | | | | | *Bldg* | *Std* | *Sel* |
| Tea-tree, broad-leaved | 082 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Tuart | 1483 | S3 | | | | | | | Str2 | Str1 | | | |
| | | | *SD3* | | | | | | | | *Str2* | *Str1* | |
| Turpentine | 082 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Walnut, yellow | 084 | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD5* | | | | | *Bldg* | *Std* | *Sel* | | | |
| Wandoo | 1483 | S2 | | | | | | | | Str2 | Str1 | | |
| | | | *SD3* | | | | | | | | *Str2* | *Str1* | |
| Woollybutt | 081 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Yertchuk | 083 | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Imported timbers | | | | | | | | | | | | | |
| Fir, Douglas | 0106 | S5 | | | | Sel | Std | Sel | | | | | |
| | | | | | Merch | Merch | Eng | Eng | | | | | |
| | | | *SD5* | | | | *Merch* | *Sel* | *Std* | *Sel* | | | |
| | | | | | | | | *Merch* | *Eng* | *Eng* | | | |
| Hemlock, western | 0106 | S6 | | | Sel | Std | Sel | | | | | | |
| (commercial)‡ | | | | Merch | Merch | Eng | Eng | | | | | | |
| | | | *SD6* | | | *Merch* | *Sel* | *Std* | *Sel* | | | | |
| | | | | | | | *Merch* | *Eng* | *Eng* | | | | |
| Balau | 0135 | S2 | | | | | | | Bldg | Std | Sel | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Balau, red | ,, | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Chengal | ,, | S1 | | | | | | | | Bldg | Std | Sel | |
| | | | *SD2* | | | | | | | | *Bldg* | *Std* | *Sel* |
| Kapur | ,, | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD4* | | | | | | *Bldg* | *Std* | *Sel* | | |
| Kempas | ,, | S2 | | | | | | | Bldg | Std | Sel | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Keruing | ,, | S3 | | | | | | Bldg | Std | Sel | | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Kwila (merbau) | ,, | S2 | | | | | | | Bldg | Std | Sel | | |
| | | | *SD3* | | | | | | | *Bldg* | *Std* | *Sel* | |
| Lumbayau (mengkulang) | ,, | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD5* | | | | | *Bldg* | *Std* | *Sel* | | | |
| Meranti, dark-red | ,, | S5 | | | | Bldg | Std | Sel | | | | | |
| | | | *SD6* | | | | *Bldg* | *Std* | *Sel* | | | | |
| Meranti, light-red | ,, | S6 | | | Bldg | Std | Sel | | | | | | |
| | | | *SD7* | | | *Bldg* | *Std* | *Sel* | | | | | |
| Meranti, white | ,, | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD5* | | | | | *Bldg* | *Std* | *Sel* | | | |
| Meranti, yellow | ,, | S5 | | | | Bldg | Std | Sel | | | | | |
| | | | *SD6* | | | | *Bldg* | *Std* | *Sel* | | | | |
| Meranti, bakau | ,, | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD5* | | | | | *Bldg* | *Std* | *Sel* | | | |
| Mersawa | ,, | S6 | | | Bldg | Std | Sel | | | | | | |
| | | | *SD6* | | | | *Bldg* | *Std* | *Sel* | | | | |
| Ramin | ,, | S5 | | | | Bldg | Std | Sel | | | | | |
| | | | *SD5* | | | | | *Bldg* | *Std* | *Sel* | | | |

**Table 5** (*Continued*)

**Relationship of Visual Structural Grades to Stress Grades for Green and Seasoned Timber**

| Species | Aust. Standard | Strength group Green | Strength group Seasoned | Stress grade F4 | F5 | F7 | F8 | F11 | F14 | F17 | F22 | F27 | F34 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sepetir | 0135 | S4 | | | | | Bldg | Std | Sel | | | | |
| | | | *SD5* | | | | | *Bldg* | *Std* | *Sel* | | | |

Visual grades defined in Australian Standards are: Bldg, Building grade; Std, Standard grade; Sel, Select grade; Merch, Merchantable grade; Sel Merch, Select Merchantable grade; Eng, Enginereing grade; Std Eng, Standard Engineering grade; Sel Eng, Select Engineering grade; Str1, Structural grade 1; Str2, Structural grade 2; Light Scant, Light Scantling grade; Std Build, Standard Building grade.

* In seasoned condition as required by AS 1490. † Excluding pith-in material. ‡ As marketed at present is mixed with a small percentage of amabilis fir.

*Note*.—As each set of grading rules is converted to metric units the reference number of the Standard will be changed (e.g. AS 078 in imperial units is now AS 1490).



Printed by CSIRO, Melbourne

CSIRO

# Forest Products Newsletter

FOREST PRODUCTS LABORATORY, CSIRO, P.O. BOX 310, SOUTH MELBOURNE, VICTORIA 3205

NUMBER 395 NOVEMBER–DECEMBER 1973

1973##395

# CREOSOTED POLE STUBS

## A 39-year-old Test at Benalla, Vic.

**By J. Beesley, Preservation Section**

The oldest creosoted poles in Australia, for which there is complete documentation, are those set out by J. E. Cummins and H. B. Wilson in February 1934, in one of their first projects with the then CSIR. These pole stubs were included in the final part of a comprehensive graveyard trial of pre-installation and *in situ* treatments on pole stubs of *Eucalyptus obliqua* (messmate stringybark) commenced some 12 months previously. Even in those days there was concern over the supply of durable timbers for transmission-line poles—and some scepticism over the value of available preservative treatments.

The originators of the test deliberately tried to separate the decay hazard from termite attack. They chose a site in the Monbulk State Forest, near Belgrave in the Dandenongs, about 30 miles east of Melbourne, as a site with a high decay hazard and little risk of termite attack. The Victorian Country Roads Board gave permission for the use of a site beside the Hume Highway, near Winton, about 12 miles north-east of Benalla, for the test against termites. Both test sites have been inspected many times over the intervening years: Belgrave has proved to be a site with a high hazard from decay and only sporadic termite attack (mostly *Coptotermes frenchi*); Benalla, on the other hand, retains a consistent and high hazard from both *Coptotermes acinaciformis* and *Nasutitermes exitiosus*, as well as a moderate decay hazard.

The nature and number of test treatments was the same at both sites, with each treatment replicated 10 times at each site. All the test poles were felled during November/December 1932, and those to be impregnated were air-dried for about 13 months before treatment and installation in February 1934. The stubs to be pressure-impregnated were brought to Melbourne for drying and treatment at the Forest Products Laboratory. All other test stubs were dried (where required) and treated on site.

No record appears to have been kept of the moisture content of individual stubs at the time of treatment, but it is known that the moisture content of the sapwood of all pole stubs to be pressure-impregnated was below 20% at the time of treatment. Presumably, the stubs seasoned at Benalla would have been just as dry, if not drier, and those seasoned at Belgrave might have been a little higher in moisture content, than stubs seasoned in Melbourne.

During April 1973, a detailed study was made of the condition of the 19 creosote-impregnated pole stubs installed in the Benalla test site in February 1934. Ten of these stubs had been given an open-tank (hot and cold bath) treatment in creosote oil and the others had been pressure-treated. One of the pressure-treated poles was never installed in the field owing to excessive splitting at the time of treatment.

Makeshift equipment was used for the open-tank treatment at Benalla, where the butt end (approximately 5 ft) of each pole stub was heated in creosote oil and held at

| | Serial number | Creosote retention in treated sapwood* (lb/ft³) | Butt condition, Benalla, after 39 yr |
|---|---|---|---|
| Open tank (hot and cold bath), butt end (5 ft) only | 129 | 22·8 | Sound, surface softened to about 1/16 in. |
| | 42 | 21·0 | Surface generally softened to about 1/16 in. but with pockets of decay penetrating to 1/2 in. |
| | 72 | 20·5 | Sound, surface softened to about 1/16 in. |
| | 110 | 19·5 | Moderate sapwood decay to about 3/8 in. |
| | 22 | 18·7 | Sound, surface softened to about 1/16 in. |
| | 12 | 17·1 | Sound, surface softened to about 1/16 in. |
| | 91 | 16·3 | Slight sapwood decay to about 1/4 in. |
| | 53 | 15·3 | Moderate sapwood decay to about 3/8 in. |
| | 32 | 15·2 | Sound, surface softened to about 1/16 in. |
| | 2 | 12·1 | Slight sapwood decay to about 1/4 in. |
| Pressure impregnation (full length) | 56 | 16·4 | Failed (1973), decayed heartwood; slight sapwood decay to 1/4 in. |
| | 75 | 16·4 | Sound, surface softened to about 1/16 in. |
| | 14 | 16·1 | Slight sapwood decay to about 1/4 in. with pockets of decay penetrating to about 3/8 in. |
| | 94 | 14·0 | Failed (1973); extensive decay in sapwood and heartwood |
| | 4 | 13·8 | Slight sapwood decay to about 1/4 in. |
| | 44 | 13·7 | Moderate sapwood decay to about 3/8 in.; heart "piped" |
| | 132 | 11·2 | Moderate sapwood decay to about 1/2 in. |
| | 24 | 10·6 | Moderate sapwood decay to about 1/2 in. |
| | 34 | 9·8 | Sound, surface softened to about 1/16 in. with streak of deeper decay over a check |

* Volume of treated sapwood, estimated at 6 ft for butt-treated stubs.

a temperature of more than 93°C for about 3 hr, before overnight cooling in the same creosote to a temperature somewhat below 38°C. This treatment achieved a mean preservative retention of almost 18 lb/ft³ (290 kg/m³) in the sapwood* of the 10 stubs.

The schedule used for the pressure impregnation was a conventional full cell process, with an initial vacuum of 710 mm (28 in.) of mercury for 30 min, followed by a pressure period of 2 hr at 150 lb/in² (1034 kPa) and 71°C and a final vacuum of 710 mm for 10 min. In these stubs, increment borings were taken to establish sapwood thickness and so to determine preservative retention per cubic foot of treated sapwood. The mean retention of creosote obtained was 14·7 lb/ft³ (255 kg/m³) in the sapwood (max. 16·4 lb/ft³ = 262 kg/m³, min. 9·8 lb/ft³ = 157 kg/m³). The creosote used was an Australian vertical retort creosote with the following characteristics.

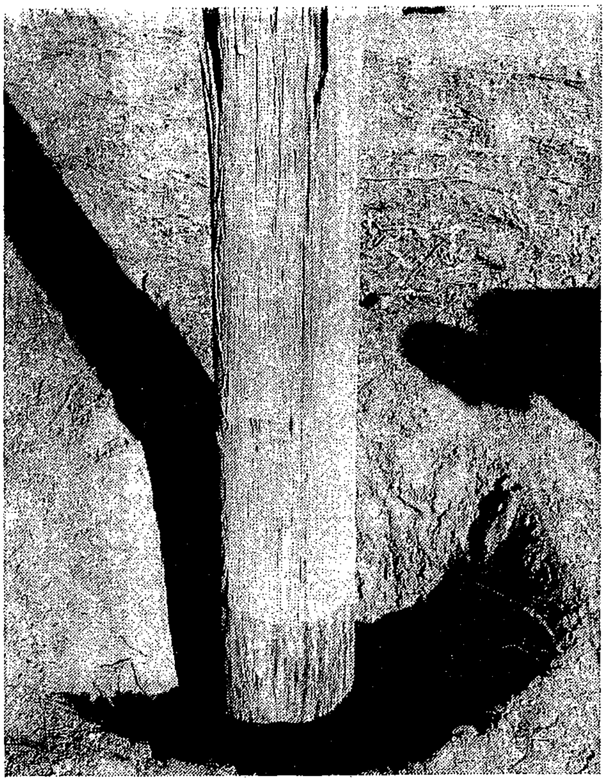
* Volume of sapwood treated has been calculated from the mean girth (both ends and centre) of each stub, assuming a uniform sapwood thickness of 1¼ in. (the average sapwood thickness in comparable pressure-treated stubs) and that treatment effectively penetrated 6 ft from the butt. The maximum absorption achieved was 22·8 lb/ft³ (365 kg/m³) with a minimum of 12·1 lb/ft³ (194 kg/m³). By assuming that treatment affected sapwood for 12 in. above the level of preservative, the treated volume has been increased by 20% and preservative retention per unit volume of treated sapwood correspondingly reduced.

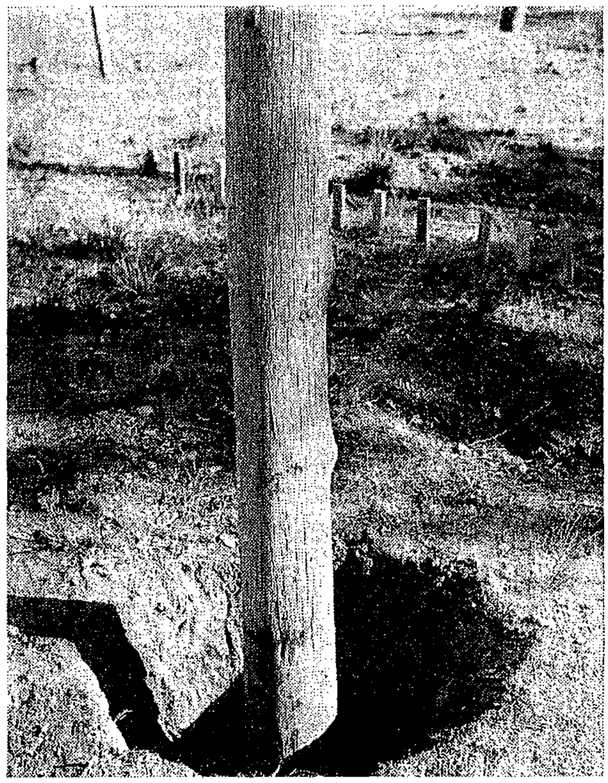
| Property | Used in open-tank treatment | Used in pressure treatment |
|---|---|---|
| Specific gravity at 38°C/15·5°C | 0·970 | 0·982 |
| Insoluble in benzol (%) | 0·05 | 0·4 |
| Water (%) | 1·0 | 0·5 |
| Distillation (%) | | |
| Below 210°C | 1·7 | 0·2 |
| 210–235°C | 11·1 | 6·6 |
| 235–270°C | 26·4 | 27·1 |
| 270–315°C | 24·8 | 24·9 |
| 315–355°C | 21·5 | 20·2 |
| Above 355°C | 14·3 | 20·5 |
| Residue, float test | < 50 s | < 50 s |

This creosote oil meets the requirements of the original Australian Standard K55 of 1936 for creosote oil for the preservation of timber and, in its listed properties, would also satisfy the 1965 revision of that standard for Type C (Impregnation) creosote.

<< Content

Print this page





*Open-tank-treated pole stub* (left), *sound after 39 years. Note sapwood deterioration above treated butt zone. Pressure-treated pole stub* (right) *after 39 years, free from decay and termite attack.*

A simple tabulation will serve to correlate the quantity of creosote oil in the sapwood of the treated poles with the condition of that sapwood after 39 years of exposure.

The most striking fact about these results is the high creosote retentions obtained by the open-tank treatment, even after allowing for a margin of 20% in the volume of sapwood penetrated by the process. With both treatments, the highest retention of preservative achieved was about double the minimum, for that treatment. The consequence of this natural "scatter" should not be overlooked when establishing average charge retentions for present-day, commercial treatments.

These results clearly illustrate that decay resistance is not correlated with creosote retention alone—pole stub no. 129, with the highest retention of creosote, and no. 34, with the lowest loading, were both rated as "sound" after 39 years in test. Only two pole stubs in this series, nos. 56 and 94, both pressure-impregnated and both with relatively high preservative retentions of creosote have been condemned. In both cases, the major deterioration was in the heartwood but in no. 94 the sapwood was also extensively decayed.

In spite of the high hazard from termites at the test site, the complete absence of termite attack from these stubs is noteworthy. At various times in the past, termite galleries have been built over the treated sapwood but in these poles the treated sapwood barrier has never been penetrated by them.

In broad terms, two-thirds of the stubs used in this test are still in a very good condition, with sapwood deterioration limited to the outer $\frac{1}{4}$ in. after 39 years in test. In about one-quarter of the test stubs, there is appreciable deterioration of the sapwood but, in service, their remaining useful life would be assessed at "more than 5 years", the maximum period normally forecast. In fact, it is quite probable the majority of these stubs would not qualify for replacement for another 15–20 years in normal service conditions with a pole-using authority. With only two stubs being taken out of service after 39 years, both treatments must be regarded as outstandingly successful, and the merits of open-tank treatments as an alternative to pressure impregnation must not be overlooked.

# The Design of Timber-framed Structures

## (A New Series of Publication)

Over recent months, officers of the Division have been preparing a series of papers covering the structural design of single- and double-storey domestic and similarly framed structures. The first three papers, Design Criteria, Single-storey Dwellings for Built-up Areas, and Two-storey Dwellings for Built-up Areas, are with the printer. Three further papers in the series, one covering the design of framed structures in cyclone-prone and exposed areas, another on Class 2 structures, and the third on non-domestic structures, are now being prepared. Other papers dealing with special framing practices, with matters relating to quality of workmanship, and with materials other than timber are planned. All the information given is in metric units and the range of timber sizes listed in the various tables is that indicated by the timber industry as likely to be available.

Generally, throughout the series, the good building practices specified in AS CA38 Light Timber Framing Code are assumed. The tables covering green and seasoned softwoods and hardwoods are arranged in such a way that, knowing the timber to be used and its stress grade, only one small set of tables, apart from a few general ones, needs to be consulted. The tables for seasoned hardwood are restricted to three stress grades but additional grades can be readily added if and when the demand arises.

Publication of the series has several objectives. It is designed to provide a comprehensive background of data that can be readily adapted by Standards Association committees or others interested in this area. In particular, several parts of the series should provide material assistance in the conversion to metric units of AS CA38, for which to date it has been practicable to prepare only a supplement to cope with the imminent changeover in timber sizes and building dimensions generally to metric dimensions.

The series has also been prepared to extend significantly the rather limited information presently available in the Light Timber Framing Code on such topics as two-storey structures and construction in cyclone-prone areas. By providing design information for Class 2 structures such as out-buildings, carports, farm buildings and the like, the series will help to fill a gap left when Pamphlet No. 112, Building Frames: Timbers and Sizes, long out of print, was superseded by the Light Timber Framing Code. The latter does not as yet cover this class of structure.

Yet another objective was to provide a definitive CSIRO publication to replace its original publication of Pamphlet No. 112. When published in 1941, the latter constituted the first attempt in Australia, and perhaps anywhere else, to rationalize home-frame member sizes using engineering principles. Now, some 30 years later, the present series summarizes in a similar practical form the results of advances made in timber technology and in technical experience in the field of framed structures.

Advice of the publication of each of the papers will be given in subsequent issues of this Newsletter.

## FILM AWARD

A film made by the CSIRO Film Unit and Dr. Bill McKenzie of the Forest Products Laboratory of the Division of Building Research, recently won the Premier Award for Scientific Films at the 27th Congress of the International Film Association held in Bulgaria.

"Rupture Pattern in Cutting Wood" deals with the cardinal cutting orientations related to veneer cutting, planing, sawing, and pulp chipping. It shows the various kinds of rupture patterns that occur and how they are related to the quality of chip or surface produced in practice.

The film is 16 mm, black and white with optical sound track, runs for 17 minutes, and can be purchased for $A56 (plus freight charges) from the CSIRO Film Unit, 314 Albert Street, East Melbourne, Vic. 3002. Industry groups may borrow it from the CSIRO Film Unit, Australian State Film Centres, and the Division of Building Research, Forest Products Laboratory, P.O. Box 310, South Melbourne, Vic. 3205.



Printed by CSIRO, Melbourne