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WHAT'S NEW

IN FOREST RESEARCH

Machining properties: how does radiata pine shape up?

To New Zealand's forest managers, the good tree form, ease of establishment, and rapid growth of radiata pine make it a profitable species to grow. However, these tree features alone do not justify the extensive plantings of radiata pine that now exist in New Zealand — radiata pine also has many desirable utilisation properties. It is easily dried and can be treated with a range of preservatives effectively, thus widening the range of its end-uses. Also, because of the generally even texture of the wood, radiata pine is capable of being machined and processed into a vast array of end products.

As the timber has been used in this country for nearly a century, members of New Zealand's wood-working industry take for granted the good machining properties of radiata pine. But now New Zealand is seeking to expand the market for radiata pine overseas, where its properties are little known. Therefore, the potential buyers and marketers of New Zealand radiata pine need information to enable them to compare radiata pine with those timbers currently being used. This "What's New" summarises data from tests carried out at the Forest Research Institute, Rotorua, on the machining of radiata pine and eight other timbers. Results from tests of other widely known timber properties relevant to end uses are also presented.



The good machining properties of radiata pine allow it to be used in high quality end-uses such as furniture and interior joinery.

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Sample material

Timber from eight species that are potential competitors with radiata pine overseas were obtained through a commercial outlet in England. These general purpose species included: loblolly pine (*Pinus taeda*) from southern United States; Douglas fir (*Pseudotsuga menziesii*) from north-western United States (this slow-grown material is quite unlike New Zealand's fast grown Douglas fir); western hemlock (*Tsuga heterophylla*) from Canada; Parana pine (*Araucaria angustifolia*) from Brazil; dark red and light red meranti (*Shorea* spp.), two commercial groupings of general purpose tropical hardwoods from Malaysia; Norway spruce (*Picea abies*), also known as European whitewood, or by its origin — Swedish whitewood and Archangel whitewood (from the U.S.S.R.); and lastly Scots pine (*Pinus sylvestris*), also known as European redwood and referred to specifically in this study as north-swedish redwood, mid-swe-dish redwood, or Siberian redwood (from the U.S.S.R.). These provided a good cross-section of competitive timbers, and included most of the species presently available in large quantities in the United Kingdom.

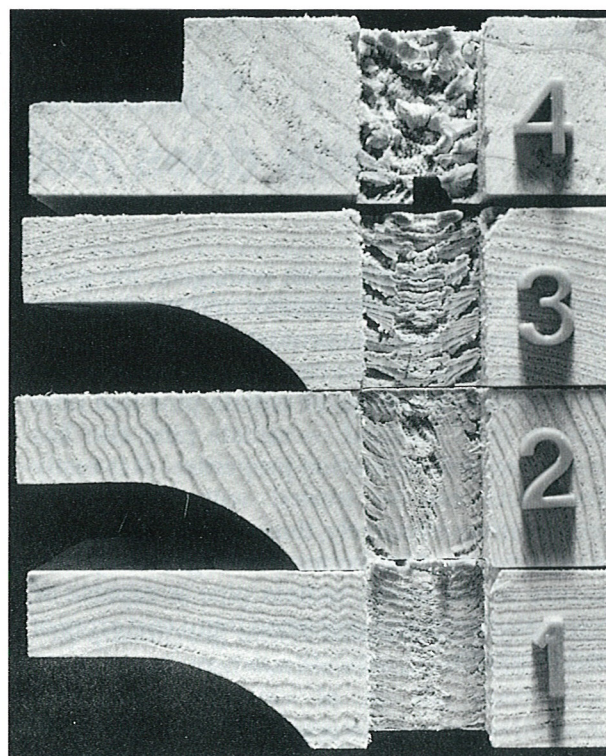
The samples of New Zealand radiata pine were representative of the timber that will supply New Zealand's export markets. Typically the stands will have been thinned and pruned, and then felled when they are approximately 35 years old. The sample material was separated into two categories: outerwood, which was selected from the wood produced by the tree after pruning; and corewood, which was cut from between the whorls of branches and near the centre of the tree (these two types of wood are the clear timber that will be exported). Since density, one of the most important wood properties affecting machining, is significantly different for outerwood and corewood, testing them independently provided information on the full range of machining results that could be expected from radiata pine.

Machining tests

Because factors such as machine speed and knife setting are variable, there are literally hundreds of ways of carrying out each machining process. It was impracticable to test all combinations so, instead, one set of fairly representative working conditions was selected for each process. These conditions and even the processes themselves may not have suited some of the species tested; for example, the great variation of density within the growth rings of loblolly pine make it unsuitable for turning. The results, therefore, were treated as relative indicators of the species properties, rather than as the optimum results obtainable.

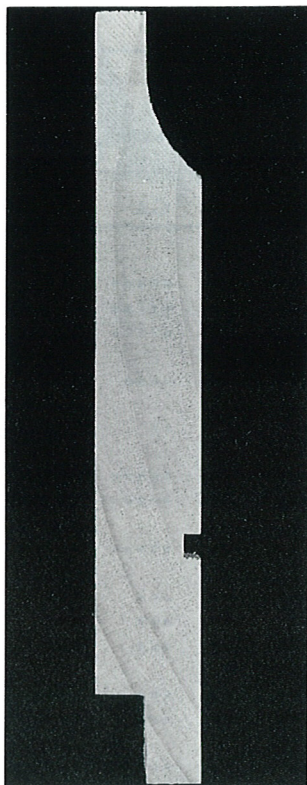
The quality of each outturn was visually graded on a scale of 1-5. In this scale Grade 1 indicates a

defect-free result ("Excellent") and Grade 2 a result having only very slight defects ("Good"). These two grades approximate the level of finish required for commercial processing such as internal joinery or furniture manufacture. Grade 3 ("Average") has a finish probably suitable for weatherboards and similar rougher work. Grades 4 ("Poor") and 5 ("Reject") indicate progressively worse results and would probably be unsuitable for many end-uses without further processing. The percentages of samples graded 1 or 2 ("Excellent" or "Good") were used to compare the species. Where this resulted in no differentiation between the species, comparisons were made using only the percentage graded as "Excellent".

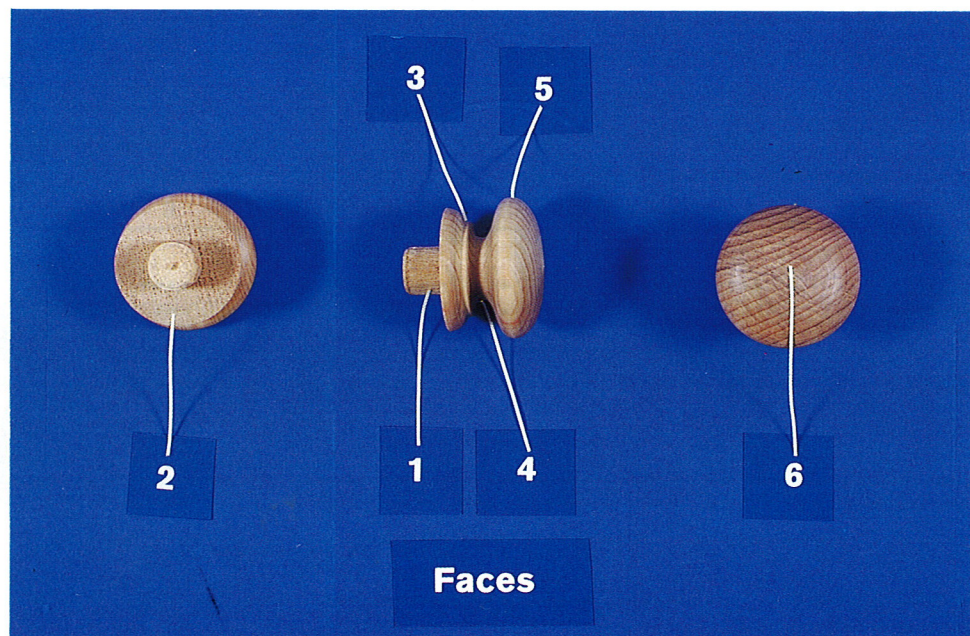


An example of four visual grades for the assessment of the quality of mortising, showing the range from "Poor" (Grade 4) to "Excellent" (Grade 1).

As turning and planing are the most common processes for shaping wood, machining patterns were selected to thoroughly test the behaviour of the timber during these processes. A drawer knob profile was chosen for the turning test because it consists of six different turning shapes that are commonly used: dowel, flat end, edge detail, concave, convex, and end grain. Each feature was assessed and then used to establish a total grade for turning. Using such a small profile also meant that a large number of samples could be produced from relatively small volumes of timber. A weatherboard pattern was chosen for the planing tests because it also has a number of different features useful for assessment. Three of these, a longitudinal groove, a rebate edge, and concave moulding, were used to establish a total grade for moulding. The flat face was used to compare ease and quality of planing.



(left) Rusticated weatherboard profile showing features used for planing assessment: longitudinal groove, rebate edge, flat face, and concave moulding.



Turnery profile showing the six faces for visual assessment. 1: dowel, 2: flat end, 3: edge detail, 4: concave, 5: convex, and 6: end grain.

Radiata pine performed particularly well in the turning, planing, and moulding tests, with the higher density outerwood performing slightly better than the corewood (see Table 1). Other good performers were Parana pine and dark red meranti.

The other machining tests that were carried out included boring, mortising, cross-cutting, routing, and finger-jointing. In conjunction with the turning, planing, and moulding trials, these covered all the main wood-working processes. Boring and mortising were assessed on the neatness of the entrance and exit holes (i.e., degree of chipping) and the smoothness of the internal machined surfaces. The cross-cutting test involved two types of saws and the outturn was graded on the neatness of the upper and lower edges of the cut and the smoothness of the finish on end grain. To determine the routing properties, a semi-circular shape was machined so that the quality of the finish on both the side and end grain could be assessed. The finger-jointing test was carried out in a commercial finger-jointing plant and was assessed using the New Zealand standard as a guide.

Again radiata pine compared favourably in practically all these processes as the comparative results in Table 1 show. The exception was in the mortising trial, where the average outturn of radiata pine was Grade 3. To restrict degrade during this process, it is recommended that extremely sharp chisel-type mortisers are used with a low cutting speed.

Related tests

Other tests were carried out to measure surface hardness, nail-holding strength, resistance to nail-splitting, dimensional stability of the wood in use, and ease of sanding and finishing. All of these properties are important for use in furniture, interior and exterior joinery, and for more specialised uses such as flooring. Most were measured by established techniques which give standard measurements for comparison. For example, both surface hardness and nail-withdrawal were measured by standard strength tests. Similarly, the standard method of measuring dimensional stability was used to indicate the maximum expected movement in response to changes in weather conditions. Samples were conditioned to a required moisture content and exposed to very humid conditions for a set length of time. The resultant swelling provided a measure of the short-term dimensional stability. The results of these tests then were compared with standard values, so that the classifications in Table 1 are based on an international range of values.

The test for resistance to nail-splitting was adapted for this study. It was a particularly severe trial: 3-mm-diameter nails were driven into the wood only 10 mm from the board ends. Radiata pine was found to be the timber least prone to splitting. Sanding and finishing were tested by selecting a range of flat-sawn and quarter-sawn boards and subjectively assessing the ease of sanding before applying a variety of stains and surface finishes. The quality of the resultant finishes was then graded.

TABLE 1 - Comparative classification of the results of FRI machining and related tests
(• = poor performance, = excellent performance)

	Machining trials								Related trials						Overall
	Turning	Planing	Mould- ing	Boring	Mort- ising	Cross- cutting	Rout- ing	Finger- jointing	Hard- ness	Nail holding	Nail splitting	Stabili- ty	Sanding	Staining	
	E/G	E/G	E/G	E/G	E/G	E	E/G	E	IV	IV	E/G	IV	GA	GA	
Radiata pine															
corewood	•	••	••	••
outerwood	••	••	••	••	••	••
total	••	••	••	••
Douglas fir	••	••	••	••	••
Loblolly pine	•	••	••	••	•	••	••	••	—	••	••	••
Light red meranti	••	••	••	••	••	••
Dark red meranti	••	••	••	••
Parana pine	••	••	••	••	••
Mid-swedish redwood	—	••	••	—	••	••	••	••	••	••
North-swedish redwood	••	••	••	••	••	••	••	••	••
Siberian redwood	••	••	••	••	••	••	••	••	••
Swedish whitewood	••	••	•	••	••	••	••	••	••	••
Archangel whitewood	••	••	••	••	••	••	••	•	••	••	••	••
Western hemlock	•	••	••	••	••	••	••	••	••	••	••
E/G = result based on % graded "excellent" or "good"															
E = result based on % graded "excellent"															
IV = result based on international range of values															
GA = result based on general assessment															
— not tested															

Radiata pine proved to be generally as good as the other species in all the related tests (see Table 1).

Conclusions

All the results of the machining and related tests were pooled into an overall classification for each species (Table 1). Again, it must be emphasised that the classifications are based on the indicative results of this study which, for some processes, may not have been the best results obtainable. The overall grade showed that New Zealand's radiata pine, Douglas fir, Parana pine, and the merantis performed best of the timbers examined.

Summary

By quantifying these machining properties, the FRI has confirmed that New Zealand radiata pine compares favourably in all the machining properties with the other general purpose timbers tested. Radiata pine has the added advantage that supplies of it will increase in the future whereas for many of the other species tested, which come from natural stands, supplies will decrease. By showing that radiata pine does have comparable properties to species currently being used, these results will help to make radiata pine more competitive and better recognised in the international market place. FRI is continuing this research to include species from other markets around the world.

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