Douglas fir performance in sawing trials in New Zealand

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Background

Douglas fir timber commands a premium for structural uses and a high proportion of mill out-turn will meet local structural standards. Old growth Douglas fir from the Pacific Northwest is world-renowned for the quality of the clear and high strength timber, and has been a major source of structural lumber and plywood as well as an important source of appearance and finishing grades domestically and for export. However, the iconic United States stands have long gone and second growth stands of Douglas fir (up to 100 years old) now dominate the market. This resource contains a much higher proportion of juvenile wood, commonly accepted as the first 20 rings from the pith in Douglas fir, and yields negligible amounts of clear lumber.

Douglas fir in New Zealand

In New Zealand, Douglas fir was first planted in 1859 and is now the second most important plantation species in the country, covering approximately 106,000 hectares (MPI, 2013). Although slower growing than radiata pine, the species has several survival advantages, particularly in cooler upland regions where winter snow can occur. Over 75 per cent of the resource is now located in the South Island, where it is less susceptible attack from Swiss Needle Cast (*Phyaeocryptopus gaeumanni*). The wood quality is much less variable than that of radiata pine and it yields a highly regarded timber preferred for its superior uniformity, strength, toughness, durability and decay resistance due to the high heartwood content (Cown, 1999).

Typical Central North Island Douglas fir stand. Source: Scion Image Library

Tree breeding trials, initially focused on provenances from along the west coast of North America from British Columbia to California, have been established across the country since 1957 and California and Oregon sources have proven to be more vigorous. Provenance trials have been assessed for wood density on occasion (Kennedy, 2012; Lausberg, 1996), and while there are some differences they tend to be outweighed by the high tree-to-tree variation. Breeding efforts are now concentrating on outstanding individual stems from within families (Dungey, et al., 2012; Shelbourne, et al., 2007).

Utilisation of older stands (40 years+) has been mostly for the export market, either as large dimension timber or as raw logs, but local mills have been processing thinnings and now more clearfell is destined for the domestic structural market. Rotations are now commonly 45 years.

Sawing studies

The first sawing studies in New Zealand were done by Whiteside et al. (1976) who showed that both wood density and knot size contributed strongly to timber stiffness. The fact that growth rate was shown to have only a modest impact on density and stiffness (Harris, 1978) led to a recommendation that Douglas fir should be grown as rapidly as possible on a short rotation. This is subject to maintaining a small branch index, an average of the largest branch in each log quartile, and an average wood density above 400 kilograms per cubic metre. Early studies of wood density revealed only a modest density increase with age compared to radiata pine. Other studies confirmed that the regional wood density trends are similar to those observed in radiata pine, i.e. a decrease southwards and with increasing site elevation (Harris, 1965).

A small unpublished sawing study was carried out in 1991 using young material aged around 30 years from the Nelson region. Somewhat surprisingly, very good visual and mechanical grade recoveries were obtained and the timber was kiln-dried with no apparent degrade (McConchie, et al., 1992). It was concluded that material from relatively young logs was very suitable for structural uses, despite containing a high proportion of juvenile wood. A much larger sawing study was undertaken in 1994 in collaboration with the US Forest Service Stand Management Cooperative. The activities were later taken over by Future Forests Ltd until 2013. Jointly almost 200 unpruned logs with varying characteristics were chosen from four managed Central North Island stands aged between 33 and 59 years, to uncover the most important variables affecting grade recovery and value.

Douglas fir sawn timber. Source: Scion Image Library

A deliberate attempt was made to include a range of both branch categories and log densities. All the timber was graded both visually and mechanically. Saw pattern (cant size), branch size, juvenile wood percentage (inner 20 rings) and wood density were all shown to be important in influencing final grade recovery. Overall, around 80 per cent of the timber was acceptable as New Zealand visual framing grade and about 70 per cent as F5 machine grade and better. It was clearly shown that the best logs had branch indices less than four centimetres and wood density greater than 450 kilograms per cubic metre (McConchie, et al., 1995).

This large study documented a wide range of log characteristics in the Douglas fir plantations and identified branch index as the most influential log characteristic for recovery of both visual and machine grades. It was concluded that silvicultural regimes that promote growth rates at the expense of branch control, with the objective of reducing rotation age, will also increase the proportion of juvenile wood, reduce wood density and significantly impact on grade recovery irrespective of the grading criteria applied. The relationships derived from this study were used in sawing models to predict structural grade recovery.

In 2002, the New Zealand Douglas fir Research Cooperative undertook another study, collecting more detailed wood property data to try to improve timber grade predictions further (Knowles, et al., 2003). This cooperative was an industry/research programme initiated in the 1990s to focus on practical R&D for forest managers with an interest in Douglas fir management. Eighteen trees (54 logs) were sampled from a 41-year-old stand. Wood density was assessed on discs and microfibril angle was measured on radial samples using the SilviScan instrument (Evans, 1998). Logs were processed into sawn timber that was tested for stiffness and strength. In general, timber stiffness and strength were strongly related to wood density, but poorly correlated with microfibril angle values. Branch (knot) size had less influence than in the previous sawing study.

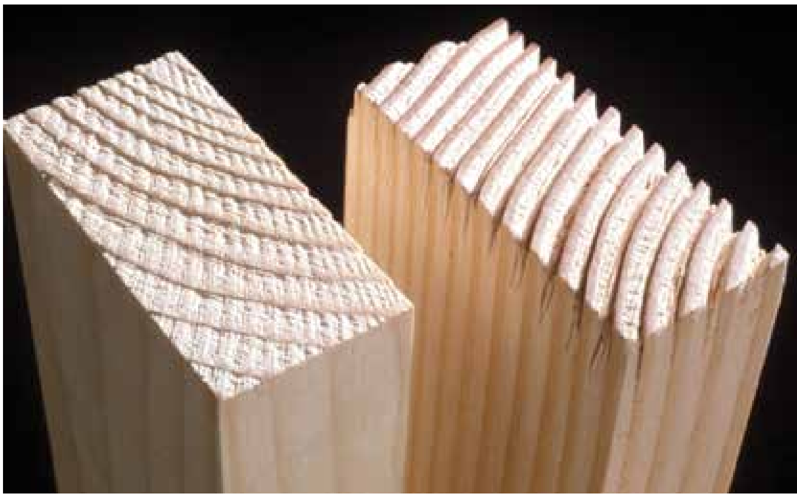
All wood properties improved with tree age. A model using breast height outerwood density and branch index explained 64 per cent of the variation in log-average timber stiffness. Similar results were obtained later in

2007 and 2009, when small sawing studies (unpublished) were undertaken with material from Whakarewarewa and Rankleburn forests to compare non-destructive standing tree tools to predict timber stiffness. Outerwood density, standing tree acoustic velocity, and branch index were all found to be useful indicators of timber stiffness.

Conclusion

Douglas fir wood properties tend to be less variable than those of radiata pine, particularly in branch size and radial density variation. There are provenance differences in stem volume growth, but there are lesser differences in wood properties and still a large amount of tree-to-tree variation. Branch sizes also tend to be much smaller than in radiata pine, but are sensitive to tree spacing. Plantation material has characteristics, which tend to limit its use for high value end products, particularly ring width, density contrast within rings and knot frequency. The structural properties are similar to those of second growth Douglas fir and western hemlock from North America.

To optimise value, future plantation regimes must carefully balance the genetics and silvicultural treatments applied to ensure that increased individual stem volume growth does not compromise good structural recoveries by increasing branch sizes beyond about four centimetres. Current research efforts are aimed at increasing the utilisation of thinnings from existing stands and including more wood quality functions into modelling systems so that forest managers are better able to predict growth, wood properties and carbon sequestration.



End grain (left radiata and right Douglas fir). Source: Scion Image Library

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