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DRYING OF DOUGLAS-FIR CLEARWOOD

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DOUGLAS-FIR COOPERATIVE

EXECUTIVE SUMMARY

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Clear boards of Douglas-fir may be dried using an ACT schedule or a conventional temperature schedule. The quality of the dry boards should be similar from either charge and the choice of kiln schedule should be based on the capability of the kiln and the estimated drying time.

DRYING OF DOUGLAS FIR CLEARWOOD

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INTRODUCTION

Douglas fir is recognised as an easy species to dry because the timber from older trees is mostly heartwood of low initial moisture content and it is not prone to warp. The major problems in drying Douglas fir are surface checking of wide boards and checking of intergrown knots. Decorative uses for Douglas fir are mainly panelling and sarking, and air drying is the most common method of drying. Air drying is a low cost option which minimises knot checking. Structural grades of Douglas fir timber have only very infrequently been kiln dried, with CT schedules largely being used despite the species amenability to HT drying.

Kiln schedules have been developed for drying Douglas fir but these schedules were developed for conventional kilns which operate up to 80°C. Kiln technology has advanced and kilns are commonly operating at 90°C (ACT) or 120°C (HT) with drying times significantly lower than can be obtained in a conventional kiln.

This study which has been funded by the New Zealand Douglas fir Cooperative has investigated the use of the higher temperature schedules for drying clear decorative grade Douglas fir boards which must be dried to low moisture contents.

METHOD

Material for this study came from pruned logs in the following compartments of Kaingaroa forest:

- Compartment 23 (Waiotapu)
- Compartment 688 (Waimihia)

Fifty-eight 4.8m lengths of 150 x 25 mm and three 4.8m lengths of 190 x 25 mm were cross-cut to give two kiln charges each of sixty-one end matched 2.4 m lengths. The material used in this study was clear Douglas fir and therefore was predominantly sapwood. Each kiln charge was dried in a 2.4 m experimental kiln in a stack which was 0.6m wide with 600 kg/m^2 top weighting. The placement of matched boards was similar for both charges so that stack position could be eliminated from the analysis.

The first series of boards was dried using an ACT schedule and because some surface checking was observed in this first series, the second series of boards was dried using the standard FRI Douglas fir schedule rather than the expected HT schedule.

A series - Accelerated conventional temperature (ACT) schedule

90/60°C	21 hours
100/100°C	4.5 hours conditioning

B series - standard FRI Douglas fir schedule (Kininmonth and Williams, 1974)

71/65°C	12 hours
77/65°C	84 hours
82/81°C	4.5 hours conditioning

Following drying the stacks were removed from the kiln and placed inside and allowed to equilibriate in fillet for one month. The following assesments were made on each board:

- moisture content
- collapse
- distortion (spring, bow, twist and cup)
- checking (surface, end and internal checking)

A paired t test was used to determine if there was any significant difference between the two kiln charges.

RESULTS

Very little degrade was observed in both charges. No collapse was observed in either charge and only slight levels of surface checking and end checking were observed. No internal checking was observed when the boards were cross cut at one third from one end. There was no significant difference in surface colour between kiln charges. Tables 1, 2 and 3 shows a summary of the data collected for each kiln charge.

Table 1 : Summary of moisture content and degrade for each kiln charge

Parameter	Kiln schedule					
	90/60°C			Standard Douglas fir		
	Mean	St dev	Max	Mean	St dev	Max
Moisture content (%)	9.7	1.0	12	10.0	1.2	13
Spring (mm)	2	1.2	5	1.5	1.3	4
Bow (mm)	2.5	2.8	19	2.1	2.3	11
Twist (mm)	1.0	1.1	4	0.5	0.8	3
Cup (mm)	1	0.5	2.7	1.1	0.4	2.2

Table 2 and 3 show the incidence of surface and end checking. NZ Standard 3631 limits surface checking in the clears grade and the number of boards rejected due to surface checking is also shown.

Table 2 : Summary of surface checking for each kiln charge

Parameter	Kiln schedule	
	90/60°C	Standard Douglas fir
Number of boards checked	9	24
Mean length of board affected (m)	0.15	0.63
Number of boards rejected	7	23

Table 3 : Summary of end checking for each kiln charge

Parameter	Kiln schedule	
	90/60°C	Standard Douglas fir
Number of boards checked	9	3
Mean length of board affected (m)	0.09	0.07

A statistical test to determine whether there was a significant difference between kiln charges was conducted (T test) and the results are shown in table 4. There was no significant difference for any parameter between kiln charges/schedules.

Table 4 : Test of significance between drying schedules

Parameter	T value	Significance*
Moisture content (%)	0.06	NSD
Spring (mm)	0.02	NSD
Bow (mm)	0.28	NSD
Twist (mm)	0.18	NSD
Cup (mm)	0.44	NSD
Surface checking length (m)	0.001	NSD
End checking (m)	0.07	NSD

* NSD = no significant difference at 95%, d.f. = 60

The boards were graded according to the New Zealand grading rules for NZ grown exotic softwoods (Group III species). Table 5 shows the numbers of boards rejected for each parameter, and a count of the number of boards rejected overall. A higher percentage of boards were reject from the standard Douglas fir schedule (38 %) than from the ACT schedule (15 %).

Table 5 : Reject due to degrade

Reason for degrade	Number of boards reject	
	90/60°C schedule	Standard Douglas fir schedule
Surface checking	7	23
Cup	3	1
Spring (Crook)	0	0
Bow	0	0
Number of reject boards	9	23
Percentage of whole charge	(15 %)	(38 %)

DISCUSSION

During the drying of both kiln charges slight problems occurred with the kiln. These problems caused uncontrolled minor fluctuations to the kiln conditions. In the 90/60° C charge for approximately 12 hours towards the end of drying, the wet bulb dried out which gave slightly more severe drying conditions in the kiln. In the second kiln charge (standard Douglas fir schedule) a power cut caused by an electrical storm made the boiler shut down and the fans to switch off. Kiln conditions were affected for approximately 13 hours during which the dry bulb temperature reduced and the fans were not operational. Without this failure the drying time would have been shorter than the 96 hours used in this study. Kiln failure is a recognised part of any mechanical operation such as kiln drying and an attempt is made to reduce the amount of kiln failure however, little can be done about thunder storms affecting power supplies.

Surface checking in excess of the standards (limited in the grading rules to three surface checks up to 0.5 mm wide, and 50 mm long in Clears grade) was the major cause of rejection. The high levels of surface checking may have been due to unavoidable kiln control problems but the incidence of checking is unusual in that the more severe ACT schedule gave the lowest number of boards rejected due to surface checking. We can offer no logical reason why the more mild CT schedule gave a higher number of reject boards due to surface checking.

Levels of distortion observed in this study were low with no boards being rejected for spring or bow. Kiln stacks which are well filleted and weighted will give low levels of distortion. Even in 150 mm wide boards cup is of little significance with only 3 boards rejected for cup from the ACT schedule and 1 board rejected for cup from the standard Douglas fir schedule.

A statistical test showed no significant difference in the moisture content or degrade observed in either charges. This indicates that the general quality of clearwood Douglas fir when dried on a ACT or standard Douglas fir schedule is similar. When deciding on which schedule to use when drying Douglas fir, consideration must be made of the the required drying time and the performance of the available kiln. If the kiln can operate on a ACT schedule, then the drying time can be only 25 hours, but if the kiln is only capable of operation at lower temperatures, then the standard Douglas fir schedule has a drying time of approximately 4 days. The quality of timber produced from these schedules is likely to be similar.

CONCLUSIONS

Clear boards of Douglas fir may be dried either using an ACT or a conventional temperature schedule. The quality of dry boards is likely to be similar from either charge if the kiln charge is well stacked and weighted. The decision concerning which kiln charge should be used should be based on the capabilities of the kiln and the expected drying times. Twenty-five mm Douglas fir will dry in approximately 20 - 24 hours using a ACT schedule or 4 days using the standard Douglas fir schedule.

REFERENCES

Anon, 1987; New Zealand timber grading rules. Standards Association of New Zealand. NZS 3631: 1987.

Kininmonth J. A. and Williams D.H., 1974; Kiln schedules for New Zealand timbers. NZ Forest Service Information series No. 69.

APPENDIX 1

Permitted defects for Clears grade Douglas fir, Group III (Anon, 1987)

In any piece the following defects only shall be permitted on either face or edge:

Cup

150 mm wide boards are permitted 2 mm cup
200 mm wide boards are permitted 3 mm cup

Surface checks

up to three in number, 0.5 mm wide and up to 50 mm long

Warp (2.4 m long boards)

Crook (spring) is permitted up to 5 mm wide in 150 mm wide boards
Crook (spring) is permitted up to 4 mm wide in 200 mm wide boards

Bow is permitted up to 30 mm in 25 mm thick boards