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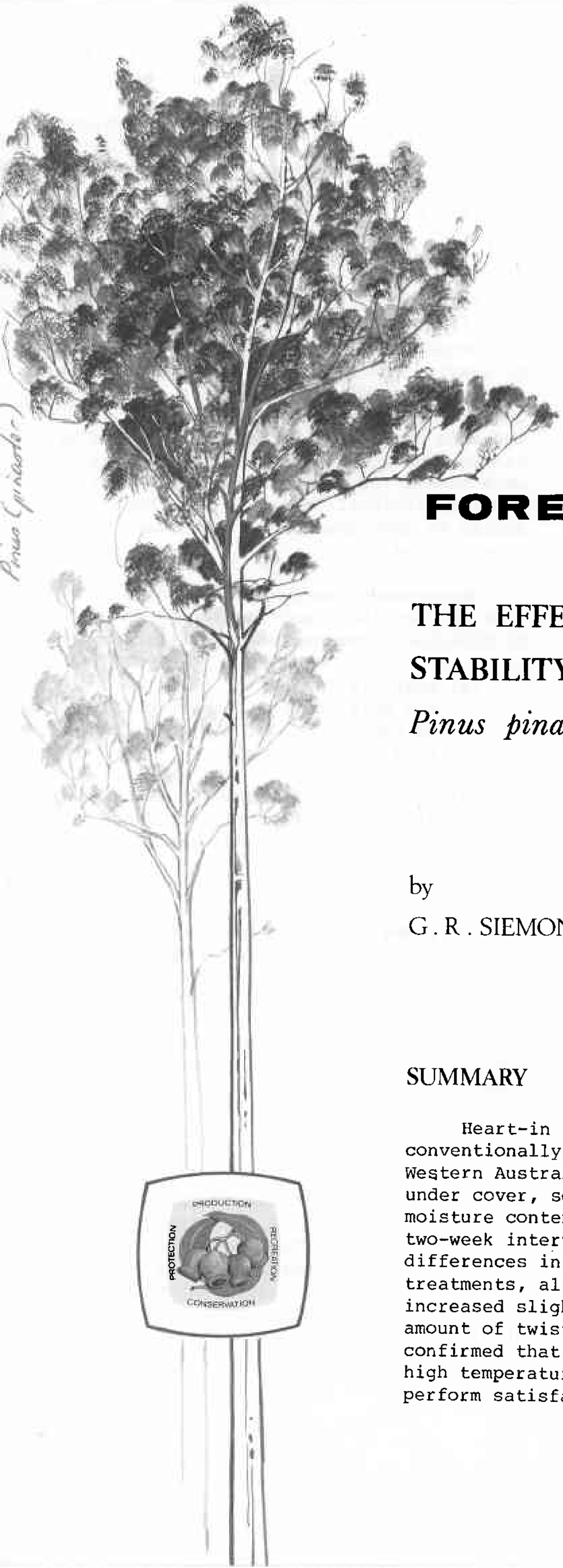

FORESTS DEPARTMENT
OF WESTERN AUSTRALIA

THE EFFECTS OF EXPOSURE ON THE STABILITY OF HEART-IN STUDS OF *Pinus pinaster*

by

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SUMMARY

Heart-in studs of high temperature dried and conventionally dried *Pinus pinaster* Ait. timber, grown in Western Australia, were stored in exposed situations, or under cover, soon after drying. Subsequent changes in moisture content, dimensions, and twist were measured at two-week intervals. The results indicated significant differences in moisture content between exposure treatments, although trends were similar. Dimensions increased slightly as moisture was taken up, while the amount of twist was reduced. Overall, the study confirmed that heart-in studs of *P. pinaster*, whether high temperature dried or conventionally dried, would perform satisfactorily in service.

INTRODUCTION

The two major softwood species grown for commercial timber in Western Australia are *Pinus radiata* D. Don and *P. pinaster* Ait. At present *P. radiata* has a better reputation with industry than *P. pinaster*, possibly because the former species has been well promoted by the Radiata Pine Association of Australia (R.P.A.A.).

Most local sawmillers dry these pines in a conventional kiln, with a typical drying schedule of 83°C dry bulb and 63°C wet bulb temperature for seven days. This is followed by about one and a half hours of steam reconditioning to relieve stress.

Research in the early 1970s indicated that twist in "heart-in" structural timber of *P. radiata* could be alleviated by high temperature drying under restraint (Mackay and Rumball, 1972). Heart-in wood is juvenile wood with short tracheids, high micellar angle, and high spiral grain (Hillis, 1975), which for practical purposes is defined as material within a 50 mm radius of the pith (R.P.A.A., 1979). The major advantages of high temperature drying over conventional drying methods are the higher percentage of acceptable heart-in material produced in each kiln charge, and the greatly reduced drying time. Experience at the Forests Department's pine research mill at Harvey has shown that *P. pinaster* can be successfully seasoned using the R.P.A.A. drying schedule for *P. radiata* (R.P.A.A., 1979).

The present study was initiated to compare the stability over several months of heart-in studs of high temperature dried and conventionally dried *P. pinaster*, in both exposed and sheltered positions.

METHODS AND MATERIALS

The study was made at the Forests Department's sawmill at Harvey. The material used was high temperature dried (H.T.D.) 2.4 m heart-in studs of *P. pinaster* from the Myalup plantation west of Harvey, graded as F5, and similar conventionally dried (C.D.) pine from Gnangara plantation north of Perth.

The treatments, each using nine randomly selected studs, were as follows:

(1) H.T.D. external severe storage

(2) H.T.D. external moderate storage

(3) H.T.D. internal storage

(4) C.D. external severe storage

(5) C.D. external moderate storage

(6) C.D. internal storage

External severe exposure was achieved by leaving studs against a brick wall with a northerly aspect, and wetting them each day when no rain fell. The external moderate exposure treatment was enacted by hanging the studs on a fence where they were shaded for about half the day. With internal storage, the studs were hung inside an open shed. All studs were unrestrained.

Measurements were made initially in late January 1982, and then each two weeks to mid-June. The parameters measured were:

(1) moisture content of case (surface) and core (centre) at two positions on each stud, using a resistance type moisture meter.

(2) dimensions of width and thickness at the centre of each stud and 30 cm from each end, using vernier calipers.

(3) twist over a 2.3 m span, using a frame where one end of each stud was fixed, and the other set in a support which moved across a graduated scale.

The statistical analysis of this data was by analysis of variance using a factorial design.

RESULTS

The results of the analysis of variance (F values and levels of significance) are given in Table 1. The mean values and trends for high temperature dried versus conventionally dried materials are shown in Figures 1.1 to 1.5, and for the effects of different types of exposure in Figures 2.1 to 2.5.

TABLE 1

Comparison of F values and levels of significance for different variables between high temperature dried and conventionally dried heart-in studs of *Pinus pinaster.*

Treatment	Analysis of Variables	F - ratios				
		Moisture Content % (case)	Moisture Content % (core)	Width	Thickness	Twist
High Temperature Dried	Main effects	12.2***	11.1***	20.5***	29.5***	4.6***
	Time	13.3***	11.8***	20.5***	16.1***	4.8***
	Drying Temp.	1.1 NS	4.0 NS	20.1***	164.1***	2.7 NS
	Interactions[1]	0.4 NS	0.6 NS	0.3 NS	0.1 NS	0.3 NS
Conventionally Dried	Main effects	45.7***	19.4***	19.6***	2.5*	10.6***
	Time	51.9***	22.3***	22.6***	2.9**	9.3***
	Exposure	14.9***	4.9*	4.5*	0.2 NS	17.0***
	Interactions[2]	6.4***	2.9**	1.6 NS	0.2 NS	1.5 NS

[1] Interactions = Time x Drying temperature
[2] Interactions = Time x Exposure

Moisture content percentage (case)

Variation with time is significant at $p < 0.001$. There are no significant differences due to drying temperature, nor for the interaction between time and drying temperature.

A separate analysis looking at the effect of exposure shows significance at $p < 0.001$, and an interaction between time and type of exposure at the same level of significance.

Moisture content percentage (core)

The variations in the core moisture contents due to time and drying temperatures are similar to those for case moisture contents, with similar levels of significance.

Differences in the type of exposure are significant at $p < 0.05$, while the interaction between time and exposure differed at $p < 0.01$.

Width

Changes in width due to time and drying temperatures are significant at $p < 0.001$, but the interaction between these two variables is not significant.

Exposure is significant at $p < 0.05$, but there is no significant interaction between time and exposure.

Thickness

Time and drying temperature produce a significant effect ($p < 0.001$), but the interaction between the two variables is not significant.

In the second part of the analysis, time is significant at $p < 0.01$, but exposure and the interaction between time and exposure was not significant.

Twist

The effect of time is significant at $p < 0.001$, but drying temperature is not significant, nor is their interaction. Exposure is significant at $p < 0.001$, but again the interaction between time and exposure does not reach significance.

DISCUSSION

The study indicated that both high temperature and conventionally dried heart-in studs of *P. pinaster* reacted similarly to changes in environmental conditions, whether stored externally in severe or moderate conditions, or stored internally. Moisture content per cent (case) and moisture content per cent (core) showed similar trends over eleven measures from mid summer to early winter (Figs. 1.1, 1.2) Examination of these figures showed that the moisture content per cent (core and case) changed from positive to negative values as the seasonal rains fell, and the surface retained more moisture than the core.

As moisture was taken up by the studs, the dimensions of width and thickness increased in direct correspondence (Figs. 1.3, 1.4). Twist showed the reverse trend to these four parameters, as moisture uptake presumably released stresses induced by seasoning, until, by June, the degree of twist was small (Fig. 1.5).

LEGEND

○ Conventionally dried studs

● High temperature dried studs

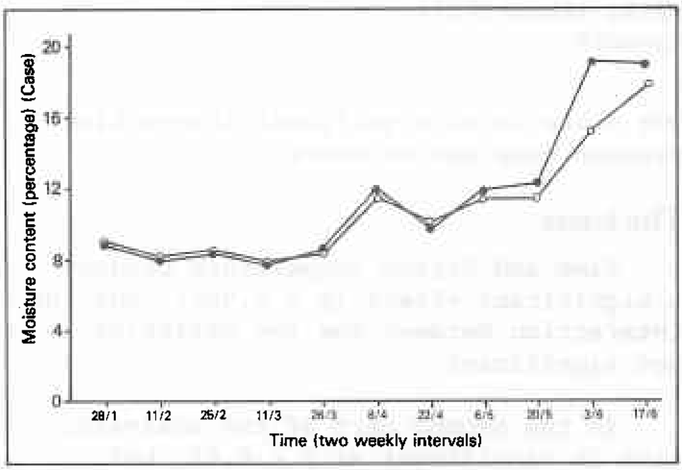


Figure 1.1: Effect of drying method on moisture content per cent (case) in heart-in studs of *P. pinaster*.

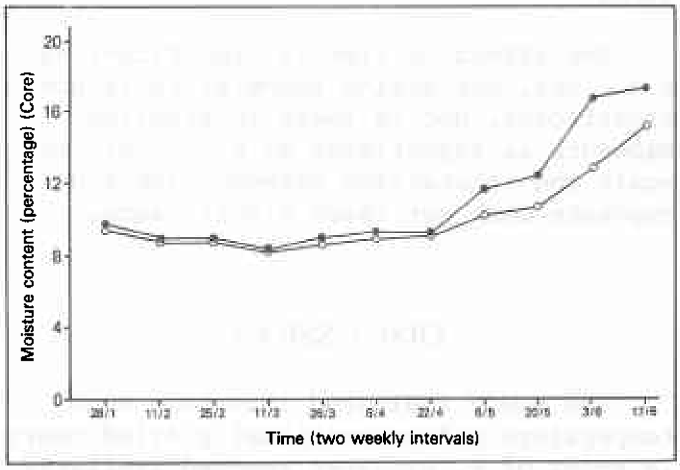


Figure 1.2: Effect of drying method on moisture content per cent (core) in heart-in studs of *P. pinaster*.

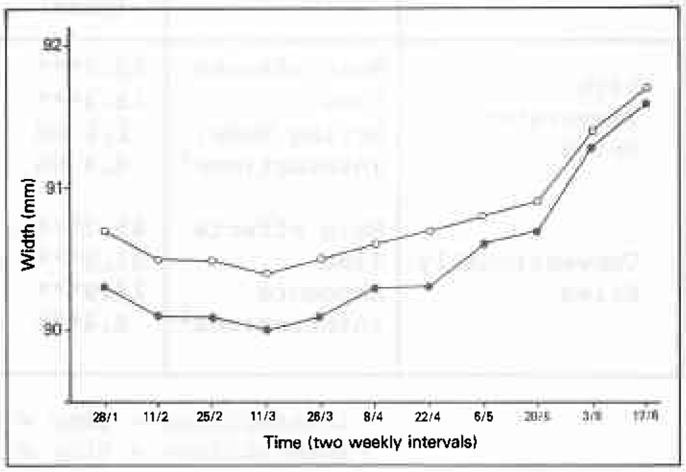


Figure 1.3: Effect of drying method on width in heart-in studs of *P. pinaster*.

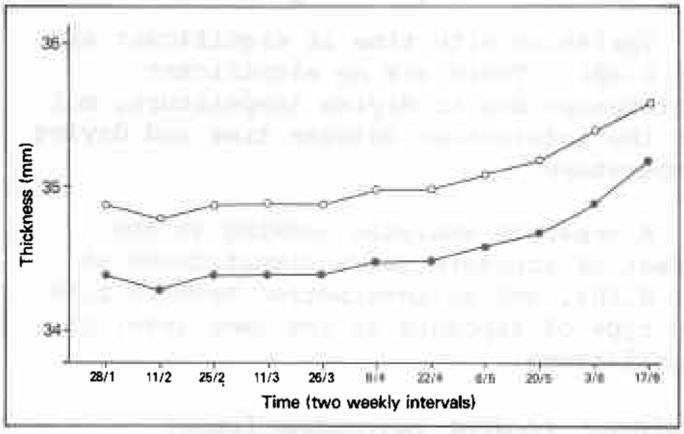


Figure 1.4: Effect of drying method on thickness in heart-in studs of *P. pinaster*.

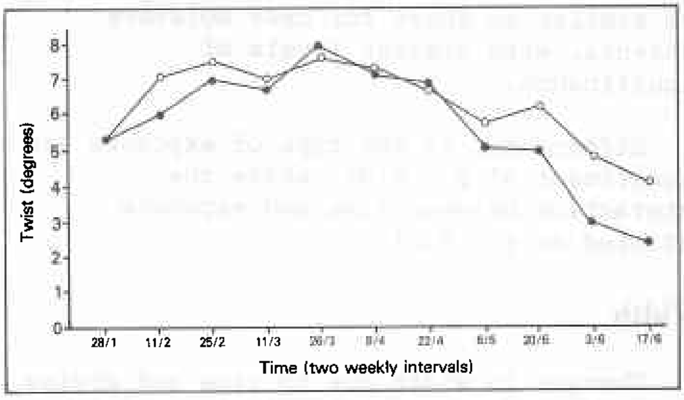


Figure 1.5: Effect of drying method on twist in heart-in studs of *P. pinaster*.

The moisture uptake in the studs in severe external storage indicated that H.T.D. material tended to absorb more water than C.D. material (Figs. 1.1, 1.2).

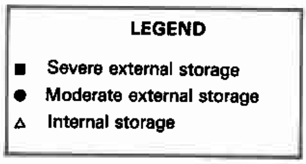
In practice, rewetting of both H.T.D. and C.D. material is difficult because the pits (which occur principally on the radial walls) become aspirated (closed) as they dry out. Seasoning of quarter sawn timber (growth rings more than 45^{o} to the width) is generally faster than seasoning of back sawn material (growth rings less than 45^{o} to the width), because the radial pitting allows easier movement of moisture within the timber. The studs, both H.T.D. and C.D., had similar mixes of quarter and back sawn material, as can be expected from random selection. If rewetting is impeded by aspirated pits, moisture must be taken up by some other means. A likely explanation is that this is achieved by the breakdown of protoplasmic contents and pit membranes in the ray-parenchyma cells (New Zealand Forest Service, 1982) i.e. the direction of moisture movement changes from tangential to radial.

Similar trends in moisture uptake in the studs (Figs. 1.1, 1.2) and increases in width and thickness (Figs. 1.3, 1.4) were observed. Although there are statistically significant differences in width between treatments, this will not affect the stability of the timber in service because in practical use the studs will be protected from the weather. The constant variations in thickness result from the dressing of the studs, as the H.T.D. studs were machined slightly smaller than were the conventionally dried studs (Fig. 1.4).

The reductions in twist (Fig. 1.5), that are statistically significant, can be related to the release of seasoning caused stress, as discussed previously.

This reduction in stress would increase in-service stability, keeping in mind that the studs had twist within the limits specified by the R.P.A.A. Grading Rules at the start of the trial.

Exposure effects were significant for moisture content per cent (case) at $p < 0.001$, but for moisture content per cent (core) significance was only $p < 0.05$ (Table 1). This confirms that



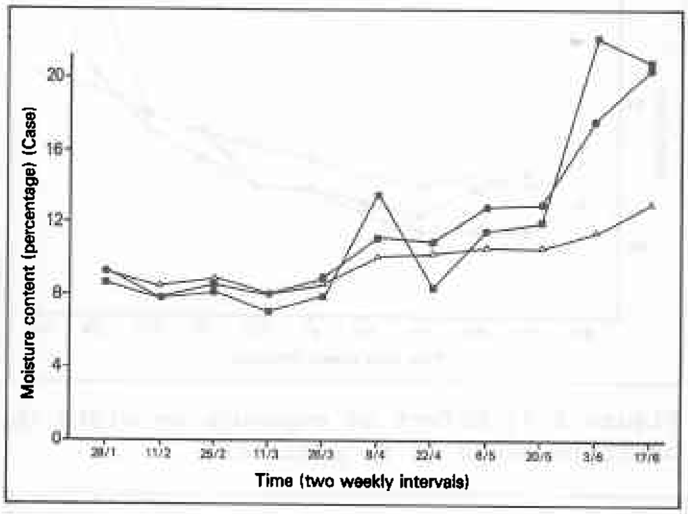


Figure 2.1: Effect of exposure on moisture content per cent (case) in heart-in studs of *P. pinaster*.

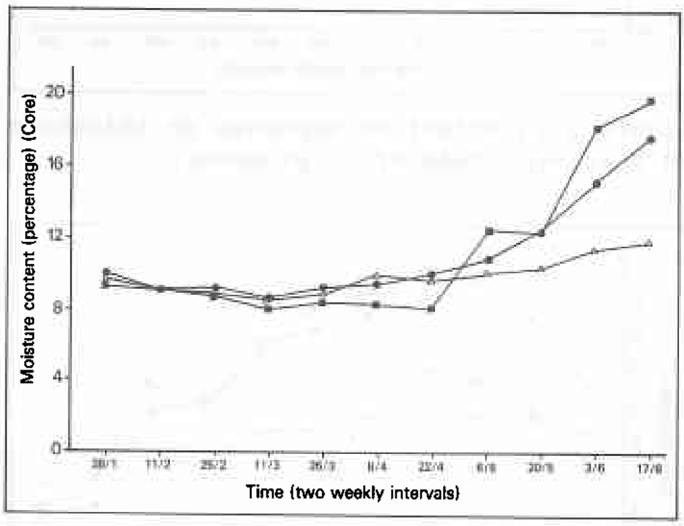


Figure 2.2: Effect of exposure on moisture content per cent (core) in heart-in studs of *P. pinaster*.

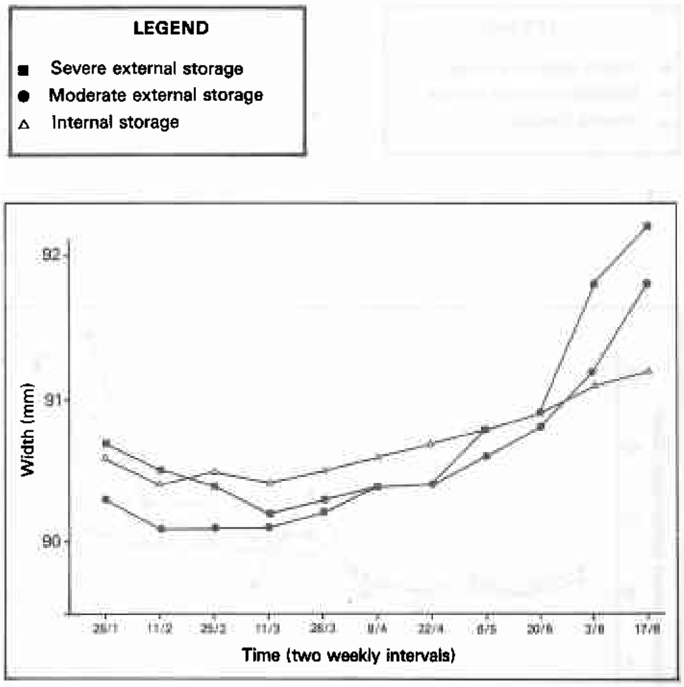


Figure 2.3: Effect of exposure on width in heart-in studs of *P. pinaster*.

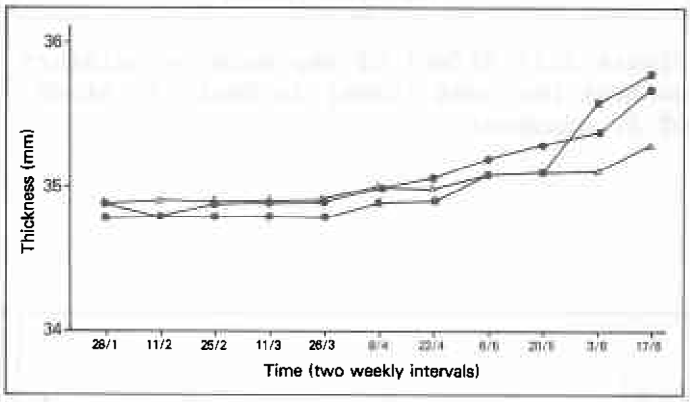


Figure 2.4: Effect of exposure on thickness in heart-in studs of *P. pinaster*.

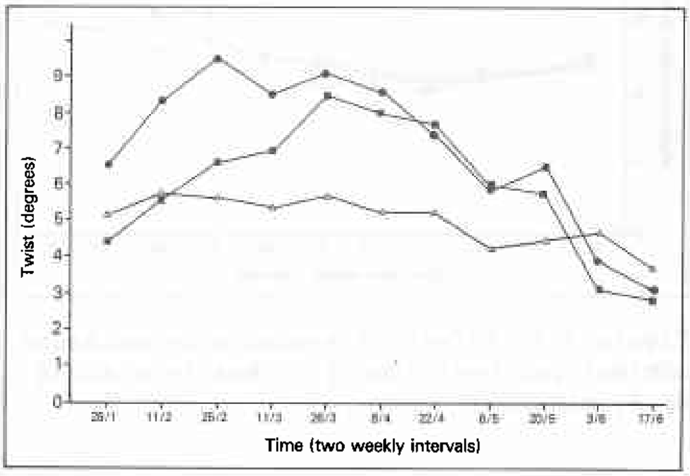


Figure 2.5: Effect of exposure on twist in heart-in studs of *P. pinaster*.

variation is greater at the surface of the piece than in the centre, as may be expected. The large variations under severe exposure conditions were noticeable in Figure 2.1. The internally stored studs increased from nine per cent to thirteen per cent surface moisture in the period, reflecting the variation in the equilibrium moisture content at Harvey between summer and winter conditions. The increase in width under different exposure treatments ($p < 0.05$) occurred well into the wet season, but under service conditions the differences would not affect the performance of the timber.

Although twist differed according to the type of exposure at $p < 0.001$, Figure 2.5 indicates that variation decreases with time. At no time was the amount of twist greater than the maximum limit stated in the Grading Rules.

Bluestain attack was noticeable by late May in the exposed studs. There was some surface checking in one H.T.D. and one C.D. stud by early May.

The study was made using heart-in studs of *P. pinaster* which were unrestrained, but in service, fastenings would restrict movement, and more importantly, moisture access would be limited.

In general, the data from this study confirms that *P. pinaster* heart-in studs are stable in use, whether high temperature dried or conventionally dried. If heart-in studs are satisfactory, then studs cut from mature wood would perform even better. As stated previously, the major advantages of high temperature drying over conventional drying are the higher percentage of acceptable timber production each kiln charge, and the reduced drying time.

ACKNOWLEDGEMENTS

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