WOOD UTILIZATION RESEARCH CENTRE 064142

FORESTS DEPARTMENT

HARVEY

PROGRESSIVE TUNNEL KILN

The need for an alternative method of seasoning down to fibre saturation point (F.S.P.) became evident with the early results achieved from high temperature seasoning of jarrah in the Harvey Kiln.

The major seasoning fault is surface checking. This occurs if timber is exposed to severe drying conditions at any time when the wood moisture content is above F.S.P.

The progressive tunnel kiln system of seasoning down to fibre saturation point is not new. Work carried out by the C.S.I.R.O. Division of Chemical Technology from 1973 to 1976 established the system's suitability.

Late in 1976 the first commercial tunnel kiln was built and successfully operated in Leongatha, Victoria.

Unlike the kiln in Victoria, we have not used any additional heating and have relied on ambient air only for our seasoning trials.

The air flow and fan size were not clearly known when the initial kiln was established in Harvey. In fact we started by drawing air through the stacks with the fan, but because of poor sealing on the inspection lids and the uncontrolled entry of dry ambient air along the chamber we have changed over to pushing the air through.

Early results obtained through the winter months while ambient air was cool and moist were very pleasing, with little or no degrade. At that time a five week cycle reduced the moisture content from approximately 80% down to under 25% or below F.S.P.

The programme for the initial trial was to add a single bundle from Bunning's, Yarloop, of 25mm thick material each week, giving an anticipated cycle of eleven weeks to obtain a moisture content under 25%. As each bundle was added sample boards from all stacks in the chamber were measured for shrinkage, weighed for moisture loss, and inspected for any visible degrade.

It was soon established from these early inspections that material in the tunnel was taking less time to dry than initially anticipated, but more importantly no visible degrade from surface checking was evident.

These conditions continued until we commenced to have more days in early spring with higher day-time temperatures and reduced relative humidity, with ambient air dryer than in winter. When these conditions occurred for two or three days in succession we started to notice some surface checking and rapid weight loss. This generally occurred in the first two weeks of drying.

A Seasoning Committee decision was then taken to double the number of bundles placed in the kiln each week. The extra moisture from these green bundles along with halving the time in the chamber should result in a reduction of surface checking.

We have now been adding two bundles a week for the past three weeks and results are still being monitored.

Further developments in this second tunnel kiln, which is nearly completed, will be additional ducting to enable vented cool moist air from the chamber to be fed back into the fan housing to increase the moisture content of the ambient air during dry warm conditions. Humidity-controlled valves will be used to vent air to atmosphere or recirculate it back through the chamber by predetermined settings within the instrumentation of the kiln.

Further changes may be needed as drier conditions are encountered through summer months, and it may even be necessary to shut the fan off through the day.

From the results obtained to date the principle of drying to F.S.P. using the progressive tunnel kiln technique has been proven.

Over the next few months more time will be spent evaluating the results to date and improving the kiln to enable much more control over temperature, humidity and air flow.

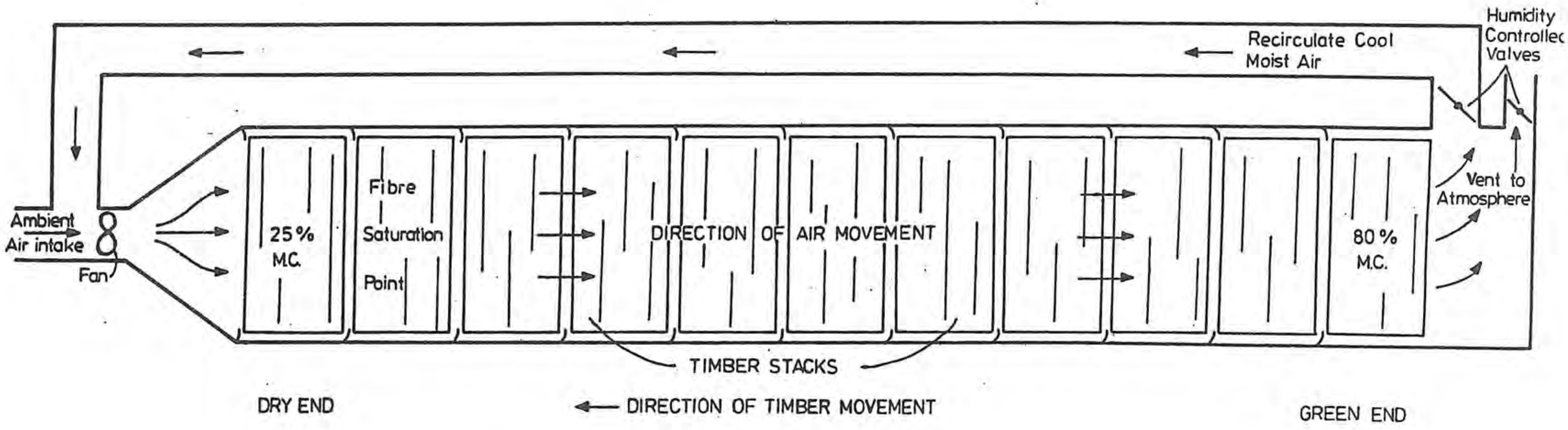
K WHITE
DISTRICT FORESTER

28 November 1984

KW:SE

FORESTS DEPARTMENT W.A.

PROGRESSIVE TUNNEL KILN – SCHEMATIC DIAGRAM



PROOFGRADING

Sound timber grading allows the inclusion in each grade of as many defects as is possible without affecting the suitability of the timber for the purpose for which it is required. The specifier can expect a consistent minimum quality irrespective of the origin of the material.

Stress grading is done by either visual or mechanical means. The simplest of the mechanical means is proofgrading.

The Hilleng proofgrader was originally designed by the Timber Research and Development Advisory Council in Queensland. There are about 30 operating in Australia and overseas. It is a robust, versatile machine, which has the potential for varying uses. These include:

i) proofgrading

ii) detection of special defects e.g. poor finger joints, internal decay

iii) in-grade testing of structural timber

iv) hybrid grading effects

The proofgrader applies a continuous bending movement to the piece of timber as it passes through the machine, with the loading on edge. Loading can be "edge-biased" (with the worst defect on the tension side) or "random-edge".

The necessary proofload is calculated from the cross-sectional dimensions and the stress grade required, using a given factor. The machine is then calibrated using a special calibration bar, which has been accurately tested to give a standard graph of load vs. deflection. Having calculated the necessary proofload, the deflection required is read off the graph. The bar, with a dial gauge attached, is placed in the machine, and pressure adjusted until the required deflection is reached. At that deflection, the necessary proofload is being applied. The bar is removed, and the proofgrader is ready to operate.

Efficient grading is achieved by pre-sorting the timber visually, with the aim of breaking perhaps 1-2 percent of pieces. Although the bending strength only is being tested, elasticity, tension and shear properties are assumed to be adequate for that stress grade.

The Forests Department has proofgraded pine using the Radiata Pine Research Institute's Industry Standards 103-1982 Specification for Machine Proofgraded Radiata Pine and 104-1982 Code of Practice fo rthe Machine Proofgrading of Radiata Pine. There is no comparable hardwood standard at present.

G R SIEMON
OFFICER IN CHARGE
BUSSELTON RESEARCH STATION

28 November 1984

GRS:SE

WOOD UTILIZATION RESEARCH CENTRE

FORESTS DEPARTMENT

HARVEY

LABORATORY HIGH TEMPERATURE KILN

This kiln has been developed with the aim of researching the extension of H.T. drying to Western Australian grown timbers.

It is important to understand the limitations of H.T. drying. Hardwood must be dried below fibre saturation point (above 28%) before being subjected to rapid H.T. drying, to reduce the possibility of degrade.

The need for this kiln became more urgent with the development of the prototype tunnel kiln, built to research the drying of jarrah from green to fibre saturation point under controlled conditions. This timber had to be dried from fibre saturation point to equilibrium moisture content.

Encouraging results had been obtained from parcels of timber dried in the commercial H.T. kiln at Harvey, but the need to expand schedules to optimum limits without risking large expensive kiln charges was recognised.

This kiln can be used in a wide range of seasoning experiments. It will be used to research drying behaviour of native and exotic hardwoods and to develop suitable seasoning schedules for these as required. It will also be used to improve schedules for softwood seasoning and to research the drying of round timbers for preservative treatment, both hardwood and softwood.

Although results from trials carried out in the existing commercial H.T. kiln have been encouraging it is not possible to vary the schedule to the degree required to obtain optimum results. The reason for this is simply the value of the 15 to 20m^3 of timber required to fill the kiln.

The problems associated with H.T. drying are not insurmountable but research is needed to allow each of these problems to be overcome in practical and economic terms.

Some of the questions still unanswered are:

1. The need for pre-steaming prior to drying
2. The ideal temperature for drying
3. The optimum air flow through the stack
4. The ideal humidity levels
5. The determination of drying end point
6. Need for reconditioning or surface moisture uptake after drying.

These are some of the practical problems we face and it is because of these that this small scale kiln was considered necessary to test and prove the optimum parameters for successful and competitive H.T. drying.

There are of course other factors that may influence the quality of drying and it is now possible to test these variables quickly, with small representative parcels of timber.

Some of these factors are:

Forest crop moistsure content.
Effect of water spray storage.
Drought or disease weakened trees, and delayed thinnings.
Mature old growth timber as against very much younger regrowth timber taken from thinnings.

Other factors include soil type, forest type, geographic location and seasons.

This laboratory kiln has been designed to perform specific functions. It is infinitely adjustable and can be programmed to follow pre-determined schedules without deviation. All functions are recorded or can be calculated from information collected.

The kiln comprises 5 independent systems:

1. The kiln structure
2. The air delivery system
3. Heat source
4. Humidity control steam and vent system
5. Programme control recording and protection system.

THE STRUCTURE is very simple, using available off-the-shelf products.

Timber frame on concrete floor. Lined with "Versilux", insulated with two layers of 50mm rockwool fibre glass insulation sandwiched between aluminium foil. External cladding is 12mm ply.

To minimize heat loss in the floor the hobs are cast in cement with vermiculite aggregate.

All joints are sealed with "Silastic". The door is closed against rubber seals.

THE AIR DELIVERY SYSTEM circulates air through the timber stack in either direction for pre-selected times.

Air flow is monitored across the stack when optimum operating conditions are reached.

Air flow can be increased or decreased by adjusting the motor speed, which is variable up to 15m/sec. The energy used to pump air is recorded by a kilowatt hour meter.

HEAT SOURCE

Air is heated by electric elements fixed in the air flow fore and aft of the variable speed axial fan. Power consumed by these elements is recorded to enable energy used to be calculated.

To protect heater elements the fan is fitted with a motion sensor to ensure heater shut down if there is a fan failure.

HUMIDITY CONTROL STEAM AND VENT SYSTEM

Humidity is controlled through a wet bulb temperature sensor activating a P962 Programme Controller that in turn controls vents to atmosphere, or cross flow vents and steam generation. This ensures the pre-determined wet bulb temperature is maintained. It can be a constant, gradually drying, or moistening atmosphere. The actual wet bulb temperature is recorded on a Chino 12 point recorder at pre-determined regular time intervals.

PROGRAMME CONTROL is both manual and electronic. The kiln schedule is pre-determined and these drying parameters are loaded into the controller memory. The kiln is started and the controller will ensure that temperature, both wet and dry bulb, are maintained for given periods.

The air flow and reversal times are pre-selected and increase or decrease, if required.

Temperatures up to 180^{o}C can be pre-selected to increaes or decrease in 1 minute intervals if required. Controller will close down kiln if over temperature is uncontrollable.

Air temperature is recorded on a Chino 12 point recorder for seven positions within the kiln.

One position will also be the temperature controller position. The other six will be across the stack, three on each side. These will be used to indicate the end point of drying.

There will also be four temperature sensors to monitor and record the internal wood temperature.

The wet bulb temperature will be recorded on the remaining 12th point.

Wood moisture contents will be tested by the oven dry method at the start and finish of each trial. Moisture content during drying will be monitored on a resistance type, temperature compensated moisture meter.

Total weight loss will also be recorded by suspending the charge on a load cell. This will demonstrate the rate of moisture loss by evaporation during the drying phase. It will also be able to show moisture uptake during pre-steaming or reconditioning.

This information will help lead to accurate prediction of the end point of drying.

This kiln has cost in the order of $15,000.

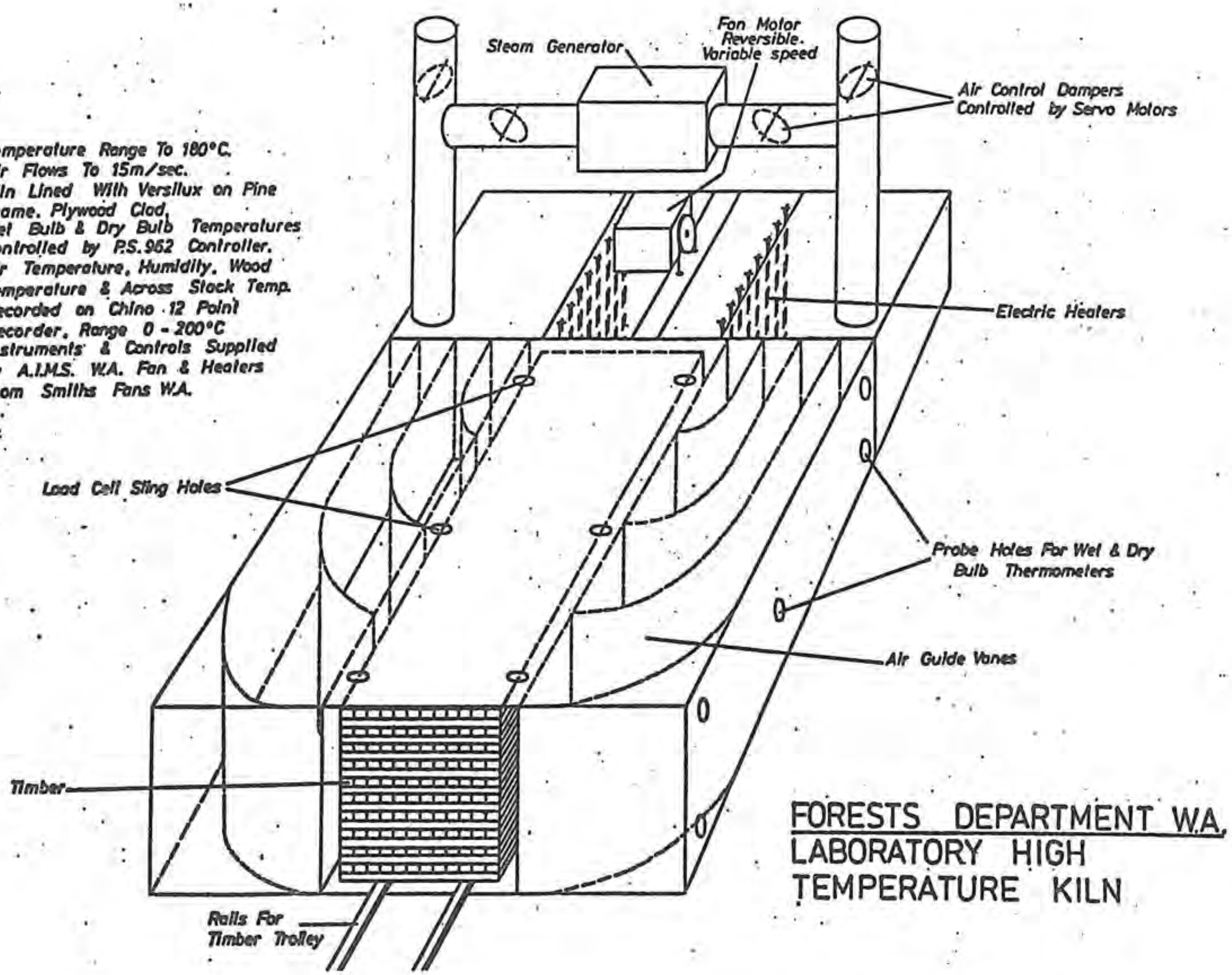
In conclusion I would like to thank all those associated with the approval, design, supply of components and the building of this Kiln.

D J DONNELLY
A/CHIEF UTILIZATION OFFICER

28 November 1984

DJD:SE

1. Temperature Range To 180°C.
2. Air Flows To 15m/sec.
3. Kiln Lined With Versilux on Pine Frame. Plywood Clad.
4. Wet Bulb & Dry Bulb Temperatures Controlled by P.S.962 Controller.
5. Air Temperature, Humidity, Wood Temperature & Across Stock Temp. Recorded on Chino 12 Point Recorder, Range 0 - 200°C
6. Instruments & Controls Supplied by A.I.M.S. W.A. Fan & Heaters From Smiths Fans W.A.



FORESTS DEPARTMENT W.A.
LABORATORY HIGH TEMPERATURE KILN

DEVELOPMENT OF TWO PIECE SLEEPERS WITHIN WESTRAIL

by

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Programming Engineer - Westrail

1. INTRODUCTION

Ever since the early developmental days of railways, timber sleepers have formed an essential element within the railway track structure. This has been particularly the case in Western Australia where the natural hardwood forests of the South West have provided an abundance of sound timber for sleepers for well over a century.

In recent times a significant increase in softwood plantations has occurred and this pattern is expected to continue. As a result useful size timber from this resource should be readily available in regrowth periods of up to 30 years.

All indications are that sufficient supplies of natural hardwoods will be available to meet the future local demand, however any additional supplies of softwood that can be accepted for sleepers will assist in extending the life of the natural forest.

The project discussed in this paper deals with the work currently carried out conjointly with the Forests Department, the Forest Products Association, Koppers (Aust) Ltd. and Westrail to develop an acceptable softwood sleeper for use within the local railway system.

2. BACKGROUND

The use of softwoods for railway sleepers has been an accepted practise in many parts of the world over a long period with a high degree of success. The sleepers have been used in a variety of forms ranging from one piece (New Zealand), to two piece (USA) and finally in laminates (South Africa).

In late 1980 Westrail was approached by the W.A. Forestry to consider the use of small section softwood sawlogs from plantation thinnings to produce railway sleepers in a similar fashion as had been used elsewhere.

It was decided at that time to embark upon a project conjointly with the following objectives.

1. To develop a softwood sleeper using available local plantation timber at an economic cost suitable for extensive introduction throughout Westrail branch lines and
2. provide and test samples of the developed sleeper in short term laboratory tests and longer term field trials to establish the suitability.

3. DESIGN CONCEPTS

In the early stages of the project it was decided to consider two softwood species of timber for the trials -

1. Pinus radiata
2. Pinus pinaster

The two piece sleeper was favoured in preference to the one piece due to the limitation in sawlog size available, and to the laminated sleeper due to the fabrication difficulties.

After considerable investigation and testing, a specification for the production of the sleeper segments was prepared. This specification required the timber to be green sawn with heart in. Pith is acceptable provided it is boxed in and lies within specific zones within the timber cross section. Similarly knots, (intergrown, encased or partly encased) are permitted provided the assembly dowels and the rail holding fasteners are not affected.

The suitability of the timber as a component within the track was investigated thoroughly by a series of laboratory tests assimilating a railway of 19 tonne axle loaded vehicles. Under these conditions a factor of safety above 5 in bending at the rail seat results. Similar tests on repetitive loading and bearing strength proved adequate.

4. PRACTICAL DEVELOPMENTS

A decision was made to assemble 100 sleepers each of Pinus pinaster (ex Myalup plantation) and Pinus radiata (ex Brunswick plantation) with various combinations of preservative and rail fastening systems.

Pairs of timber segments were fastened while green with the pith nearest the bottom face of each. The fastening was done by clamping the pieces edge to edge and inserting four twisted steel dowels horizontally in pre drilled holes. (See Appendix A).

The sleepers were strip stacked and exposed to the weather for final seasoning prior to predrilling of rail fastening holes and preservation treatment.

Preservation was done in two separate centres - 50% of each species being treated in each.

1. Koppers, Picton Junction - 80% oil, 20% creosote at 1400kPA (Av Ret. 180kg/m^3)
2. Bunnings, Pemberton - 99.5% oil, 0.5% termidicide at 7000kPA (Av. Ret. 175-350kg/m^3)

Considerable concern was expressed at the extent of twisting (up to 35mm) which occurred across the rail seat of most pieces caused by the characteristic spiral grain of the species. This condition was well advanced prior to preservation exposing the instability of the material when permitted to air season in a relatively unconstrained form.

As an extension to the project, a further sample of 50 sleepers of each species was provided and subjected to high temperature kiln seasoning at Harvey. Although some twisting was evident in these timbers the problem was reduced to an acceptable level.

In addition to the two piece softwood sleeper, testing of two piece jarrah sleepers is being carried out in parallel using similar assembly and rail fastening arrangements. As a further extension, glued laminated softwood pieces are also being prepared for testing.

5. FIELD TRIALS

Experience in railways elsewhere has indicated a life of in excess of 30 years can be expected for a softwood sleeper. To fully extend our current project, the test sleepers are being placed on the relatively heavy trafficked railway between Northam and Goomalling.

All sleepers will be fitted with steel sleeper bearing plates and the rail will be secured by either coach screws (direct fastening) or by a spring clip (resilient fastening).

The test section has been carefully monumented and will be systematically inspected at regular intervals to ascertain the performance levels of the various combinations.

6. CONCLUSION

The economics of milling, kiln seasoning and assembling the type of sleeper under discussion is not acceptable at the moment. Technology will no doubt improve this in the future and based on the results of the current trials widespread adoption of the two piece softwood sleeper throughout the Westrail branch line network could be a reality.

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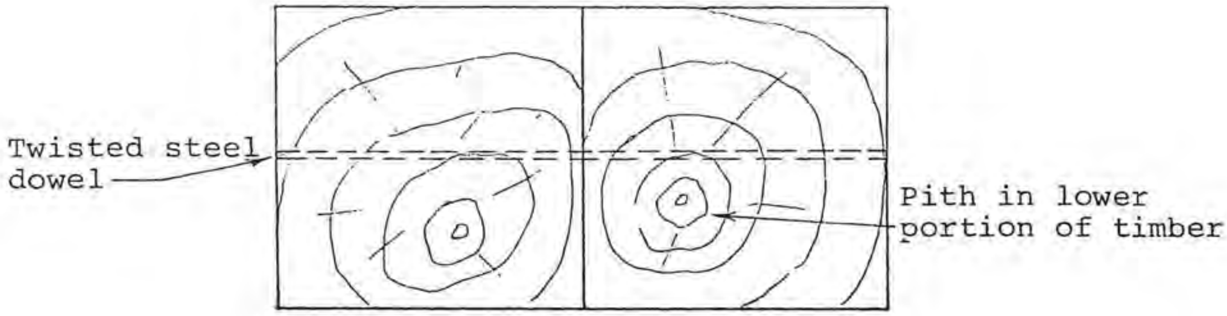
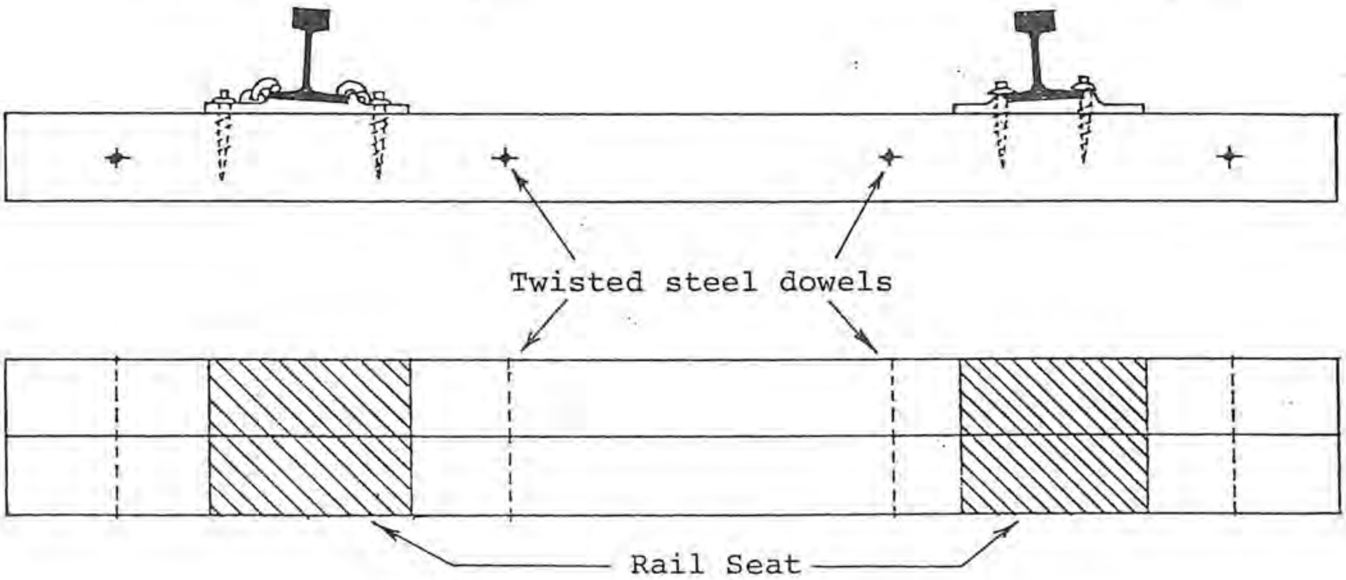
TWO PIECE SOFTWOOD SLEEPER



Typical Cross Section



Sleeper Assembly

NOT TO SCALE