Client Report :

A summary of the conclusions and recommendations from the CRAFT DRYCON Project

Client report number
204-987

Prepared for :

CRAFT DRYCON
BRST-CT09-5270

June 2001

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Introduction

This report was undertaken as part of the European CRAFT-DRYCON project BE-S2-53-60: **Improved Control Methods and Systems for the Consistent Drying of Wood**, as described in the technical annex of the CRAFT-DRYCON project proposal.

The report is a short summary of the main conclusions and recommendations produced throughout the DRYCON project, mostly concerning work carried out by BRE. Each set of recommendations/conclusions is covered under the specific work task heading where the relevant information was assessed. The recommendations and conclusions within this document are by no means exhaustive, and it is recommended that the individual reports be read for further information and clarification.

A list of the reports produced during the project can be found in the bibliography at the end of this document.

Findings

The main recommendations and conclusions produced during BRE's work within the DRYCON project are set out below. Each set has been grouped under the relevant subject area headings.

Baseline drying quality and the effect of stack design on drying quality

This work area was split into two sections, the first covered baseline drying quality and the second, stickering and stacking of the kiln load.

1. Baseline Quality Assessment

- It was identified that the seasonal variation in the moisture content of 'green' processed timber affects the length of drying time. The length of drying will also be influenced by external climatic conditions, i.e. longer in the winter and shorter in the summer.
- Saw logs should be processed as quickly as possible after felling to reduce the variability in 'green' moisture content. This action will help in reducing the final moisture content spread of kiln dried material and allow a more precise target moisture content figure to be set during drying.
- Log quality and dimension is a primary factor affecting the distortional quality of kiln dried battens. It is important, therefore, to link the final quality requirements of dried battens with the quality of the logs being processed.
- To achieve good distortional quality levels in bow, spring and cup, the use of current kiln schedules, as used by the industry, is recommended. This will produce material with distortion levels well below the maximum allowable levels stated in both the old standard (BS 4978: 1988) and new standard (BSEN 519: 1996).
- The main factor affecting the severity of twist was the presence of pith within individual battens. To reduce the percentage of battens exhibiting excessive twist in kiln dried battens, it is recommended that battens containing the pith be removed prior to drying. This is especially true when drying to below 15% moisture content. The pith material may need special drying schedules, possibly using high temperatures, but further work is required in this area.
- Freshly processed (just off the saw) 'green' battens often exhibit one or more forms of distortion i.e. twist, bow or spring. After kiln drying, bow and spring often show signs of improvement, whereas the assessment has shown that twist increases.

Stickering and Stacking Assessment

- Dunnage or bearers should be as small in cross-section as possible, whilst still allowing easy entry of forks for loading and un-loading.
- Stickers should be of adequate length to support the timber, but not excessively long to hinder close loading.
- Bearers or dunnage should be positioned directly beneath each line of stickers to provide adequate support to all parcels, thus minimising drying distortion.
- It is recommended that sticker spacing should be in the region of 500 mm to 600 mm.
- Parcels of battens should be made up of timber containing all the same lengths and dimensions to improve airflow uniformity.
- Spaces between parcels of battens should be minimised, and excessively large gaps between the timber load and kiln frame blocked, to direct air through the kiln load.
- Saw blades and chipper canter blades should be changed regularly to produce a smooth surface finish on battens, thus ensuring a uniform and constant air flow through the load.
- All baffles, curtains and flaps should be well maintained and regularly checked for correct working.
- Kiln operators should have appropriate training and guidance.
- Operatives should be allocated an adequate amount of time in which to correctly load the kiln, to ensure consistent and uniform drying of the load.

2. Existing kiln designs

A review of existing kiln designs and a guide to improvements

- To ensure a uniform airflow through the timber stack, the main corridors should be approximately two thirds the width of the main ceiling space (where the heat exchangers and fans are located).
- Fit baffles or airflow directors in the airflow exit areas (above main corridors) to reduce turbulent airflow and improve airflow uniformity. This is advisable if the ratio of corridor/ceiling height is incorrect.
- Always fill the entire kiln with timber to ensure that airflow is uniform.
- The top of the timber stacks should be level (parallel) with the false ceiling, to reduce turbulence and ensure uniform drying.

- It is recommended that the gap between the top of the stack and the false ceiling be as small as possible to reduce turbulence and promote uniform air-flow.
- To improve the drying process, fit the wet and dry bulb stations (used by the kiln operating system to monitor and control the drying conditions) as near to the sides of the wood stack as possible. This will ensure that the operating system is monitoring the conditions of the drying timber and not empty kiln space.
- Change all wet blankets or wafers before each new kiln charge.
- Ensure that the wet blanket reservoir is set-up to receive water as and when required (It is important that the water flow to the reservoir is regulated and not filled continuously and overflowing, as this condition will seriously affect the wet bulb readings).
- Use the airflow model developed in DRYCON to check for likely problems.

3. Quality Rules and Standards

Good distortional quality is a key factor which influences the sale of kiln dried timber. This is especially important for the marketability of UK dry graded material. Within this work task, a questionnaire was completed by a number of sawmillers regarding the quality requirements of C16 dry graded battens. The maximum values shown in table 1 are values to which most softwood sawmillers are attempting to comply with when producing sawn timber. Although not always achieved, the figures represent a sawmill industry standard which will be acceptable to the vast majority of industrial and public customers. Several sawmillers have aspirations of producing timber with twist values half those presented in table 1.

Table 1. Industrial Distortional Limits

	Dimension of Timber	
Distortion Type	**50 x 100 mm**	**50 x 200 mm**
Twist	4 mm	6 mm
Bow	6 mm	6 mm
Spring	6 mm	6 mm
Cup	2 mm	3 mm

- The use of top-loading will significantly reduce the incidence of twist, especially in the top layers of the kiln loaded battens.
- Stickers should be close spaced to reduce the incidence of twist (500 mm to 600 mm is recommended).

- Care should be taken during the heating-up phase to prevent excessive drying of the batten surfaces, which may lead to deformation of the battens before regulated drying commences. Relative humidity should be as near 100% as possible and the wet bulb temperature should be constant whilst the dry bulb temperature is rising.
- Battens with high moisture content show lower levels of twist than do similar battens with lower moisture contents.

4. Kiln Schedules - Progress Towards their Optimisation

Within the DRYCON project, quite a number of simulated kiln runs have been carried out to determine the optimum schedules for particular sawmills using TNO's 'Woody' simulation programme. The accompanying kiln trials and assessments have given encouraging yet often confusing results. In some runs, bow and spring have improved whereas twist has increased. The unknown factor with all the comparative assessments concerns the general matching quality of the raw material. In future, more consideration must be given to matching the experimental samples for drying assessments. This will probably mean cutting 4.8m battens in half and drying the two halves by two different schedules or methods. This system will be used in the new STRAIGHT project.

In general the WOODY simulation programme produced schedules with higher maximum drying temperatures, often with faster rates of drying (especially below fibre saturation point) than is currently used. In some cases the kiln operating staff were not keen to implement the WOODY schedule, so a compromise was implemented. In the future more attention to the criteria input into simulation programmes is required and consideration should be given to using the programmes developed in Sweden and Finland. BRE have taken the opportunity, at a recent visit to VTT, to test the Finnish system using UK kiln and material data. More work is required in this area, but the programme showed promise.

Two key factors towards the successful kiln drying of UK timber is the control of humidity in the kiln, and having good information on the moisture content of the kiln load, especially under fibre saturation point. Steam is the best way to introduce humidity, but as demonstrated in the trial at Falkirk, an efficient atomised spray system is a good alternative. Many sawmills, which have a resistant pin method of recording moisture during drying, don't use it, relying on a time factor to reach the desired MC. Recognising the final MC target point and achieving uniformity of MC throughout the kiln load is an essential point.

5. Kiln Schedules

Work on kiln schedules within the DRYCON project has pointed to the following:

- In general higher kiln drying temperatures could be used to reduce drying times and increase throughput. However, this may result in a decrease in distortional quality.

- The use of higher temperatures should be linked to the general control of humidity. It is essential that the accurate control of the conditions within the kiln are maintained, to prevent drying distortion due to humidity and temperature fluctuations.
- During the heating up phase, the humidity must keep pace with the dry bulb temperature (maintained as near 100% RH as possible) to prevent excessive drying of the wood surface.
- Efficient atomised spray systems can improve humidity control.
- A number of the optimised schedules developed using the 'Woody' simulation programme have improved drying and final wood quality. However, more work is required in the use of simulation programmes to determine optimum schedules for drying UK timber.
- Better 'in kiln' moisture content measuring devices are required for the determination of final target moisture content.
- In the future, comparative assessments should use samples which are at least matched for spiral grain, which is one of the key growth factor which influences twist. This information will provide more accurate information on the raw material quality.

6. Pre-sorting battens for moisture content

Within the DRYCON project, a task was allocated to assess the feasibility of pre-sorting recently processed battens for moisture content. 'Green' sorted battens could then be dried in kiln loads of similar moisture content, mainly to improve final moisture content distribution and drying efficiency.

This task proved much more difficult than previously thought. The results from several trials indicated that more work was required on the basic electronics. This was necessary to provide more accurate and reliable readings, mainly because of the very high moisture contents encountered whilst processing spruce. Brookhuis Electronics managed to partially overcome some of these problems and now state that they can measure moisture content up to approximately 50% moisture content.

- Results from 'Green' pre-sorting trials has indicated that further work in this area, is required to accurately measure the full range of 'Green' moisture contents for successful pre-sorting to be carried out. New analysis by Brookhuis Electronics, has shown that moisture contents up to 50% can be measured with some success, enabling pre-sorting to be carried out on battens below this value. The use of this system would allow for a two tier sorting, battens above and below 50% moisture content. Further research is being undertaken by the company to measure moisture contents above this value.

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