Client Report :

Perception survey for incised timber

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Prepared for :

Forestry Commission and Scottish Enterprise

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Executive Summary

This report was prepared under contract to the Forestry Commission and Scottish Enterprise (contract agreement PPD29/02) and constitutes BRE output number 214436. This output constitutes an interim report of this contract for the milestone of September 2003.

The development of a new incising pattern has been undertaken and in principle, a system that would be compatible with modern woodworking procedures has been achieved. The conclusions for trials to date are:

- There are very similar in their uptake of preservative solution between the two incising patterns trialed, however, the pattern of distribution is different. Laboratory and field trials will determine if this is significant.
- The treatment trials undertaken to date demonstrate that similar a uptake of preservative solution has been identified at 90 minutes pressure compared to 180 minutes pressure. This may indicate that the maximum absorption is reached relatively early in the cycle and the additional time may be unnecessary, more work is planned to investigate this avenue by Arch Chemicals Ltd.
- Spruce that is fast grown may have an unusual uptake of preservative solution as it penetrates the timber via the spring wood of the growth rings. This will be investigated further by trials at Osmose Ltd.
- Incising has been shown to increase the depth of preservative penetration significantly. However, can additional trials improve the depth of incision and achieve sufficient preservative penetration to achieve a 15, 30 or a 60 year service life? Should this be possible major customers e.g. Highways Agency will benefit as incising timber will provide a more consistent and durable product.
- Work still to be completed as part of this project includes:
    - Biological assay of preservative for incised and unincised timber.
    - Limited trials to determine strength characteristics
    - Installation of demonstration fence at BRE
    - Produce BRE Digest – Incising UK Spruce.

Contents

Introduction

Incising timber by creating small slits or pin holes in the surface of the timber to improve uptake and penetration of preservative has long been recognised as an accepted method for improving the durability of timber. Previous BRE trials (Smith and Orsler1995) and experience from existing international practice to seek demonstrate the potential for incising timber prior to preservative treatment. Although very small volumes of imported incised timber are used in applications such as freshwater jetties, incising is currently practiced in the UK by only one company based in Lincolnshire.

This report was prepared under contract to the Forestry Commission and Scottish Enterprise (contract agreement PPD29/02) and constitutes BRE output number 214436. This output constitutes an interim report of this contract for the milestone of September 2003. It is an intermediate report where key buyers, preservative manufacturers and preservative a timber treatment company have commented on the quality of preservation, and consistency of the incised commodities.

The review objectives were to:

- Produce some incised timber and apply a range of preservative treatments.
- To seek the perception of the woodworking industry, preservative manufacturers and opportunities in the commercial and retail markets.
- To determine what benefits incising can offer to improve the preservative uptake of difficult to treat timbers.

Technical and economic feasibility issues were covered in BRE report 208 080.

UK grown Sitka spruce is becoming available in large quantities and sizes suitable for the construction industry. In many ways spruce can be an excellent construction timber. It also has a cell structure that gives it a relatively low permeability to water, but like other constructional softwoods, it is also susceptible to fungal and insect attack when not treated. However, impregnation with wood preservatives by normal pressure methods achieves relatively poor penetration and therefore only modest enhanced protection. Increasing treatment pressures to improve penetration can lead to the collapse of the timber cell structure. Douglas fir and Larch have similar preservative treatment difficulties to Spruce. By incising the surface of these timbers prior to preservative treatment, it is hoped to demonstrate a greater consistency of treatment penetration, loading of the active ingredients and possibly improved inferred durability.

Experimental trials of incising

Incising as a routine technique for improving preservative penetration and retention is primarily used in the United States (Crawford et al 1999) and Canada. The techniques are also being employed to some extent in Japan for railway sleepers and South Africa for woodpoles. This review has confirmed that the techniques are employed to a much lesser extent in Europe (Sweden and The Netherlands) and Australia

There has been much work conducted on the size of the incision, shape, depth, density and method of producing incisions that is the best for a species and the required level of preservative protection. In most cases the visual effects of incising have caused some concern, and has lead manufacturers to concentrate the uses of fully and partially incised materials for commercial, industrial and agricultural uses.

BRE has re-commissioned the original equipment used in the 1972 trials conducted at the BRE site Princes Risborough, and produced incised materials with an original high density pattern. The experimental matrix will compare two incising patterns (an original pattern and a new one) with normal sawn finish timber for the penetration, uptake and efficacy of the preservative treatment (Annex A, Picture 1).

Samples of these incising patterns were produced in battens (750mm long, 50mm wide and 50mm deep) of Douglas fir, Spruce and Larch using kiln dried timber. In total over 1000 battens have been produced to date. The incising pattern is clearly visible before treatment and now a permanent feature in the timber. All timber used had moisture contents between 20% - 30% before preservation treatment. Each batten has been given a unique number that allows individual data sets to be recorded and also allows the samples to be tracked through the laboratory and field trials.

Development of the new incising pattern

When the original incising machine was made by the Princes Risborough Laboratories, workshops were freely available to supply all the needs of the researchers. As a consequence, the original cutters were bespoke and in this respect unique. The problem encountered when this equipment was re-commissioned was the cost of reproducing these original blade designs.

During consultations with workshop tool workers, a suggestion was made that we investigate some metal cutting slit saw blades. Some of these blades were purchased and set into the incising machine. Initial trials using these blades and Spruce wood were carried out, however, it became clear that the tooth shape was causing compression of the timber as it penetrated and plucking fibres as it was pulled clear (Annex A, Picture 2). Also, due to the tooth shape, penetration into the timber was very limited.

As an alternative, an old slitting saw blade with a peg tooth design was considered for replacement of the slit saw blades. This tooth design which has neither a positive or negative rake, meant that the penetration into the timber was a clean cutting action. Also when it was removed it did not compress or pluck fibres from the surface. Now the tooth design was refined, a manufacturer was located to produce a number of blades from High Speed Steel (HSS), they are hollow ground so the teeth need no set, and keyed so they can be fixed onto a drive shaft that can be powered or allowed to freely rotate (Annex A, Picture 3).

Incising patterns

This experiment has chosen two incising patterns to assess the benefits for preservative uptake and to enable the comparison of data from the original BRE experiment (BRE Report BR 267).

The old incising pattern was classed as a high density pattern. The gap between the blades was 2.0mm with a blade width of 1mm, also the frequency between the points of the teeth was 24.5mm. At these blade spacings and incision frequency, this represents 20,408 incisions per m^2. The average penetration of the tooth into the face of the timber was 2.5mm. The shape of the tooth, creates a flat bottomed slit in the timber 9mm long, which when assessing the patterns of preservative penetration, gives a very uniform appearance: See Annex A, Pictures 5, 8 and 11.

The new incising pattern has been developed to be compatible with modern sawmilling and woodworking machinery which has improved considerably in the last 35 years. The new blades are HSS, a much stronger material than the original blades, and considerably longer intervals before re-sharpening. These blades are also available commercially ‘off the shelf’, which makes them a more attractive option. The shape of the blade (see Annex A, Picture 3) was chosen so that when the tooth is pressed into the wood it neither crushed the wood when penetrating, nor caused ‘rip out’ fibres leaving splinters, when withdrawn.

The gap between the blades was 6.5mm with a blade width of 1mm. Also the frequency between the points of the teeth was 8.5mm. At these blade spacings and incision frequency, this represents 15,647 incisions per m^2. The shape of the tooth creates a ‘V’ slot which can be up to 6mm deep. When assessing the patterns of preservation, the new blade gives a more ‘spiky’ appearance in regions of heartwood but visibly improved sapwood penetration: See Annex A, Pictures 4, 7 and 10.

These blades when suitably mounted can either be directly driven or utilise existing power feeders on other woodworking machinery. This system has been designed specifically to be adopted by sawmills or wood processors, so that it can be added as an inline process to existing woodworking machinery for little extra cost and little reduction in the machine speed. Also, on-site saw doctors can maintain these blades as required.

Preservative treatments

Two major preservative manufacturers have been helping with the trial, by both the use of their treatment plants and their expertise.

Osmose, Marlow have performed a limited trial with spruce using their CCA replacement solution AC500, with a range of cycle times. More work for this project is underway investigating the mechanisms of how incising works, especially investigating the effects of rate of growth on preservative uptake.

Arch Chemicals have treated the main trail materials (750 battens) at their treatment plant in Castleford, West Yorkshire, using their CCA replacement solution Tanalith E. More work in relation to this project is underway, investigating the effects of cycle times and possible reduction in treatment times.

Trail 1 - Various incising patterns with AC 500

A small trial of the preservation uptake and distribution was undertaken using the old incising patterns, the slitting blade (Annex A, Picture 2) with various densities of incisions, using Douglas fir and Spruce battens at a commercial preservation plant at the Rowfant Sawmills, Crawley, West Sussex. For this trial only the batten size was 50mm x 50mm x 600mm long. The objective of this trial was to determine, what, if any differences were readily detectable.

The treatment schedule used was for hazard class 1/2. The schedule (HP 9) was:

- Initial vacuum of -0.8 bar for 5 minutes,
- Pressure of 12.4 bar for 13 minutes and
- Final vacuum of -0.8 bar for 15 minutes.

Although this cycle was not intended for difficult to treat timbers (Spruce, Douglas Fir and Larch) and preservative penetration was minimal. There was, however, a greater penetration (grams) for the timber that was incised.

Trial 2 - New incising pattern with various treatments times (AC 500)

Osmose, based at Marlow was using the new pattern of incising for Spruce timber only; dimensions 50mm x 50mm x 750mm long. Three batches of incised timber with unincised controls were supplied to Osmose who undertook three different preservation schedules using a commercial strength solution. The purpose of this experiment was to establish if by incising the timber it was possible to:

1. Increase the preservative uptake sufficiently to allow a reduction in the pressure cycle time, whilst maintaining the desired service life, or
2. Keep the cycle times the same, but guarantee lateral penetration to the required depth, or

3. Increase the durability of the timber from 15 years to the next class, 30 years.

The three preservation cycles used were:

1. HP 9 - initial vacuum -0.8 bar for 5 minutes, pressure 12.4 bar for 20 minutes and a final vacuum of -0.8 bar for 15 minutes.
2. HP3 - , initial vacuum -0.8 bar for 30 minutes, pressure 12.4 bar for 90 minutes and a final vacuum of -0.8 bar for 15 minutes.
3. HP4 - initial vacuum -0.8 bar for 60 minutes, pressure 12.4 bar for 180 minutes and a final vacuum of -0.8 bar for 15 minutes.

Trial 3 – Old and new incising pattern using Tanalith E

Arch Chemical plant, Castleford, West Yorkshire, treated 840 battens using a 3.0%, and a 5.0% preservative solution, using the commercial treatment schedule HP4 (Initial vacuum -0.8 bar for 60 minutes, 12.4 bar for 180 minutes and a final vacuum of -0.8 bar for 15 minutes). Three timber species (Douglas fir, Spruce and Larch) were incised (dimensions 50mm x 50mm x 750mm long) with an original high density pattern, the new pattern and one batch left un-incised for each species as a control.

Of the materials treated, the individual weights were recorded before and after treatment and their preservative uptake calculated. These treated timbers were used for biological assessment, in ground contact trials, strength loss testing and preservative penetration analysis.

The moisture content of all the materials tested was between 20 and 30 % moisture content and was of commercial quality.

Standards for preservative preservation and retention

BS EN 351-1:1996 outlines the necessary requirements for specifiers to ensure that they can choose the correct preservative treatment for solid wood depending on it's intended end-use. This Standard also makes no attempt to quantify the expected working life that can be expected from a particular preservative treatment as this will depend on the individual service conditions encountered. The performance of treated wood cannot be assessed directly, for example by field tests or bioassays, as no agreed European Standards exist specifically for this purpose. As a consequence the penetration and retention of a preservative treatment are used to define the quality of treatment.

BS EN 351-1:1996 also has clauses relevant to the factory production control and marking. This Standard has also clearly defined the penetration classes and their respective analytical zones, so that every charge of treated timber can be shown to comply with the requirements of the specification.

To the commercial wood treatment companies, BS EN 351-1:1996, represents a means whereby the less conscientious treatment operators can be measured. The purpose of incising timber before preservation is to help ensure the penetration is uniform and to the correct depth. BS EN 351-2:1996, enables the correct sampling and analysis to be applied when assessing the loading of preservative in the treated materials.

While there are a large number of Standards relating to the selection of preservative, treatments schedules, suitability of timber species for preservation and the definition of hazard classes, BS EN 351-1:1996 sets the requirements for the specifiers and against which the quality of treated timber can be benchmarked.

BS 8417:2003 Preservation of timber – Recommendations give end users and treatment facilities the information on the required treatments cycles for specific end-use applications, also expected service life and hazard class.

Results of incising trials

Trial 1- developing incising patterns (AC 500)

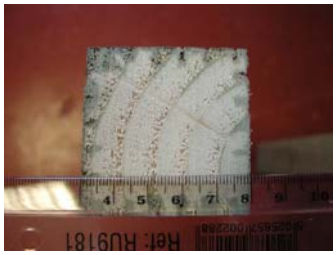
Using the pressure cycle HP9, the averaged preservative uptake for all the incised materials (Douglas fir and spruce) was 360g of solution. This is shown below in Table 1 along with unincised uptake for comparison.

Table 1: Uptake of preservative solution for incised and unincised battens

Timber species	Not incised (uptake grams)	Incised (averaged uptake grams)
Spruce	263.9g	360.0g
Douglas fir	304.6g	360.0g

One of the hypotheses proposed is that the incising simply exposes more surface area to preservative solutions and in doing so you have a surface treatment around the incisions. The proof of this would be a cross section sample with incisions showing 'spikes' of treatment and no lateral penetration from them. See Figure 1 below.

Figure 1: showing spikes of preservative penetration with little lateral penetration



The opposite hypotheses would be as more end grain is exposed to preservative solution, greater penetration will be achieved as a result.

Figure 2: showing lateral penetration from incisions and an effective protective envelope treatment.

As the preservation cycle was not specifically for the treatment of these species it did not demonstrate what we were looking for. After discussions with Osmose regarding this outcome another trial was organised which was designed to demonstrate any differences with incising.

Trial 2- New incising pattern only (AC 500)

Osmose have undertaken to treat 60 samples of incised spruce wood, 54 were incised and 6 were unincised controls. These were divided into three sets of 20 each containing 2 unincised controls.

HP9 treatment schedule – 20 minutes at 12.4 bar

Annex 1, Picture 12 shows 20 Spruce battens (18 incised and 2 un-incised). Much of the timber appears to be heartwood, and poor preservative penetration is very evident. In the regions of sapwood, there appear to be considerable penetration along the growth rings, especially in the faster grown material. Uptake of preservative for this treatment schedule was:

- Unincised controls, 143.6 g.
- Incised battens, 251.9g

These results demonstrate a greater uptake in preservative solution, but not sufficient lateral penetration to make this an effective treatment schedule for Spruce.

HP4 treatment schedule – 180 minutes at 12.4 bar

Annex 1, Picture 13 shows 20 Spruce battens (18 incised and 2 un incised). Much of the timber again appears to be heartwood, the penetration pattern is clearly different. This is the only recommended schedule for Spruce and the picture shows that lateral penetration from the incisions has been achieved, as well as considerable penetration along the growth rings in most cases. Uptake of preservative for this treatment schedule was:

- Unincised controls, 308.8 g.
- Incised battens, 462.3g

These results demonstrate a considerable increase in the volume of preservative entering the wood. Again, incising has made a considerable difference in the preservative uptake, and from the picture evidence, protective envelopes are being established. Also the penetration along the growth rings is interesting, as it is unclear as to how the solution is reaching these locations. Is it via the end-grain or laterally?

HP3 treatment schedule – 90 minutes at 12.4 bar

Annex A, Picture 14 shows 20 Spruce battens (18 incised and 2 un incised). Much of the timber again appears to be heartwood, the penetration patterns are again different. The uptake of preservative solution, for a cycle with half the pressure time as HP4, is very similar. Uptake of preservative for this treatment schedule was:

- Unincised controls, 475.5 g.
- Incised battens, 481.1g

This is a very interesting result as the controls have taken up almost as much solution as the incised battens, and the incised battens have very similar uptakes to those treated using cycle HP4. Can this mean that the Spruce wood has achieved maximum absorption after 90 minutes? Or that with incising we can genuinely reduce the time required to treat Spruce to somewhere in between 90 – 180 minutes?

After discussions with Osmose on this phenomenon, more samples are being sent to them to investigate different treatment times. Included in these samples are some which are end-sealed, to determine if the preservative solution has been entering the growth rings via the end-grain or if it enters the wood through the lateral surfaces.

Trial 3 – Comparison of new and old incising patterns (Tanalith E)

The main trial was treated at Arch Chemicals, Castleford Ltd. Here only one treatment cycle was used (HP4 Initial vacuum -0.8 bar for 60 minutes, 12.4 bar for 180 minutes and a final vacuum of -0.8 bar for 15 minutes). Three timber species (Douglas fir, Spruce and Larch) were incised (dimensions 50mm x 50mm x 750mm long) with an original high density pattern (old), the new pattern (new) and one batch un-incised as a control.

Two solution strengths were used. As some of the battens treated here are to be installed in an in-ground contact trial at Princes Risborough, some were end-sealed with a 2-pack epoxy for biological assay.

The solution uptake after treatment is given in Tables 2-5. Here comparison can be made between the species and also sealed end-grain and open end-grain. It is encouraging to note that the uptake between the old and new incising pattern is very similar for both the 3% and 5% preservative solution.

Table 2: 5% solution uptake for unsealed end-grain

Timber	Uptake, grams, unincised battens		Uptake, grams, old pattern incising		Uptake, grams, new pattern incising	
Spruce	Average	376.3	Average	464.0	Average	516.9
	Minimum	210.0	Minimum	299.0	Minimum	311.0
	Maximum	654.0	Maximum	679.0	Maximum	837.0
Douglas fir	Average	No data	Average	467.9	Average	480.4
	Minimum		Minimum	271.0	Minimum	344.0
	Maximum		Maximum	694.0	Maximum	689.0
Larch	Average	306.0	Average	409.0	Average	418.7
	Minimum	232.0	Minimum	262.0	Minimum	257.0
	Maximum	614.0	Maximum	582.0	Maximum	530.0

Table 3: 5% solution uptake for sealed end-grain

Timber	Uptake, grams, unincised battens		Uptake, grams, old pattern incising		Uptake, grams, new pattern incising	
Spruce	Average	220.3	Average	414.0	Average	468.95
	Minimum	167.0	Minimum	262.0	Minimum	287.0
	Maximum	310.0	Maximum	652.0	Maximum	639.0
Douglas fir	Average	214.8	Average	377.1	Average	393.9
	Minimum	122.0	Minimum	225.0	Minimum	250.0
	Maximum	373.0	Maximum	600.0	Maximum	708.0
Larch	Average	240.2	Average	365.5	Average	382.9
	Minimum	133.0	Minimum	258.0	Minimum	258.0
	Maximum	545.0	Maximum	535.0	Maximum	692.0

Table 4: 3% solution uptake for unsealed end-grain

Timber	Uptake, grams, unincised battens		Uptake, grams, old pattern incising		Uptake, grams, new pattern incising	
Spruce	Average	405.8	Average	536.1	Average	546.8
	Minimum	261.0	Minimum	355.0	Minimum	399.0
	Maximum	644.0	Maximum	742.0	Maximum	811.0
Douglas fir	Average	No data	Average	557.7	Average	544.5
	Minimum		Minimum	380.0	Minimum	325.0
	Maximum		Maximum	938.0	Maximum	923.0
Larch	Average	339.7	Average	435.6	Average	506.3
	Minimum	209.0	Minimum	250.0	Minimum	318.0
	Maximum	512.0	Maximum	671.0	Maximum	585.0

Table 5: 3% solution uptake for sealed end-grain

Timber	Uptake, grams, unincised battens		Uptake, grams, old pattern incising		Uptake, grams, new pattern incising	
Spruce	Average	281.8	Average	451.1	Average	464.1
	Minimum	193.0	Minimum	313.0	Minimum	376.0
	Maximum	603.0	Maximum	667.0	Maximum	569.0
Douglas fir	Average	279.8	Average	424.7	Average	486.9
	Minimum	140.0	Minimum	259.0	Minimum	300.0
	Maximum	682.0	Maximum	671.0	Maximum	737.0
Larch	Average	265.3	Average	396.2	Average	449.7
	Minimum	181.0	Minimum	257.0	Minimum	337.0
	Maximum	431.0	Maximum	485.0	Maximum	809.0

A consistent pattern emerged form the uptake data, unincised > old pattern > new pattern. The data given in Tables 6 and 7 are compared to the unincised reference battens. Comparisons between Tables 6 and 7 will not work as these figures are relative and not absolute.

Table 6: Average uptake increases for open end-grain battens

Timber	Unincised	Old pattern	New pattern
Spruce	0.0%	27.5%	35.5%
Douglas Fir	0.0%	No data	No data
Larch	0.0%	30.5%	43.0%

It is encouraging to note that increased preservative uptakes of ~ 30.0% can be achieved on small section timbers with open end-grain. This represents an average increase of 140.0 grams preservative solution for incised Spruce, and for incised Larch.

Table 7: Average uptake increases for end-grain sealed battens

Timber	Unincised	Old pattern	New pattern
Spruce	0.0%	74.0%	88.0%
Douglas Fir	0.0%	64.0%	78.5%
Larch	0.0%	50.5%	65.0%

With the end sealed samples, even though the preservative uptake was lower incised timber demonstrated an average increase of ~ 70.0%. This represents an average increase of 190.0 grams of preservative solution against un-incised materials.

Perception survey results

A number of survey techniques were considered for this part of the report, they were:

- Postal questionnaire
- Web based questionnaire
- Company visits
- Telephone interviews

The preferred technique was the use of the telephone because it can:

- Be an effective use of time
- Allow you to talk to the MD's or key decision makers
- Deliver an instant response
- Offer quality information
- Be cost effective for the project budget.

Some of the main leads from this were followed up with more detailed interviews and conclusions.

A number of sawmillers, merchants and wood preservative manufacturers were questioned regarding their views on incising home grown timber before preservation for the fencing market.

To the woodworking and preservation industry it was no surprise that this was being re-visited and were all interested in the process.

Arch Chemicals have expressed great interest in the project, and the product.

Osmose have also been very interested in the project as it relates back to their own work done many years ago.

B and Q have been approached to comment on the products, and to date have only commented on the fact that they are, in principal, in full agreement about making better use of UK grown timber.

Ransfords Sawmill, Shropshire have been very interested in the whole process, as one of the top fencing producers in the UK, they view incising as a means to achieve consistency and quality of their final products. They are key suppliers to the Highways

Agency and currently see incising as a means to ensure that sapwood achieves at least 6mm lateral penetration.

John Brash, this company has the in-house capability to incise up to 180mm square timber. They are offering the service for posts in high hazard applications e.g. posts for jetties.

Initial Industry survey

The benefit of the telephone survey has been to get information from these companies and how they view their business. From the analysis of the comments received, it was clear that this sector of the market was not the right starting point and as a consequence the focus changed. Results of the survey are considered and a brief summary of the comments are given below.

Phone interviews with 11 companies:

- Anglian Timber Ltd, Essex – Producers of Douglas fir fencing from their own sawmill in Scotland. Mainly feather edge boards, posts and fence panels, all CCA treated. They are undecided what alternative to use when CCA is phased out. Not very interested by incising.

- Anglo Norden Ltd, Suffolk – They import all materials from Lithuania and currently CCA treated until Jan 2004 (undecided on ACQ or Tanalth E as replacements). Not particularly interested by incising timber.

- George Barker and sons (Timber Merchants) - they use UK grown Spruce for fencing, treating with ACQ. They dry the product down to 28% or less before treatment and have good results as a consequence. It is reported that customers are returning after 20+ years because of their treatment quality.

- Challenge fencing Ltd – They are importing timbers from all over the world to meet specification and demand. They are buying in treated materials and selling on completed fencing products. They indicated that the customer perceptions in their part of the UK are for timber to be in perfect condition with smooth appearance and with very few defects. General consensus was that contracts for high value properties made up a considerable volume of their sales and that these customers would not appreciate the timber being incised.

- Clwyd durable timber Ltd - Using timber sourced from Welsh forests and are treating with AC 500. The species mentioned were Hemlock, Pine, Spruce, Douglas Fir, Larch and Cedar. However, when asked about Incising the timber, four objections were immediately raised:
  - additional costs for processing timber
  - increased preservative uptake
  - unable to compete on a level playing field with Eastern European imports on price.
  - Very few customers request preservation to a guaranteed level, most are happy with cycle times.

- Duchy Timber and Country store – They imported Spruce and Douglas fir for fencing some in the round, some dimensioned timbers. They are currently treating with CCA but will be moving to Tanalith E very shortly. They find it is cheaper to import timber, than to source from the UK. When asked about incising timber, gave a mixed response in that some customers would accept it, others would not.

- East Anglian Sawn Timber – A hardwood sawmiller, using homegrown Oak, Chestnut, Larch and Douglas fir. No treatment facilities but used local plants when needed. Not interested in incising timber as it is additional costs and no added return.

- Lawsons (whetstone) – They purchase fencing materials from Timbmet (so will be mainly imported). Customers are not that fussy, but do complain about timber checks and splits, not sure if customers would accept or reject incised materials.

- Lowther Forestry group – They now purchase materials to suit the job in hand. Will use home grown materials, but now not really in the sawmilling trade.

- Timber Direct Ltd – They purchase cut and treated materials ready for re-sale, and uses CCA but will change to Tanalith E. Often has customers complaining about toothed sprockets damage from automated production facilities, and suggests that incising would suffer similar customer rejection. If customers want better service life they request 40 year life and this can be easily accommodated with dryer timber and stronger preservative solutions.

- Timber Mart UK ltd – They import most of their timber from their own mill in Latvia, however, the price differentials are critical. Customers are unlikely to want incised timber as any increased costs will be making them look to Scandinavian and Canadian timber of similar price and better quality.

Presentation to Osmose 6 October 2003-12-15

As part of a bigger programme, incising was presented for discussion, and the implications and results of Trial 1. Trial 1 was undertaken at Rowfant sawmills as they were the most local treatment plant to BRE using the new AC 500 solution and the cycle HP 9.

The presentation centred on the improved penetration of the preservative, and on their perception of the holes left in the surface of the timber.

The penetration drew a strong discussion as to the standards and requirements for the various hazard classes that treated timber encounters. While the Douglas fir demonstrated an even protective envelope and favourable comments, the Spruce did not. In Trial 1, it has already been established that the preservation cycle HP 9 does not satisfy the penetration for spruce, one of the arguments raised in the discussion was the incisions simply pushed the surface into the timber. Meaning that the spikes of preservative seen were due almost entirely to a superficial treatment on all faces of the incision, giving the impression of an in-depth treatment.

As regards the appearance, the latest style of blade has overcome the torn and splintered surface and now leaves neat lines of slits along the length of the timber. The final comment was that it was a unique selling point and a marketing opportunity. These holes were very specific, and it would be very easy promote the pattern as a mark of quality, simply on the basis that unless you had gone to the trouble to incise the timber, it would not be easy to copy the process without the additional benefits of improved preservative penetration.

Forward Look

Following from the summary to this presentation and subsequent discussion another trial, Trail 2, was agreed and has delivered great benefit to the project. Also more work is planned to re-inforce the findings and to begin to establish if there are grounds to re-visit the BWPDA's recommendation of using only the treatment cycle HP4 for Spruce.

Positive industry leads

Arch chemicals

In their opinion compliance with BS 8417:2003 is key, which is also the document to which the Highways Agency will refer.

For impermeable timbers to be exposed in-ground, BS 8417:2003 requires 6mm penetration for a 15 year service life and 12mm for a 30 year service life. These are in the sapwood for Douglas fir and larch, and all the cross-section for spruce. It stipulates an Acceptable Quality Level (AQL) of 25% for these species i.e. 25% non-conforming units allowed.

For above ground, the equivalent penetrations are 3mm and 6 mm. From the photos presented, it is clear that the penetration has been significantly improved. Would it be possible to comment on improving the chance of compliance?

Arch Chemicals are now very keen to conduct more trials on the process times between 90 minutes (HP3) and 180 minutes (HP4). Following the results of sealed end-grain and open end-grain, there is a possibility of more work in this area as well.

Osmose

Following the presentation at BRE, Osmose were very interested to work with BRE on the project. As with Arch Chemicals they have arranged for more work to be undertaken in the New Year to investigate preservative penetration in fast grown Spruce and slower

grown Spruce, with sealed and open end-grain. Of the work already undertaken, they have issued a provisional summary:

'Three batches of Spruce were treated with AC 500 under different treatment schedules (P9, P4 & P3). The uptake and penetration of fluid into the timber was observed and recorded.

It is apparent that incising ***does*** indeed ***improve*** the penetration of fluid into Spruce.

Although further, more extensive trials must be conducted, it is also apparent that incising may allow the treatment of Spruce by lesser schedules than that recommended by the BWPDA. For example, it might be possible to use a schedule HP3 to achieve the same acceptable level of treated timber as was previously only possible with HP4 treatments. This would effectively cut treatment times by up to 90 minutes.

Incising also gives potential for the use of incised Spruce for P4 applications (6mm lateral penetration) where previously this was not possible'.

Ransfords Sawmills

This company is one of the top fencing manufacturers in the UK, supplying quality fencing for motorways and other high quality applications. Here incising is seen as a means to guarantee the minimum penetration of preservative into products with a 30 year or 60 year service life. Should these trials show that this method can help achieve this requirement, then the cost of installation could be justified.

B and Q

B and Q have been one of the positive sales leads for this project and have expressed their support for the better use of UK grown timber.

John Brash and company

This company is the only company BRE has located in the UK who currently will incise timber before preservation for some applications in hazard classes 3, 4 and 5.

Potential Markets

If the incising process can demonstrate that difficult to treat timbers like Spruce, Douglas Fir and Larch can be treated effectively to meet the requirements of BS 8417:2003, then the potential markets are:

- Cladding,
- Fencing,
- Decking

- Wooden buildings(timber frame, trussed rafters and sole plates),
- Retaining/weeping walls for agricultural / Industrial lagoons,
- Animal housing/ loose boxes etc.
- Pallets
- Cooling tower timbers
- Marinas
- Pontoon decking/walkway boards,
- Rubbing strips,
- Piles
- Lake, canal and river bank supports
- Outdoor furniture
- Timber play equipment
- Landscaping timbers
- Trellis's, Pergolas etc.

Discussion

Trial 1

This trial sought to determine if the new style cutting pattern was a viable prospect (Annex A, Picture 2). In terms of preservative solution uptake, all the patterns used demonstrated an increased absorption.

HP9 treatment schedule – 20 minutes at 12.4 bar

These battens were only 600mm long, were not end-sealed and were treated in a commercial plant with little control over the operation. It is worth noting that the only recommended preservative cycle to be used for Spruce is HP4 (180 minutes at 12.4 bar).

The main observations from this trial were:

1. The penetration of preservative into the wood was superficial.
2. The preservation cycle was not suitable for difficult to treat timbers.
3. With the 'original' new style cutters before modification, the surface of the timber was rough and splintered.

Trial 2

This trial was conducted by Osmose who treated 60 samples of incised spruce wood in the new pattern. A total of 54 were incised and 6 were unincised controls. These were divided into three sets of 20, each set containing 2 unincised controls.

Due to the poor surface condition of Trail 1 'new' incising pattern a new blade was sourced and used. This blade (see Annex A, Picture 3) has an improved cutting action and is able to penetrate the wood up to 6mm depth, using the current lab scale equipment.

HP9 treatment schedule – 20 minutes at 12.4 bar

As with Trial 1, this was reproduced under more controlled circumstances and very similar results were obtained:

1. The average uptake in grams for the unincised controls was 143.6 g.
2. The average uptake for the incised battens was 251.9g

3. These results demonstrate a greater uptake in preservative solution as a result of incising, but not sufficient lateral penetration to make this an effective treatment schedule for Spruce.

HP4 treatment schedule – 180 minutes at 12.4 bar

This is the only recommended schedule for Spruce and the picture shows that lateral penetration from the incisions has been achieved. It is also noted that considerable penetration along the growth rings has occurred in most cases. The main observations from the trial were:

1. The average uptake in grams for the unincised controls was 308.8 g.
2. The average uptake for the incised battens was 462.3g
3. These results demonstrate a considerable increase in the volume of preservative entering the wood. Again, incising has made a considerable difference in the preservative uptake, and from the picture evidence, increased the establishment of protective envelopes.
4. Also the penetration along the growth rings is interesting, as it is unclear as to how the solution is reaching these locations: Is it via the end-grain or laterally? This will be investigated further to try and draw conclusions.

HP3 treatment schedule – 90 minutes at 12.4 bar

Annex A, Picture 14 shows 20 Spruce battens (18 incised and 2 unincised) while much of the timber again appears to be heartwood, the penetration patterns are again different. For a cycle with half the pressure time as HP4, the uptake of preservative solution are very similar as show by these observations:

1. The average uptake in grams for the unincised controls was 475.5 g.
2. The average uptake for the incised battens was 481.1g
3. The controls have taken up almost as much solution as the incised battens,
4. The uptake for the incised battens is very similar to those treated using cycle HP4.
5. Could this mean that the Spruce wood has achieved a maximum absorption after 90 minutes?
6. Does it mean that with incising we can reduce the time required to treat Spruce to somewhere in between 90 – 180 minutes?

After discussions with Osmose on this phenomenon, more samples are being sent to them to investigate different treatment times. Included in these samples are some which are end-sealed, to determine if the preservative solution has been entering the growth rings via the end-grain or if it enters the wood through the lateral surfaces.

Trail 3

HP4 treatment schedule – 180 minutes at 12.4 bar

This treatment schedules was used for Spruce, Douglas fir and Larch. Some of the samples were end-grain sealed and each species were incised with the old and new pattern and including unincised controls in the sample batches.

The main discussion points for this trial are:

1. The similar volume uptake of the preservative solution for both the new and old incising patterns.
2. The difference in uptakes for end-grain sealed and open end-grain battens.
3. The different responses each species has to preservative treatment.

The design difference between the two incising patterns were considered to be significant, because of the blade spacing and the frequency of cuts.

The old pattern has closely spaced blades and a long interval between incisions. This is a very suitable design for the closed cell structure timbers included in these trials. The shape of the tooth is square, but the outermost edge follows the circumference of a larger circle. This has the effect of producing a long flat bottomed incision, which penetrates 2mm – 3mm. The reasoning being that preservative penetration into the timber occurs via the end-grain and this pattern reveals the maximum quantity of exposed end-grain.

The new pattern has wider blade spacing (about twice the distance of the old pattern) and has a much greater cutting frequency. Penetration of the cutting blade into the surface can be as much as 6mm, and This has the visual effect of cutting lines in the surface of the timber. Preservation uptake is very similar to the old pattern, but distribution of the preservative solution between the two incising patterns are different.

While both patterns have absorbed similar volumes of preservative solution, it remains to be tested the efficacy of this CCA replacement solution (Tanalith E) and the pattern of preservative distribution within the timber.

The results of preservative penetration uptakes with battens that were end-grain sealed and those that are open end-grain are unexpected. While it is expected to achieve preservative penetration up the end-grain of approximately 40mm, the results in Table 3 and Table 5 indicate that depending on the species, significant volumes of solution were entering the end-grain of the timber.

The point that remains unanswered is how far can the preservative travel up the end-grain of these timber species? This will be addressed by Osmose in the New Year.

Perception survey

The initial part of this study focussed on the customer/ industry interface and the perception of the smaller fencing retailers, manufacturers and contractors, for whom incised timber is not currently an option. Their market place is driven on price differentials and proof of quality is not always required. Following, the mostly negative response incised timber encountered, the focus was moved to the key companies in the wood preservation industry and fencing manufacturers.

Here the response has been completely different. Motorway and utility fencing is specified on a quality assured basis and checked for compliance to the required standards. In this marketplace, not being able to guarantee the quality can mean considerable operating losses. When faced with such commercial issues, perhaps this can lead to a less efficient operation, because overloading of preservative to ensure quality is being employed.

This is where incising could play a significant role? By incising green timber in the sawmill and then kiln drying to the correct moisture content, incising must offer some benefits in the drying process, as postulated below:

- Do the incisions penetrate deep into the surface of the timber and allow moisture to escape more easily?
- Have the incisions reduced the stresses in the surface and does this mean you can increase the rate of drying?
- Is there any significant ‘recovery’ of the timber around the incision when shrinking down during drying?

Then when being preservative treated, after the questions are posed:

- Is there any significant ‘recovery’ of the timber around the incision when being treated with a polar solvent based wood preservative?
- Is there a consistency in preservative uptake that can belied upon?

The incising pattern itself could be regarded as a ‘unique selling point’ in that if someone has gone to the lengths to copy or replicate the pattern in any way, it is easily identifiable. Also, different colours or tints could be used in the preservative that would not be available to non-registered operators.

Conclusion and recommendations

The development of a new incising pattern has been undertaken and in principle a system that would be compatible with modern woodworking procedures has been achieved.

1. The treatment trials undertaken to date demonstrate that a similar uptakes of preservative solution at 90 minutes pressure can be achieved compared to those at 180 minutes pressure. This may indicate that the maximum absorption is reached relatively early in the cycle and the additional time may be unnecessary.
2. There is a very similar uptake of preservative solution between the two incising patterns, however, the pattern of distribution is different. Laboratory and field trials will determine if this is significant.
3. Spruce that is fast grown may have a different uptake of preservative solution as it can penetrate the timber via the spring wood of the growth rings. This will be investigated further by trials at Osmose.
4. Incising has been shown to increase the depth of penetration significantly. Can additional trials improve the depth of incision and achieve sufficient preservative penetration to achieve a 15, 30 or a 60 year service life.
5. Incising has an application in the specified quality fencing market and other high quality applications.
6. Within this project limited trials to determine the degree of strength loss associated with incising and preservative treatment. However, this should be considered for further work as a discrete project.

References

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BS EN351-1 (1996) Durability of wood and wood based products - Preservative treated solid wood Part 1 Classification of preservative penetration and retention. BSI 1996.

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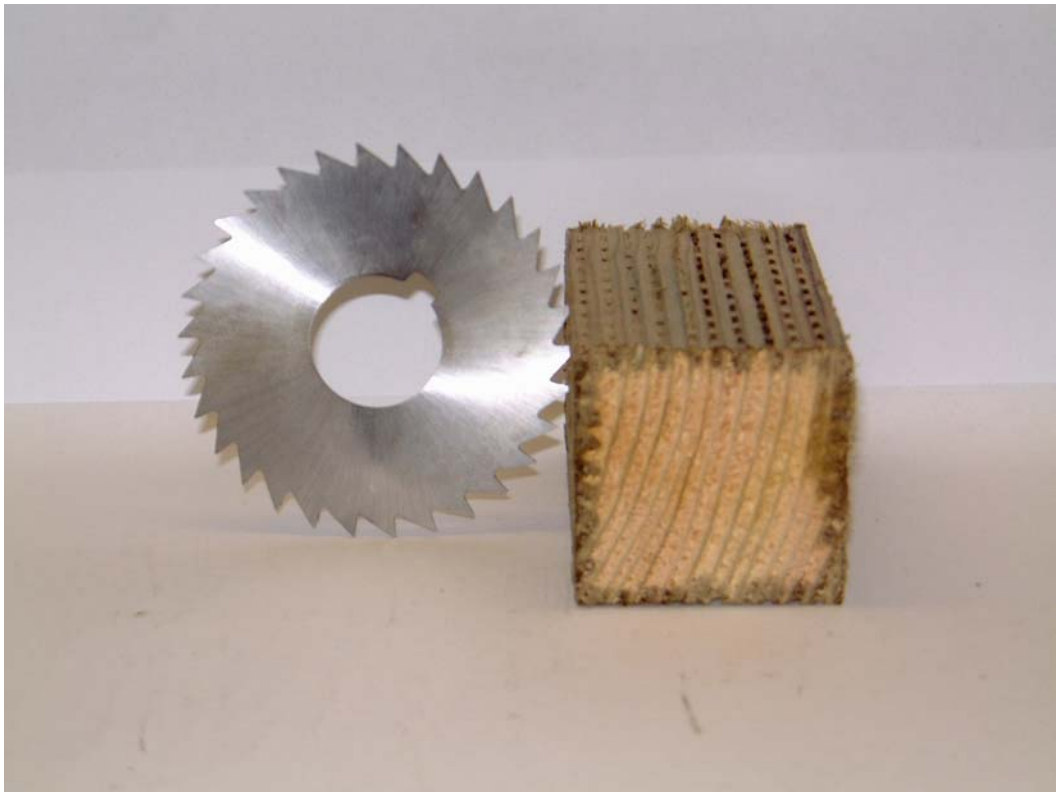
BS 8417:2003 Preservation of timber

Appendix A – Photographs of incised timber

Picture 1: Picture of new incising pattern (top) old pattern (middle) and no incising (bottom) before treatment.

Picture 2: Slitting blades and example of the fibres being plucked out of the surface of the timber.



Picture 3: New style incising blade with High Speed Steel, Hollow ground, Peg tooth design.

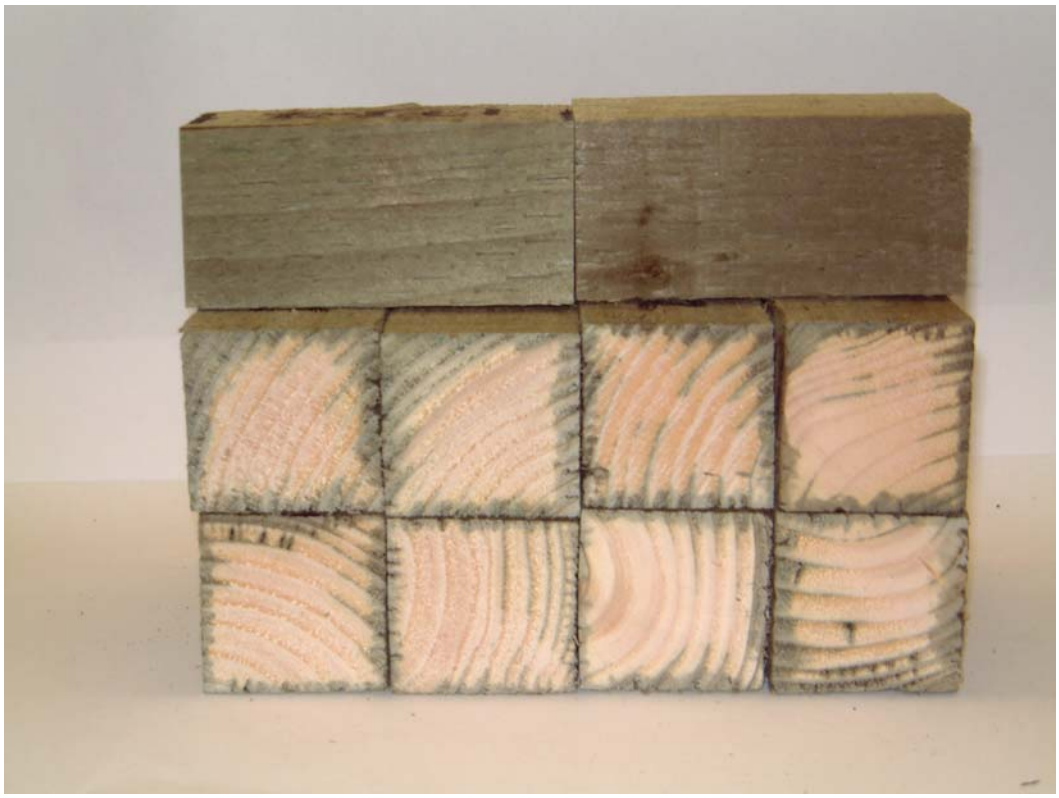
Picture 4: Larch, new incising pattern

Picture 5: Larch, old incising pattern

Picture 6: Larch, no incising

Picture 7: Spruce, new incising pattern

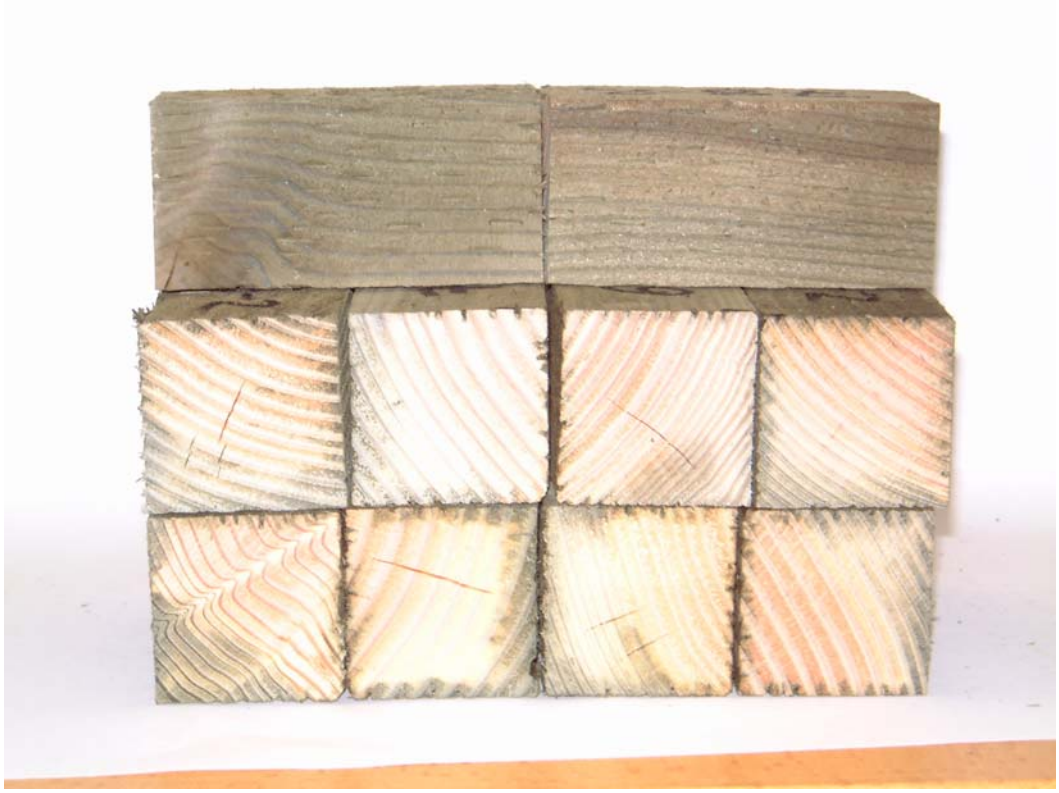
Picture 8: Spruce, old incising pattern



Picture 9: Spruce, no incising

Picture 10: Douglas fir, new incising pattern

Picture 11: Douglas fir, old incising pattern



Picture 12: Preservation treatment HP9, showing poor lateral penetration of preservative.

Picture 13 Preservation treatment HP4, showing better lateral penetration of preservative with development of some protective envelopes.

Picture 14 Preservation treatment HP3, showing mixed lateral penetration of preservative, with development of fewer protective envelopes.