Client Report :

Comparison of home grown and imported softwood for Timber Frame market – Progress Report 1

Client report number 215 -339

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10th December 2003

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Executive Summary

This report details the progress and results to date (Dec 2003) on the following project, full title: "Home grown softwoods for UK timber frame construction". The project work involves a critical, independent evaluation of home grown softwood for the UK timber frame construction sector. This involves selection and assessment by comparison of sample batches of home grown and imported material. The project involves a partnership approach by BRE, James Jones and Sons Ltd and Stewart Milne Timber Systems.

The project was given the go-ahead in Nov 2002. Consequently the originally proposed outputs and milestones are 6 months out of sequence.

In Jan 2003 BRE requested 2 batches of 89x38mm CLS from UK and Swedish sources. Since its arrival this material has undergone a programme of testing and conditioning. Assessment of a random selection of 100 battens from each set is now complete, including the following:

1. Measurement of distortion.

2. Assessment of level of compression wood.

3. Measurement of knot size and frequency on one random face.

4. Compression perpendicular to grain tests to BS EN 1193.

On the basis of the results obtained some of the originally proposed test details have been changed and rescheduled. Ongoing work is as follows:

- Experimental monitoring of frame distortion
- Shrinkage tests on small scale specimens
- A test production trial has been initiated.

Low levels of distortion were present in both imported and home grown timber as supplied, although the home grown timber showed a greater tendency to distort when allowed to dry unrestrained.

The home grown timber showed better performance in compression tests due to the greater frequency of knots.

The greater frequency and size of the knots in the home grown timber is more likely to cause a problem with nail fouling. However, in another BRE Project (DTi sponsored Pii on "Providing High Quality Timber for the UK Construction Sector") this problem has effectively been eliminated.

Contents

1. Introduction

General:

This report details the progress and results to date (Dec 2003) on the following project, full title: "Home grown softwoods for UK timber frame construction”

Project Details: PPD 26/02 (BRE project no. CV0256)

The current BRE Project Manager is Mr Tim Reynolds, Senior Consultant (01923 664832, reynoldst@bre.co.uk)

Other key contributors: Mr Matthew Cornwell, Mr Gerald Moore and Mr Keye Liu.

Background and objectives:

The project work involves a critical, independent evaluation of home grown softwood for the UK timber frame construction sector. This involves selection and assessment by comparison of sample batches of home grown and imported material. The project involves a partnership approach by BRE, James Jones and Sons Ltd and Stewart Milne Timber Systems. The home grown material was supplied by James Jones and Sons Ltd, whilst the imported material was taken from Stewart Milne’s existing stock.

The project was given the go-ahead in Nov 2002. Consequently the originally proposed outputs and milestones are 6 months out of sequence.

In Jan 2003 BRE requested 2 batches of 89x38mm CLS from UK and Swedish sources. Since its arrival this material has undergone a programme of testing and conditioning. Assessment of a random selection of 100 battens from each set is now complete.

1. Measurement of distortion (bow, spring, twist) at:

- Supplied moisture content (approx 20-22%).
- After 3 weeks at 25 deg C and RH 65%, unrestrained.
- After conditioning to low moisture content (approx 14%) unrestrained.

The distortion measurements made after unrestrained material has been conditioned or part conditioned are designed to determine the *propensity* to distort. It is recognised that timber studding in a timber frame house will be well restrained in service.

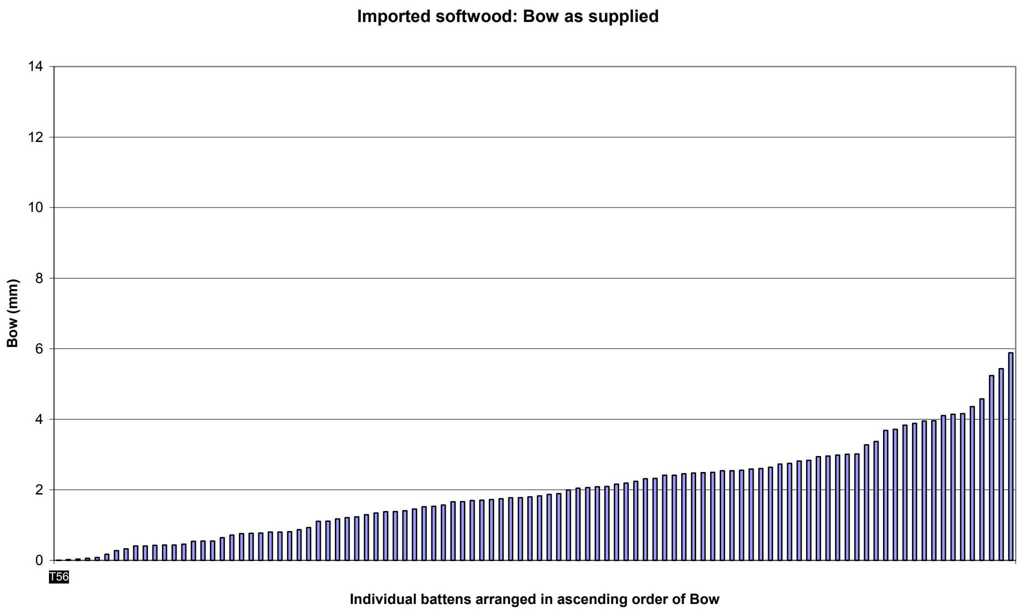
2. Assessment of level of compression wood

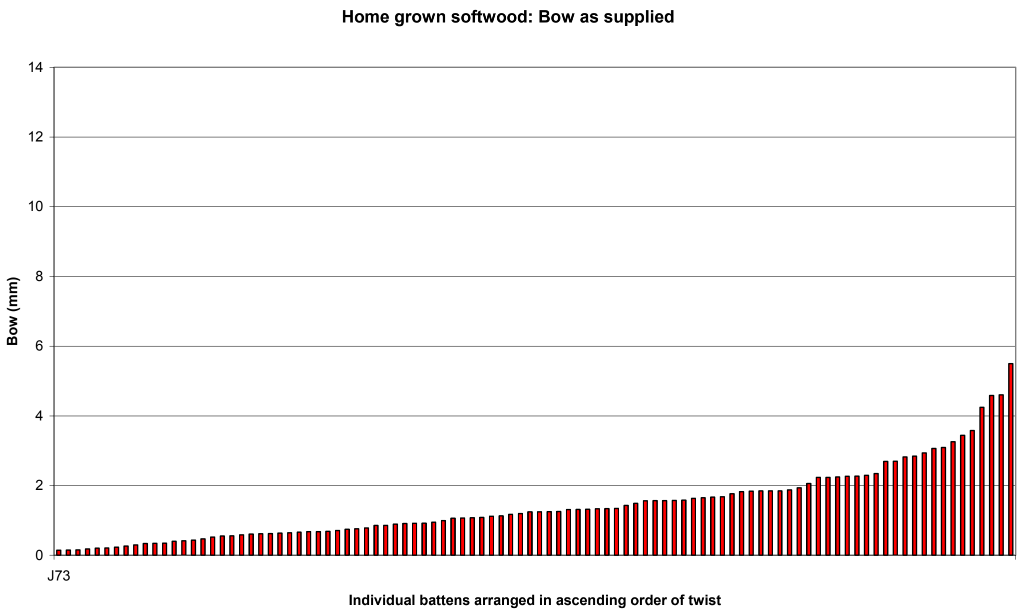
3. Measurement of knot size and frequency on one random face

4. Compression perpendicular to grain tests to BS EN 1193

2. Distortion Test Results

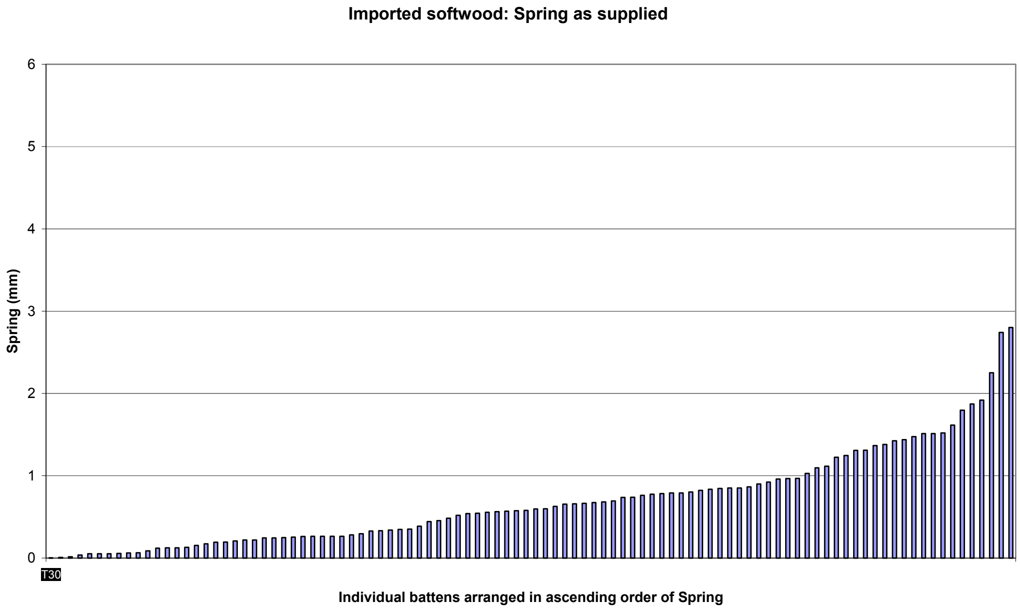
2.1 Distortion as supplied - Bow. Figures 1 and 2 (below) show the measured bow graphs of the Imported (coloured blue) and Home grown material (coloured red)

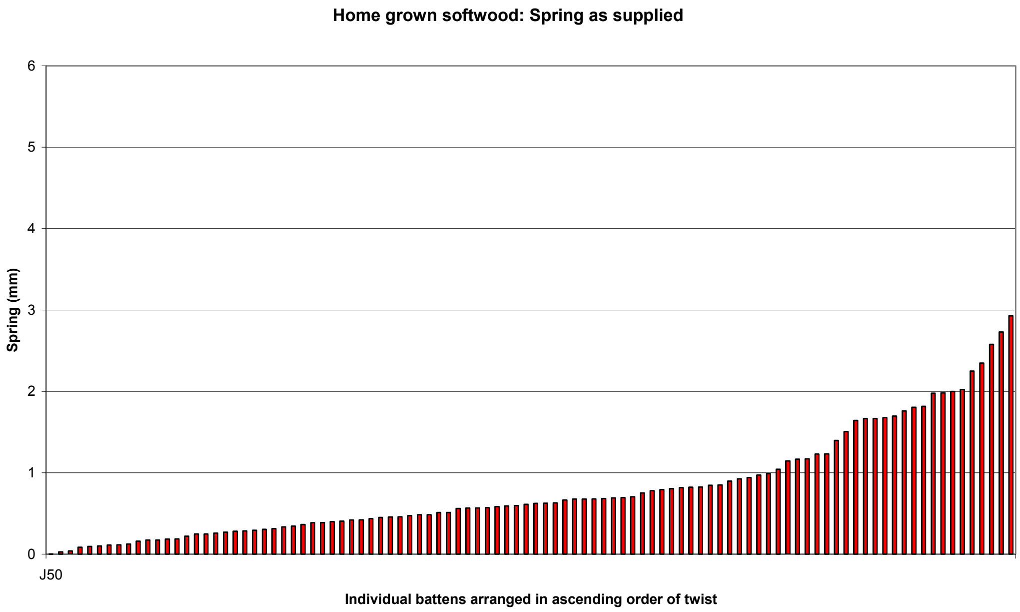




Figures 1 and 2 Comparison of Bow at supplied moisture content

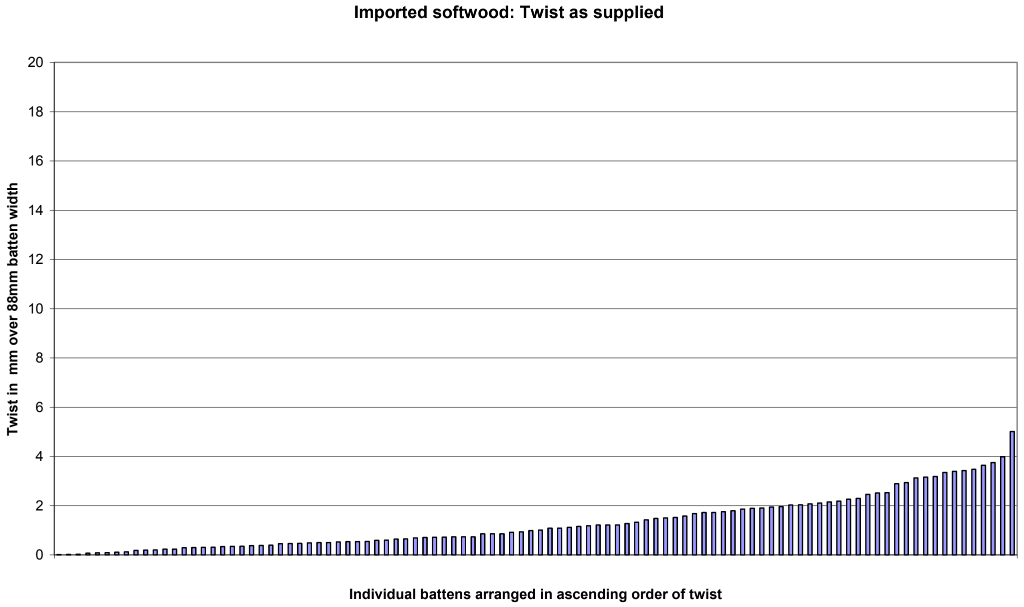
2.2 Distortion as supplied - Spring. Figures 3 and 4 (below) show the measured spring graphs of the Imported (coloured blue) and Home grown material (coloured red)

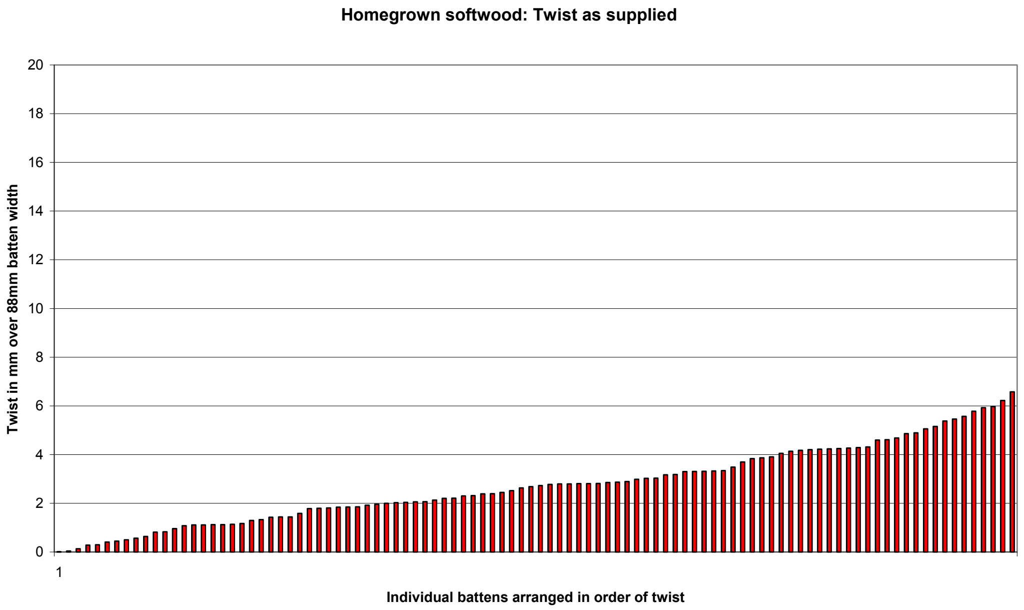




Figures 3 and 4 Comparison of Bow at supplied moisture content

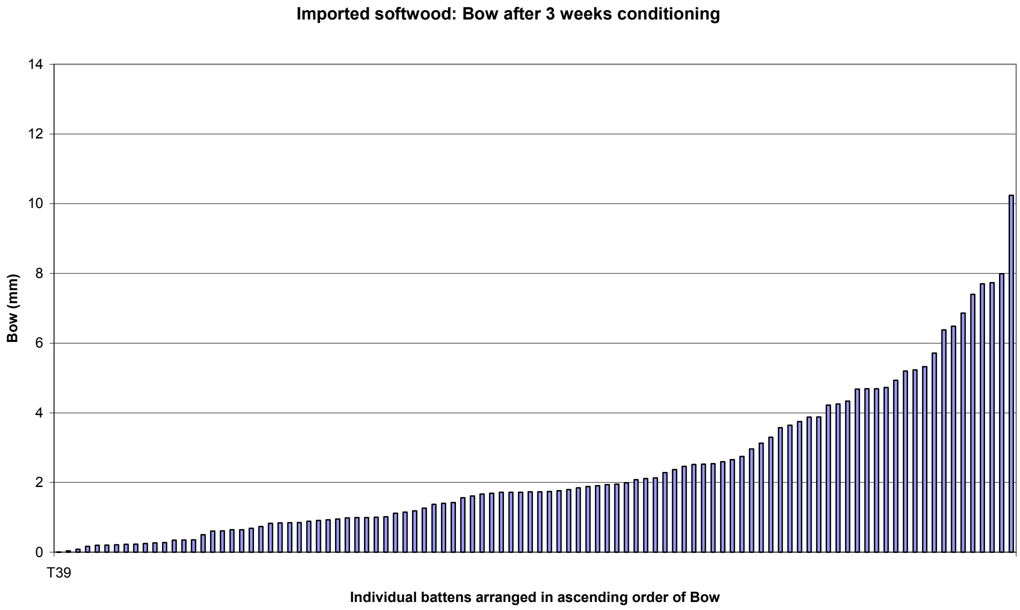
2.3 Distortion as supplied - Twist. Figures 5 and 6 (below) show the measured twist graphs of the Imported (coloured blue) and Home grown material (coloured red)

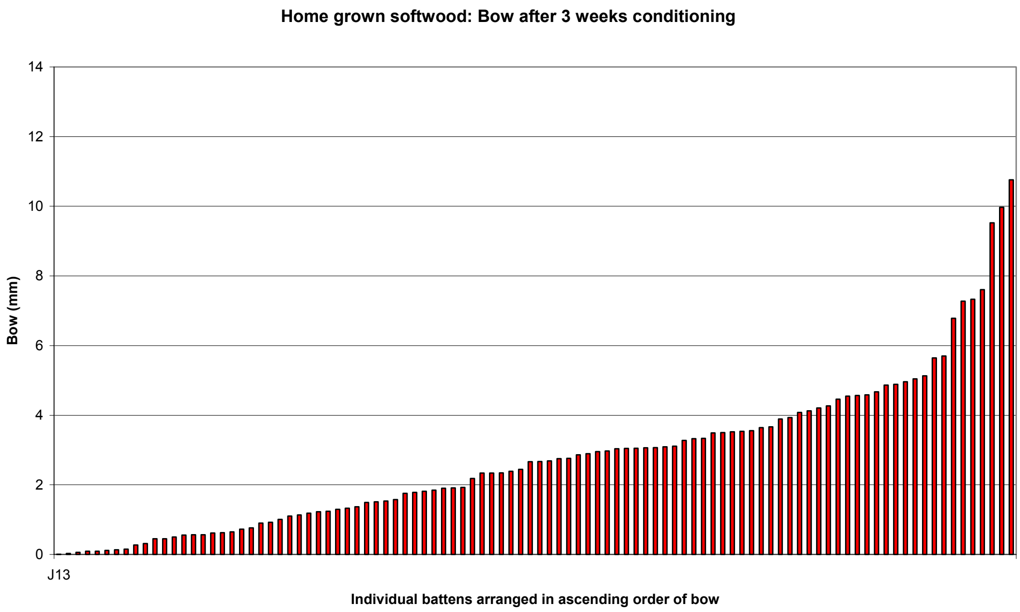




Figures 5 and 6 Comparison of twist at supplied moisture content

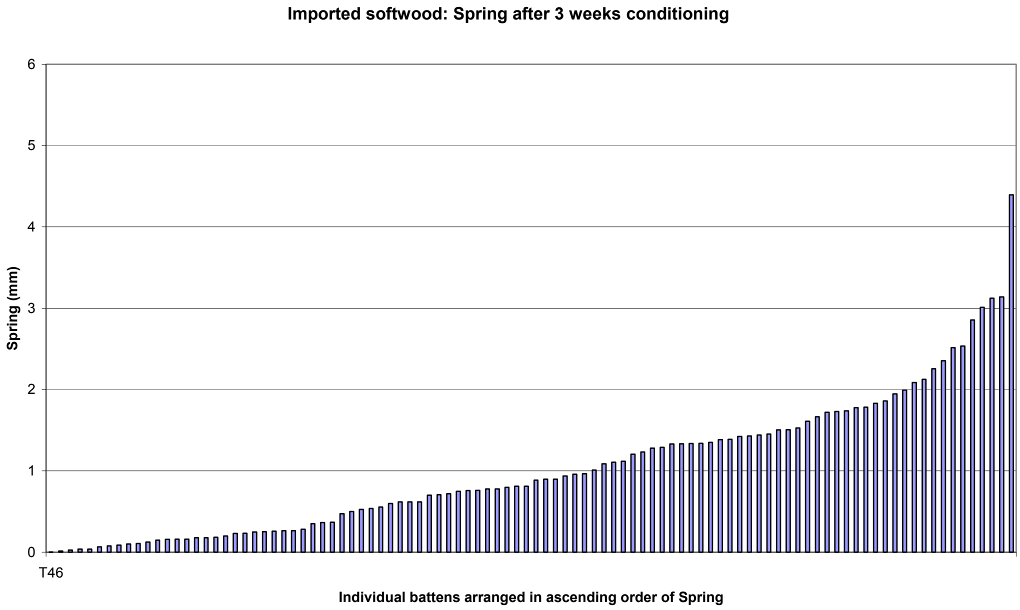
2.4 Distortion after 3 weeks conditioning - Bow. Figures 7 and 8 (below) show the measured bow graphs of the Imported (coloured blue) and Home grown material (coloured red)

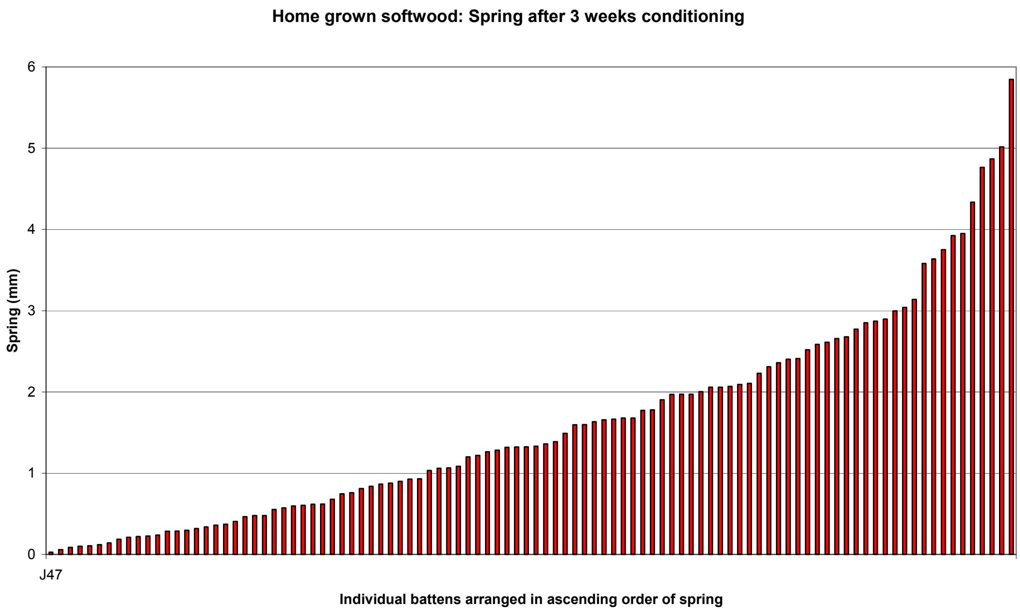




Figures 7 and 8 Comparison of Bow after 3 weeks conditioning

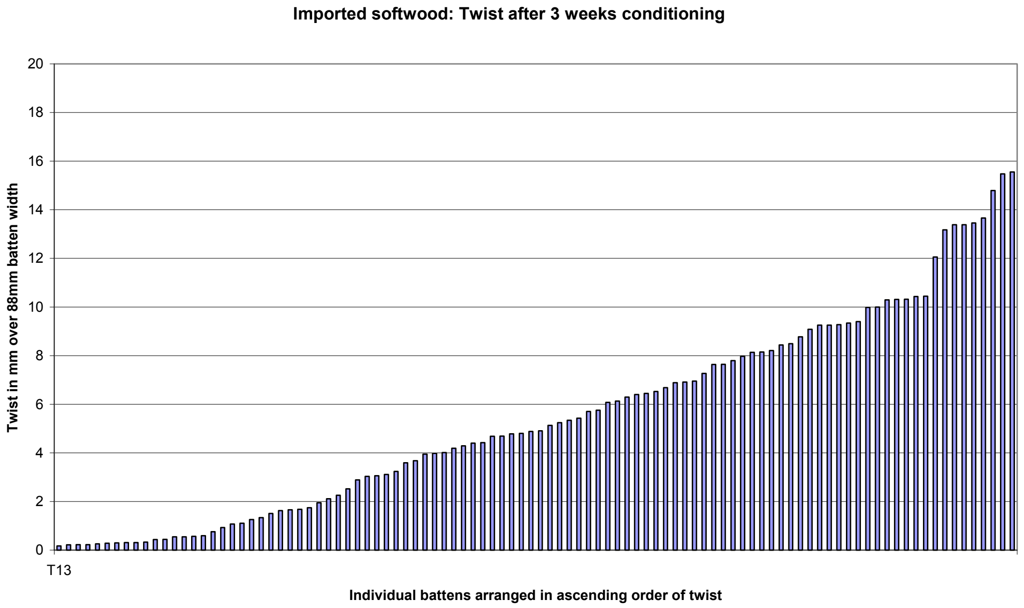
2.5 Distortion after 3 weeks conditioning - Spring. Figures 9 and 10 (below) show the measured spring graphs of the Imported (coloured blue) and Home grown material (coloured red)

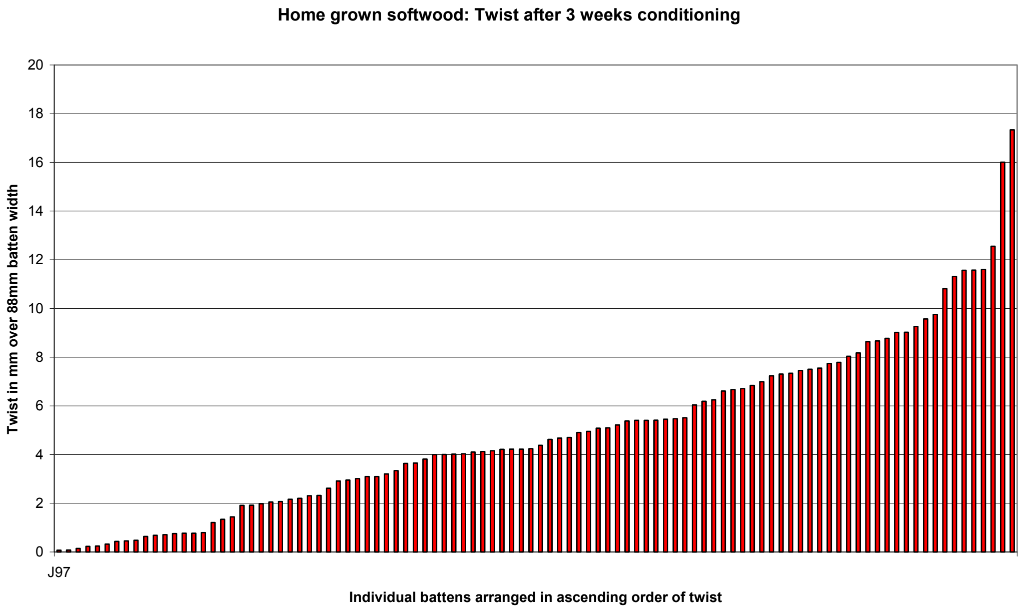




Figures 9 and 10 Comparison of Spring after 3 weeks conditioning

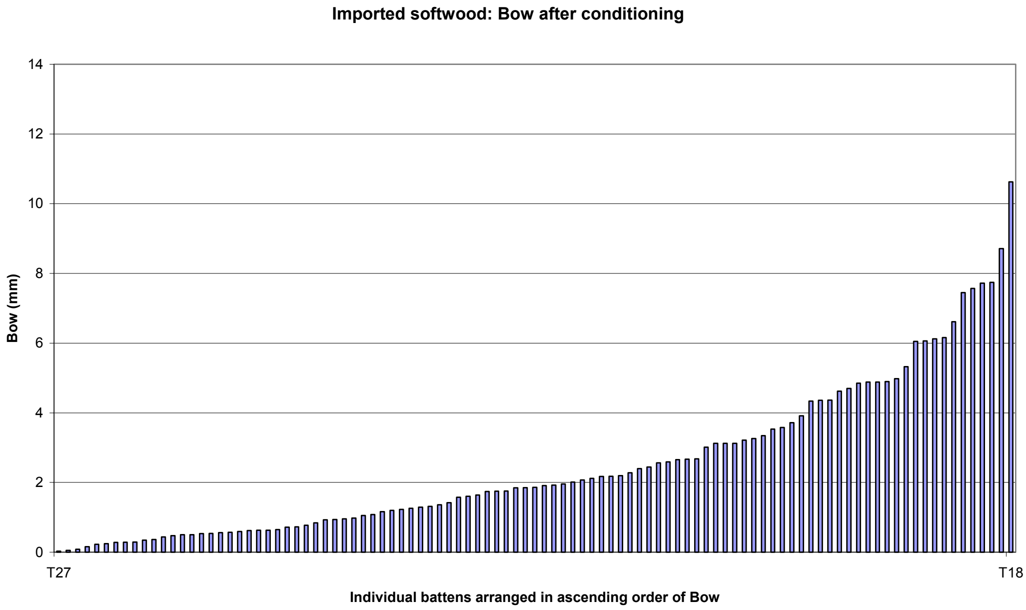
2.6 Distortion after 3 weeks conditioning - Twist. Figures 11 and 12 (below) show the measured bow graphs of the Imported (coloured blue) and Home grown material (coloured red)

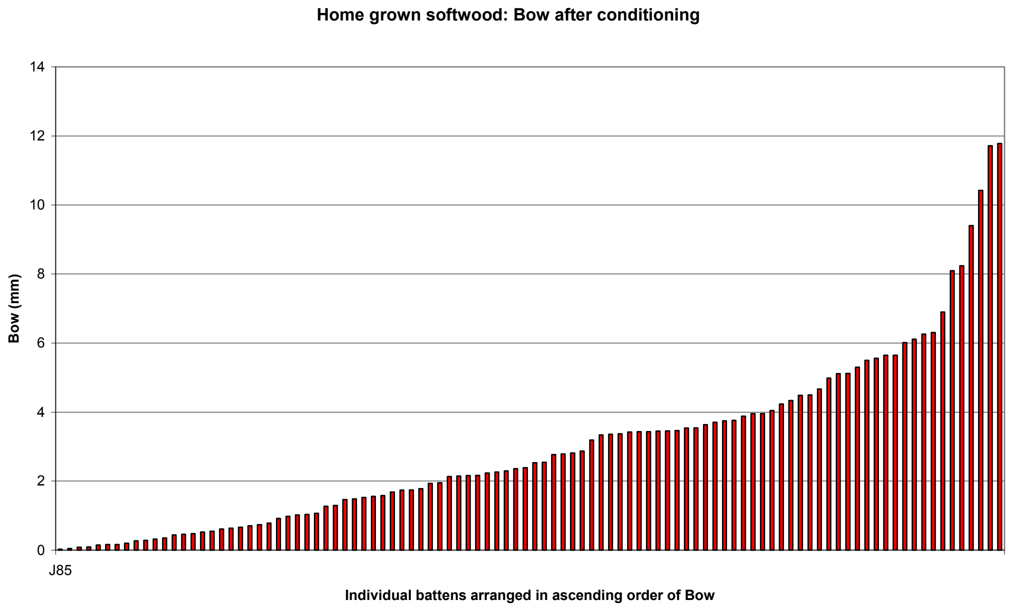




Figures 11 and 12 Comparison of Twist after 3 weeks conditioning

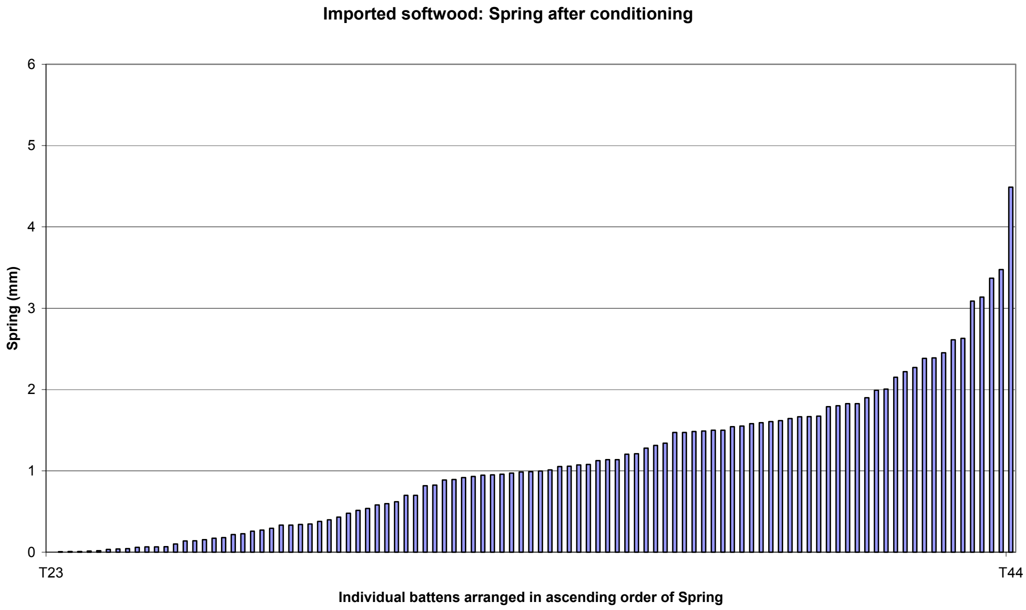
2.7 Distortion after full conditioning - Bow Figures 13 and 14 (below) show the measured bow graphs of the Imported (coloured blue) and Home grown material (coloured red)

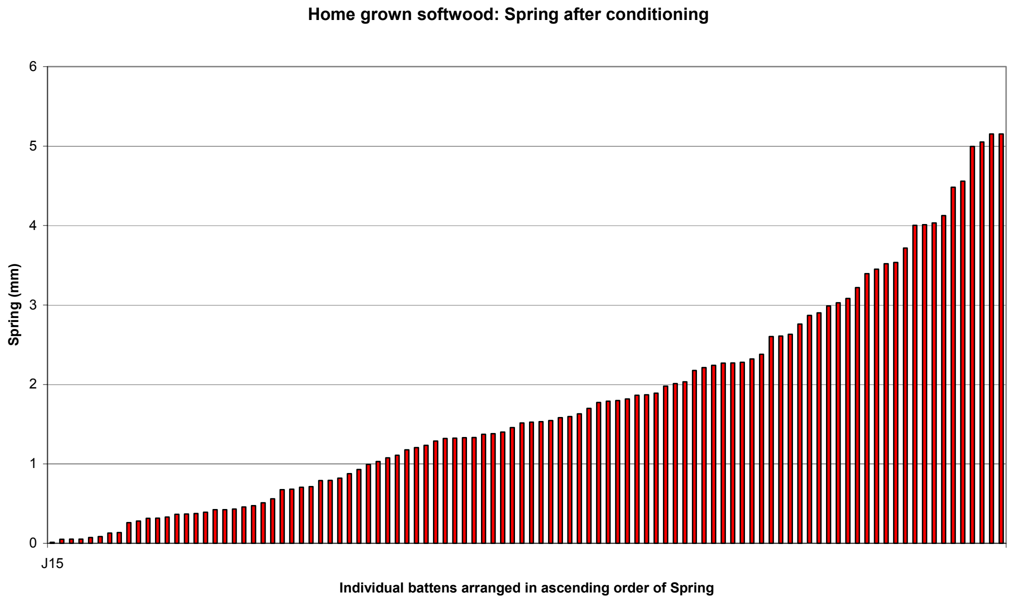




Figures 13 and 14 Comparison of Bow after full conditioning

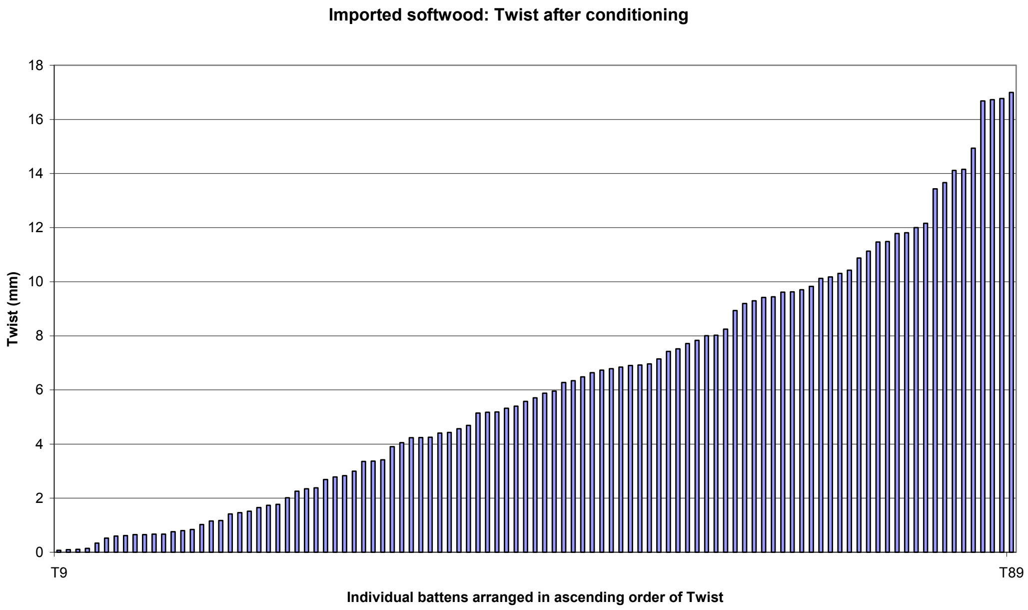
2.8 Distortion after full conditioning - Spring Figures 15 and 16 (below) show the measured spring graphs of the Imported (coloured blue) and Home grown material (coloured red)

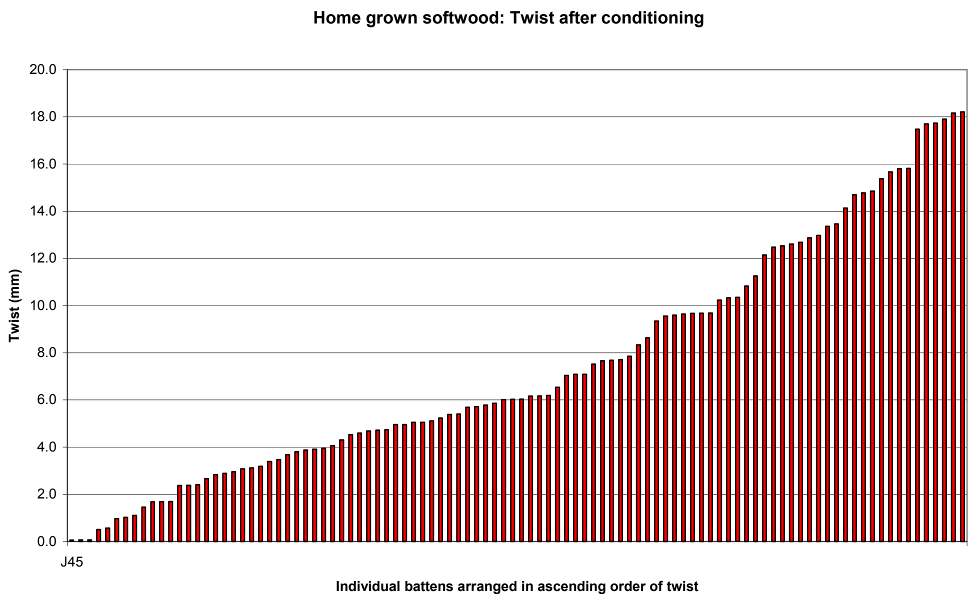




Figures 15 and 16 Comparison of Spring after full conditioning

2.9 Distortion after full conditioning - Twist Figures17 and 18 (below) show the measured twist graphs of the Imported (coloured blue) and Home grown material (coloured red)





Figures 17 and 18 Comparison of Twist after full conditioning

2.10 Distortion Averages

Table 1 (below) shows the average distortion values for both sets of timber

		Average values (mm)				
		Twist	Bow	Spring	Cup	Moisture (%H_2O)
Imported	High m.c.	1.31	1.98	0.7	0.14	22
	Medium m.c.	5.49	2.37	1.03	0.32	16.9
	Low m.c.	6.24	2.53	1.12	0.35	14
Home grown	High m.c.	2.76	1.44	0.81	0.02	22.6
	Medium m.c.	4.97	2.78	1.61	0.32	16.8
	Low m.c.	7.44	2.99	1.75	0.3	14

Table 1: Average Distortion data

The higher bow and spring at conditioned (low) moisture content in the home-grown timber was determined to be caused by the presence of significant levels of compression wood in about 30% of the samples.

3.0 Compression Wood

The home grown samples measured for distortion at the various moisture contents were also visually assessed and put into the following three compression wood categories;

1. No compression wood;
2. Slight compression wood
3. Significant compression wood.

Figures 19, 20 and 21 (below) show bow, spring and twist at low moisture content, arranged into three compression wood categories and ascending order of distortion.

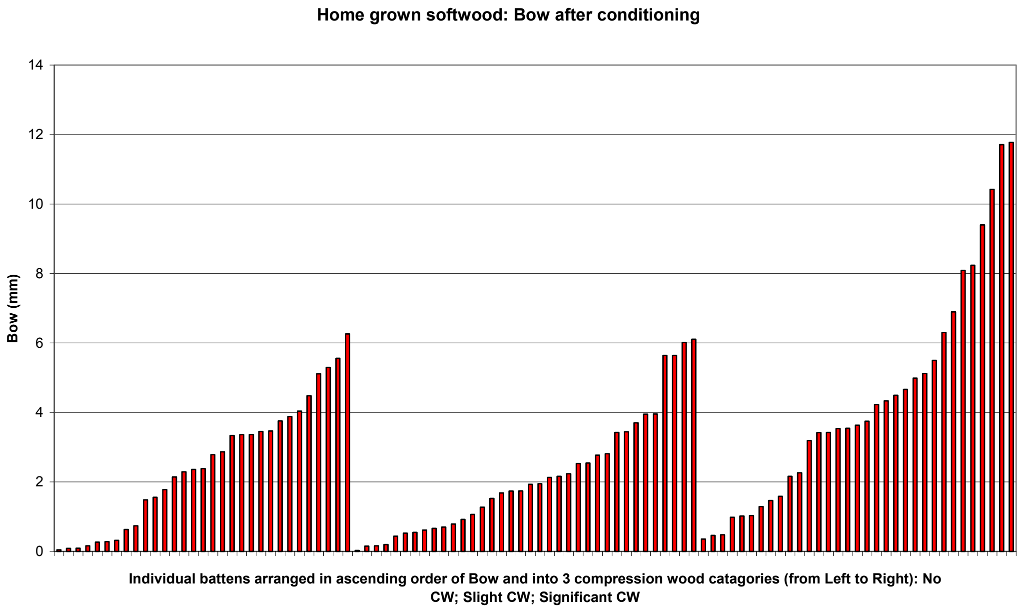


Figure 19: Compression Wood Content and Bow

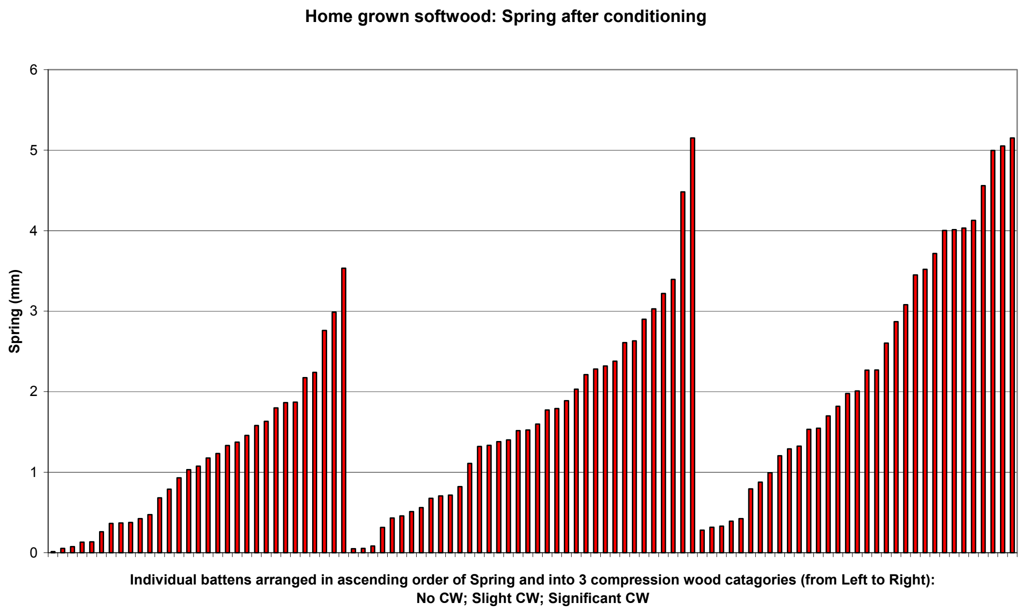


Figure 20: Compression Wood Content and Spring

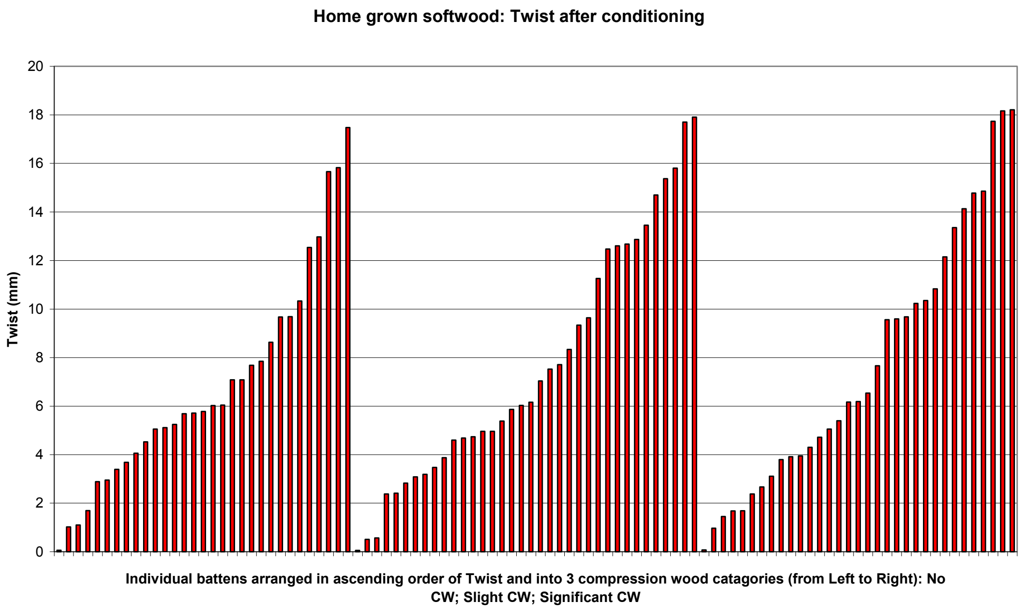


Figure 21: Compression Wood Content and Twist

It is clear that compression wood is the factor in both bow and spring, but not twist as would be expected.

It was not possible to determine with sufficient confidence the compression wood content in the imported timber because of the preservative treatment colouration. However, the levels of bow and spring as shown in graphs 1 to 18 indicate a lower level of compression wood.

4.0 Knot Content

Table 2 (below) summarises the knot measurements and analysis:

	Average Knot area for one face of batten (mm^2)	Area of 1 batten face (2400*88mm) (mm^2)	Knot proportion of 1 batten face (%)	Average No. of Knots per batten	Average Knot size (mm^2)
Imported	1092.88	211200	0.517462121	6.1	184.7295
Home grown	1733.30	211200	0.820691288	8.4	206.3447

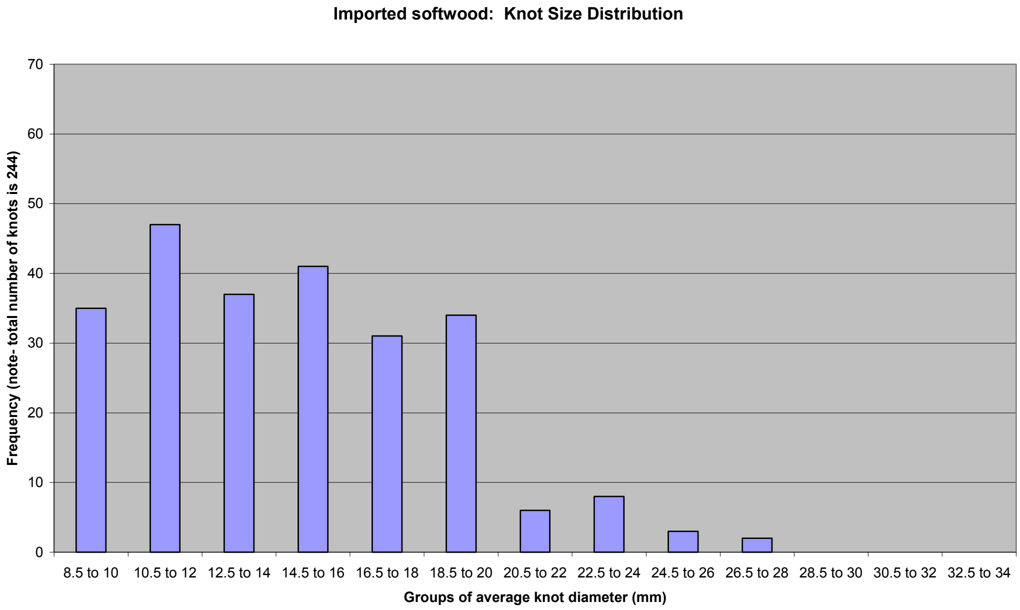
Table 2: Knot data

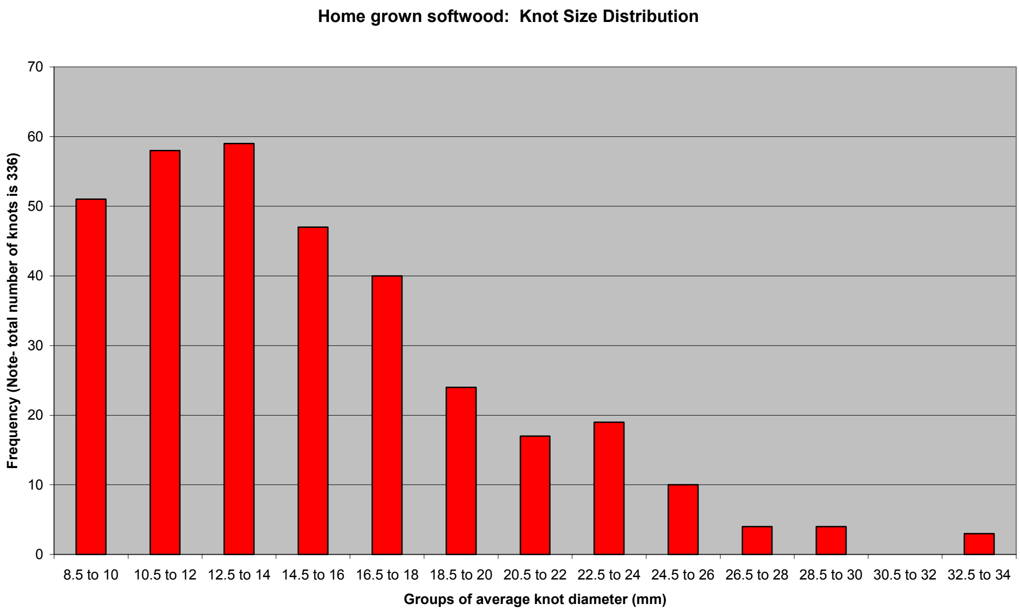
NB/ Only knots with diameter above 10mm are included.

The above results show:

- The proportion of knots in terms of total knot area on one face of the home grown timber was 60% greater than that of the imported material.
- The UK timber contains 38% more knots over 10mm in size than the imported material.
- The average knot size is 12% larger in the home grown timber compared with the imported.

Figures 22 and 23 (below) show the knot size/distribution graphs for both sets of timber:





Figures 22 (top) and 23: Comparison of knot size and frequency

5.0 Compression perpendicular to grain

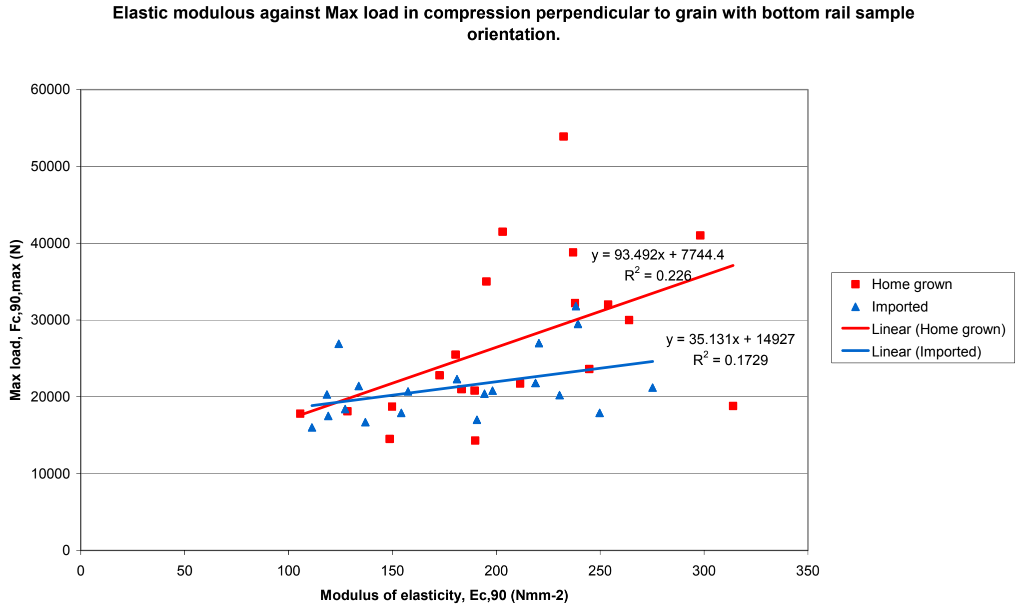
Samples were tested in accordance with BS EN 1193:1998. (ref = 1) The timber samples were selected from the ends of battens at random and samples which contained defects were not deliberately avoided. This was so that the tests were more representative of the compressive loading experienced in a typical timber frame.

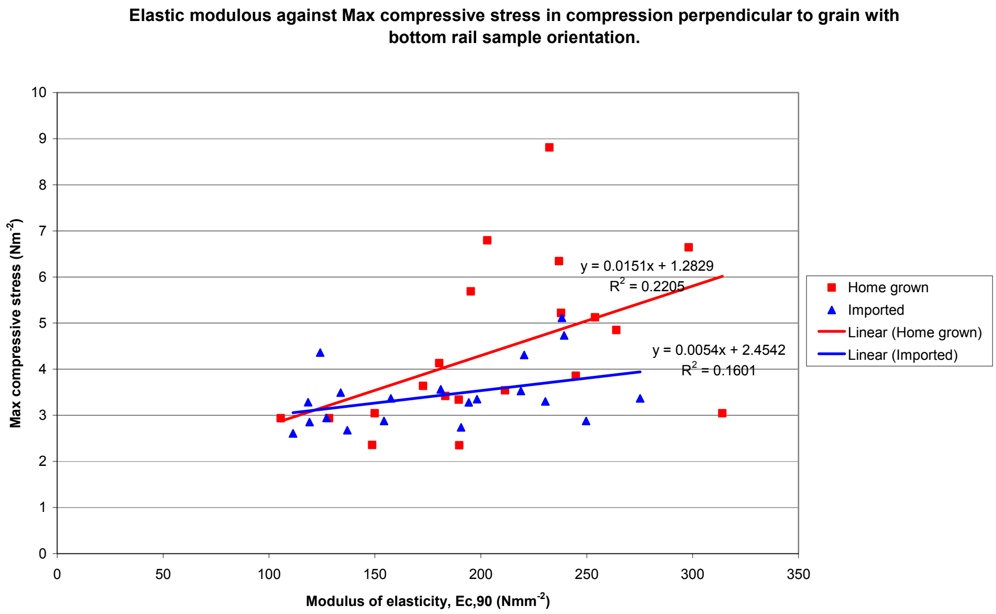
Table 3 (below) details the results in summary form.

Figures 24 and 25 (below) show comparative results of Load v MOE and Compressive stress v MOE, respectively, for both sets of timber.

Sample type	Sample Code	Density (Kgm^{-3})	Moisture content ($H_2O\%$)	Fc,90,max (N)	Ec,90 (N/mm^2)	fc,90 (N/mm^2)
Imported	T98A	454.7	14.47	17900	154.3	2.88
Imported	T42A	447.1	14.68	20800	198.2	3.35
Imported	T22A	686.4	13.58	26900	124.2	4.36
Imported	T10A	463.1	14.66	20400	194.3	3.28
Imported	T68A	476.8	14.98	21400	133.8	3.49
Imported	T81A	494.1	14.39	27000	220.5	4.31
Imported	T19A	594.9	13.45	31800	238.3	5.12
Imported	T94A	450.4	14.58	16700	137	2.68
Imported	T92A	522.1	14.70	17000	190.7	2.74
Imported	T76A	471.4	14.41	20700	157.5	3.36
Imported	T89A	455.9	14.70	18400	127.2	2.95
Imported	T2A	497.1	14.17	17500	119.1	2.85
Imported	T45A	465.7	13.30	29500	239.3	4.73
Imported	T5A	512.6	14.92	21800	218.9	3.53
Imported	T53A	442.8	14.46	22300	181.1	3.56
Imported	T64A	507	13.65	21200	275.2	3.36
Imported	T1A	488.4	15.05	20200	230.5	3.30
Imported	T13A	444.6	14.67	20300	118.5	3.28
Imported	T92B	523.2	14.27	17900	249.7	2.88
Imported	T44A	441.2	14.96	16000	111.3	2.61
Imported	Average	491.98	14.4	21285	180.98	3.43
Home grown	J98A	431	14.65	22800	172.7	3.64
Home grown	J76B	545.5	14.78	41500	203.1	6.79
Home grown	J87A	427.5	14.42	30000	264	4.85
Home grown	J92A	455	14.87	18700	149.9	3.04
Home grown	J25A	617.9	15.14	53900	232.4	8.81
Home grown	J52A	445.7	15.35	25500	180.4	4.13
Home grown	J61A	472.9	14.53	21000	183.3	3.42
Home grown	J53A	365.8	11.29	14500	148.7	2.35
Home grown	J21A	438.3	14.89	21700	211.5	3.54
Home grown	J32B	400.3	14.80	20800	189.6	3.34
Home grown	J74A	478.5	14.73	32000	253.9	5.12
Home grown	J92B	547.8	14.83	41000	298.2	6.64
Home grown	J48A	455.1	14.90	17800	105.6	2.94
Home grown	J50A	542.3	14.35	35000	195.3	5.69
Home grown	J77A	609.6	14.82	38800	237	6.34
Home grown	J30A	458.1	14.53	18800	314	3.04
Home grown	J32A	455	15.67	23600	244.8	3.86
Home grown	J44A	484.2	14.62	32200	237.9	5.22
Home grown	J51CN	385.9	15.00	14300	189.9	2.35
Home grown	J74B	408.4	14.55	18100	128.4	2.94
Home grown	Average	471.24	14.64	27100	207.03	4.4

Table 3: Compression Test Results





Figures 24 (top) and 25: Compression Test Results

The high modulus of elasticity and maximum compressive stress found for the UK spruce is likely to be due to high knot contents. Both sets of samples were conditioned to 14% moisture content.

6.0 On-going work

On the basis of the results obtained some of the originally proposed test details have been changed and rescheduled. Ongoing work is as follows:

- Experimental monitoring of frame distortion (these will be conditioned from supplied moisture content to in service level, in a partially restrained manner)
- Shrinkage tests on small scale specimens is underway (longitudinal, tangential, radial measurements), since this is a better assessment of timber quality, eliminating the problem of the limited number of test panels originally proposed and errors due to bedding in and construction variability.
- A test production trial has been initiated with the timber frame manufacturer, since the difference in knots is the primary problem identified.
- Timber for production trials and possible use in a timber frame house (subject to Stewart Milne's approval) has been dispatched.
- A pack of C16 grade, preservative treated timber (140mm x 38mm) for production trails has been requested to be sent to Stewart Milne for the production of wall panels potentially for house building.

7. Conclusions

Low levels of distortion were present in both imported and home grown timber as supplied, although the home grown timber showed a greater tendency to distort when allowed to dry unrestrained. This was due, in part, to the level of compression wood within the sample batch. However, in a timber frame building distortion will be limited by:

- Restraint afforded by the sheathing board, plasterboard, brickwork outer leaf and noggins
- Studs at panel ends and corners will be fixed back to back with other studs
- Sole plates, headers and footers will be under constant dead load from floor and roof
- Distortion will be limited by the lower change in moisture content from supplied to the expected service condition, in comparison with joists (example).
- The forces arising in distortion will be low because of the small section size and lower section modulus
- In panel production timber will have little time to dry out unrestrained
- Most bow present in supplied timber is caused by poor support (stickering)

Shrinkage tests are on-going. However, in a timber frame building most of the vertical movement comes from cross grain shrinkage in the floor zones and take up of construction slack (Grantham and Enjily, 2003 [ref = 2]), with cross grain shrinkage of sole plates, bottom and top rails contributing much less. Longitudinal shrinkage of studding is negligible. It follows that the shrinkage differential when comparing imported and home-grown stud material is minimal.

The home grown timber showed better performance in compression tests due, in part, to the greater frequency of knots.

The greater frequency and size of the knots in the home grown timber is more likely to cause a problem with nail fouling. However, in another BRE Project (DTi sponsored Pii on “Providing High Quality Timber for the UK Construction Sector”) this problem has effectively been eliminated.

References

1. British Standards Institution BS EN 1193:1998 *Timber structures- Determination of shear strength and mechanical properties perpendicular to the grain*. BSI, London.

2. Grantham, R., Enjily, V. (2003) *Multi-storey Timber Frame Buildings*, BRE Report BR 454, CRC London.