SOUTH WEST FORESTRY FOR FUTURE CONSTRUCTION

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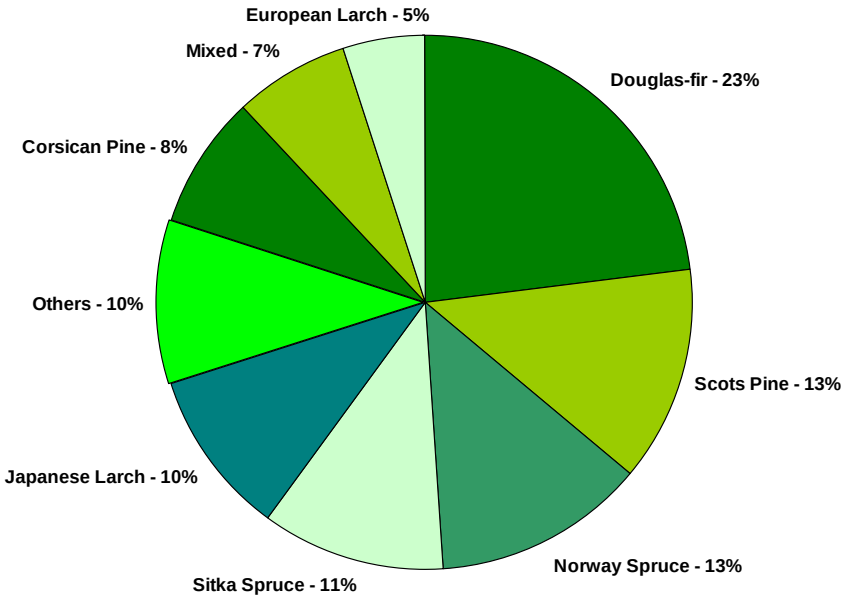
South West forestry

Ownership

Composition of South West conifer forests



Source: Woodland and Forestry Framework Steering Group 2005

Forestry Commission – 16%

Private Ownership – 84%

- Ownership of the South West forestry estate is diverse
- Over 50% of all harvesting in the region in 2008 was conducted by Forest Enterprise
- Douglas-fir is the most abundant conifer species

Source: Forestry Commission 2003

Research aims

“Why can’t I use local timber in my project?”

Lack of knowledge surrounding material quality

Fragmentation of resource

Weak supply chains

Poorly developed market awareness

Under-Achievement

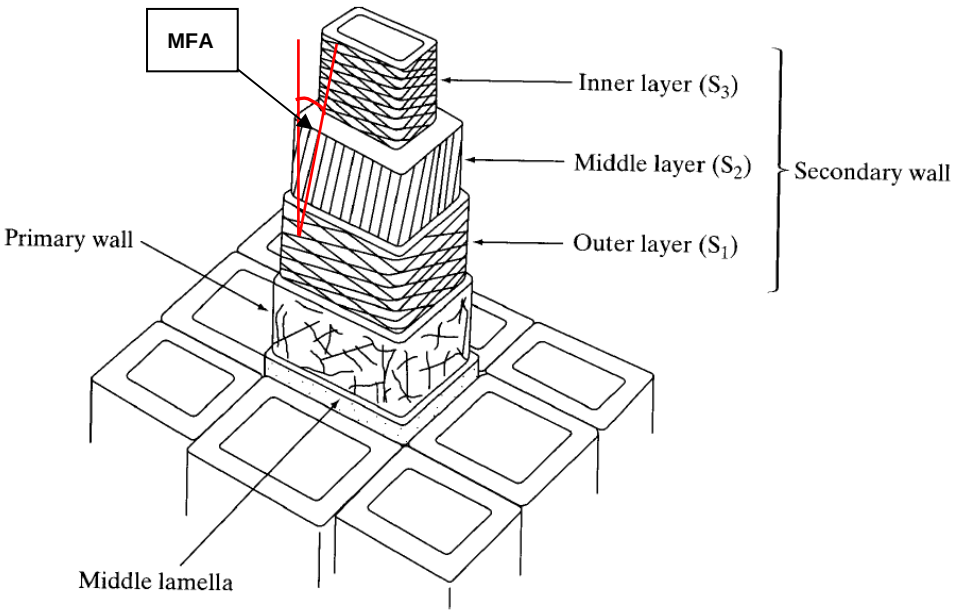
Gain a greater understanding of the factors influencing the variability in structural quality of Douglas-fir grown within the South West of England so that better use may be made of this potentially valuable material

Project objectives

1. The development of empirically derived statistical models for predicting radial and longitudinal variations in anatomical properties and the key mechanical properties of interest to a structural engineer.
2. Establishing the key anatomical drivers for the radial and longitudinal variations observed in mechanical properties within both juvenile and mature wood.
3. An evaluation of the efficiency of BS 4978:2007, the current visual strength grading code for softwood, when being used to grade Douglas-fir.

Anatomic properties to be studied

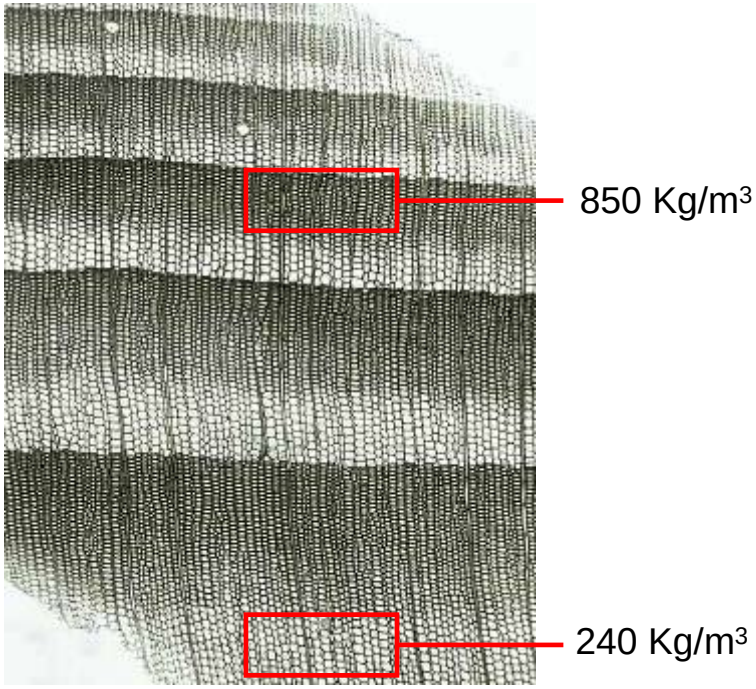
Microfibril angle



Helical angle of cellulose microfibrils in relation to the longitudinal axis of tracheid cells

Source: Dinwoodie (2000)

Density



Density of all oven-dry wood cell wall material approximately 1500 Kg/m^3

Source: www.woodanatomy.ch

Proportions of earlywood and latewood

Mechanical properties to be studied

Quality from a structural engineering perspective:

- Strength (Modulus of Rupture)
- Stiffness (Modulus of Elasticity)

British Standards

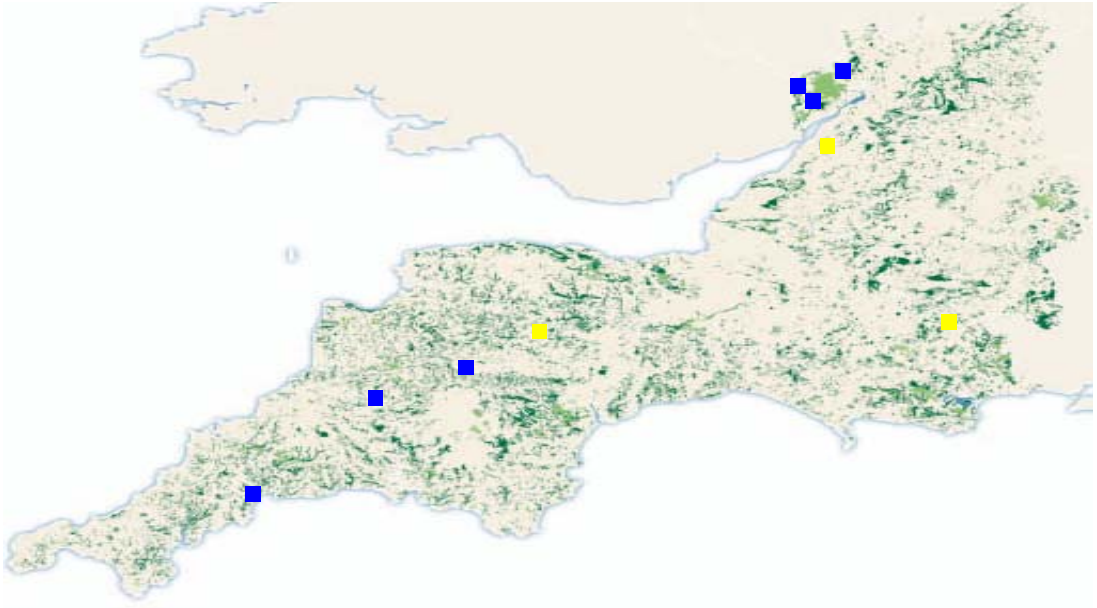
'BS EN 338:2003 Structural timber – Strength classes'

Table 1 — Strength classes - Characteristic values

		Poplar and softwood species												Hardwood species					
		C14	C16	C18	C20	C22	C24	C27	C30	C35	C40	C45	C50	D30	D35	D40	D50	D60	D70
Strength properties (in N/mm²)																			
Bending	$f_{m,k}$	14	16	18	20	22	24	27	30	35	40	45	50	30	35	40	50	60	70
Tension parallel	$f_{t,0,k}$	8	10	11	12	13	14	16	18	21	24	27	30	18	21	24	30	36	42
Tension perpendicular	$f_{t,90,k}$	0,4	0,5	0,5	0,5	0,5	0,5	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6
Compression parallel	$f_{c,0,k}$	16	17	18	19	20	21	22	23	25	26	27	29	23	25	26	29	32	34
Compression perpendicular	$f_{c,90,k}$	2,0	2,2	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3,1	3,2	8,0	8,4	8,8	9,7	10,5	13,5
Shear	$f_{v,k}$	1,7	1,8	2,0	2,2	2,4	2,5	2,8	3,0	3,4	3,8	3,8	3,8	3,0	3,4	3,8	4,6	5,3	6,0
Stiffness properties (in kN/mm²)																			
Mean modulus of elasticity parallel	$E_{0,mean}$	7	8	9	9,5	10	11	11,5	12	13	14	15	16	10	10	11	14	17	20
5% modulus of elasticity parallel	$E_{0,05}$	4,7	5,4	6,0	6,4	6,7	7,4	7,7	8,0	8,7	9,4	10,0	10,7	8,0	8,7	9,4	11,8	14,3	16,8
Mean modulus of elasticity perpendicular	$E_{90,mean}$	0,23	0,27	0,30	0,32	0,33	0,37	0,38	0,40	0,43	0,47	0,50	0,53	0,64	0,69	0,75	0,93	1,13	1,33
Mean shear modulus	G_{mean}	0,44	0,5	0,56	0,59	0,63	0,69	0,72	0,75	0,81	0,88	0,94	1,00	0,60	0,65	0,70	0,88	1,06	1,25

Experimental site selection

50 - 55 Years	70-80 + Years
Typical Forestry Commission rotation length	Longer rotation – potentially higher quality and value



Peninsula
18 trees from 3 sites

Forest of Dean
18 trees from 3 sites

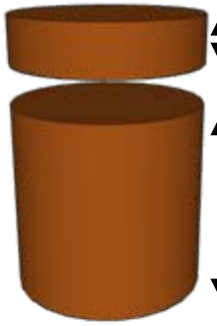
Non Forestry Commission – Number and location tbc

- Initial empirical models are to be developed utilising results obtained from 36 trees extracted from 6 Forestry Commission sites across the South West region – *to date trees have been felled from three sites in the Forest of Dean.*

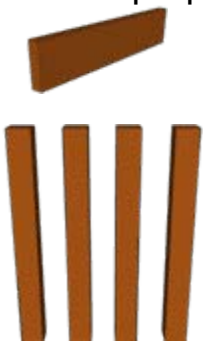
- The ability of these models to predict the properties of older trees outside of the initial sample range will be tested by extracting sample trees from privately owned sites with ages of 70-80 + years.

Experimental methodology

8 m

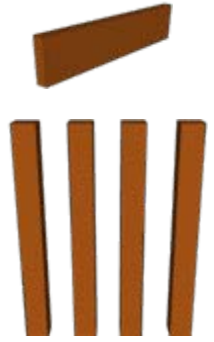


Anatomical properties



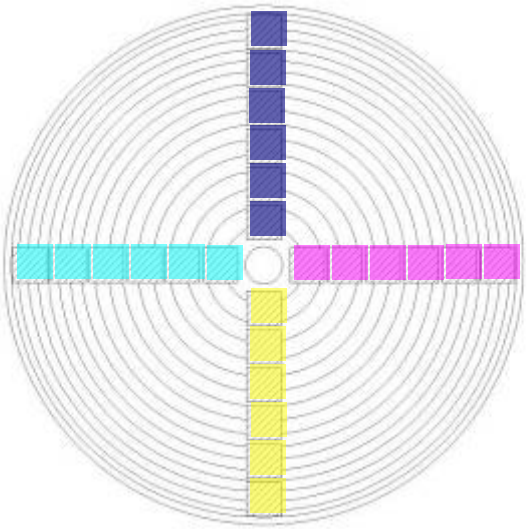
From each test tree two logs and two discs are to be taken for the evaluation of anatomical and mechanical properties

Breast height



Strength and stiffness

Mapping variation in strength and stiffness



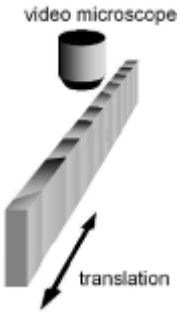
BS 373: 1957 ‘Testing of Small Clear Specimens’

Mapping variation in anatomical properties – Silviscan

Forest Research

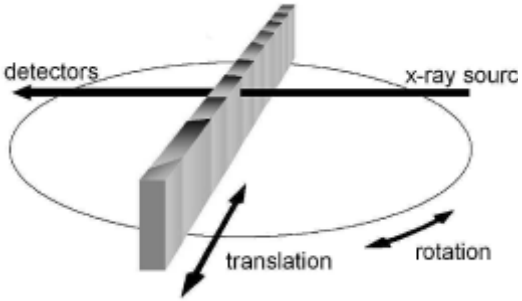
Source: www.ensisjv.com

Optical Imaging



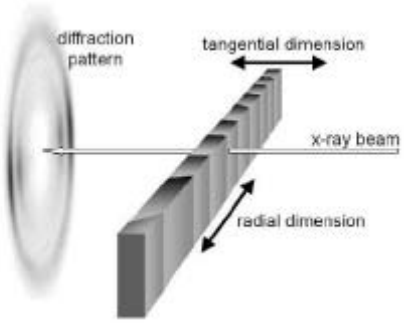
Ring width, earlywood and latewood proportions

X-ray densitometry



Density

X-ray diffractometry



Microfibril angle

- Variations in ring width, early/-latewood proportions, density and microfibril angle are to be assed with the use of the Siliviscan-3 system at the Innventia AB laboratory, Stockholm.
- Results from the analysis are presented in the form of values at a given radius from the pith and the average for growth rings and early-/latewood bands.
- **Statistical models are to be developed with the use of correlation and path analysis**

Visual strength grading

A review of UK species / grades and strength class has demonstrated that there are anomalies that need to be addressed to allow UK species to better compete against imports.

200, 4000 mm x 200 mm x 47 mm, Douglas-fir sections are to be obtained from the European project ‘Grading of timber for engineered wood products’

All sections are to be visually graded by a certified visual timber grader

When visually grading timber sections the key criteria assessed are:

- Knots
- Slope of grain
- Ring widths

This research hypothesises that measuring latewood width rather than ring width is a more efficient visual grading technique

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