SIRT

Strategic Integrated Research in Timber

Edinburgh Napier UNIVERSITY

Bringing new species to the market place

EFIATLANTIC IEFC Forestry Commission Scotland Coimisean na Coilltearachd Alba Forest Research

Dan Ridley-Ellis

Centre for Wood Science and Technology

EFIATLANTIC AND IEFC ANNUAL MEETING

The Role of Alternative Tree Species in the Forests of Atlantic Europe

The Queen's Anniversary Prizes
For Higher and Further Education
2015

What is wood quality?

- Wood quality depends on the application
- Most important thing is to have knowledge

- Focus on density is misleading
- Species is not everything
  (to some it does not matter *at all*)

Density
– not always a good thing

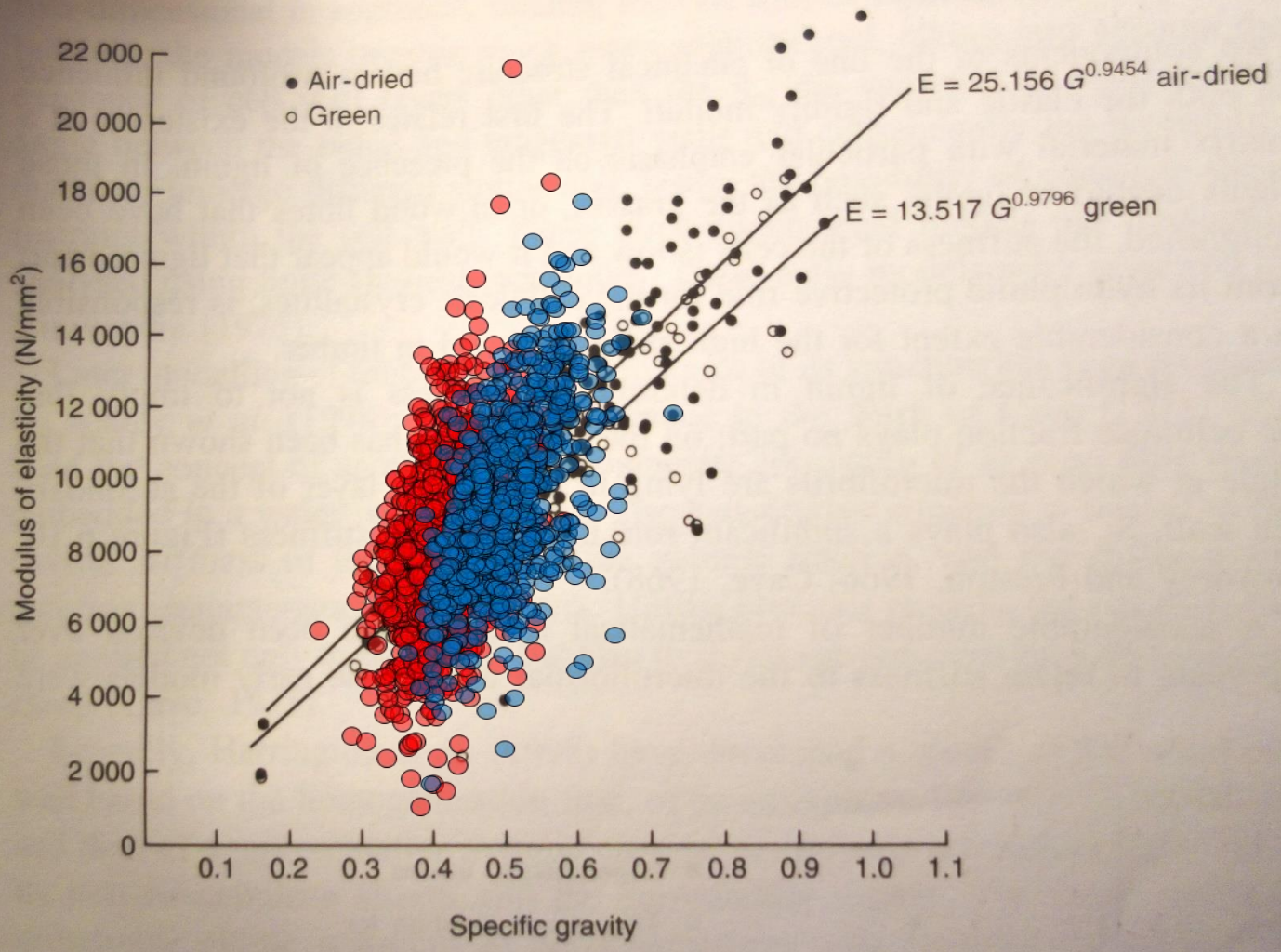

Figure 6.9 Effect of specific gravity on the longitudinal modulus of elasticity for over

Sources of the variation in the UK Sitka resource

Source	Density	Strength	Stiffness
Between sites	23%	18%	26%
Between trees on a site	51%	25%	36%
Between logs in a tree	2%	5%	2%
Within log	25%	52%	35%

Moore, J. R., Lyon, A. J., Searles, G. J., Lehneke, S. A., Ridley-Ellis, D. J. Within- and between-stand variation in selected properties of Sitka spruce sawn timber in the United Kingdom: implications for segregation and grade recovery. Annals of Forest Science (February 2013) DOI 10.1007/s13595-013-0275-y

Variation in the UK Sitka resource

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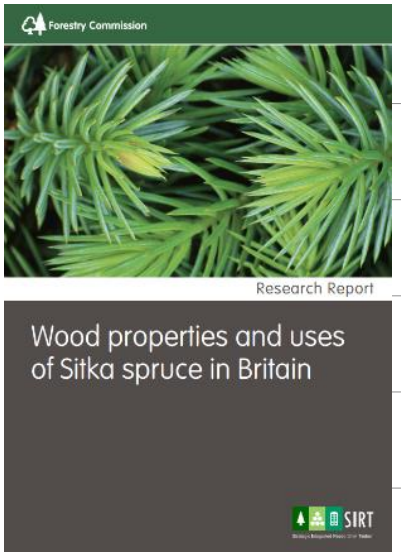


Stand averages of tree measurements with IML hammer

"< 7"

"7 to 9"

"> 9"

C14

C16

C18

C24

ID339
ID285
ID23
ID5313
ID449
ID2946
ID2792
ID412
ID5544
ID157
ID250
ID85
C14
C16
C18
C24

2 4 6 8 10 12 14 16 18

Modulus of Elasticity (kN/mm²)

Back to new species…

- Perhaps the biggest challenge is overcoming what people think is possible with wood

- Perhaps the biggest problem is junk and/or unverified knowledge
(both negative and positive)

Some things that matter to processors

- Is it Sitka?
- Log diameter, length, curvature and taper
- Fluting
- Debarking issues
- Drought crack and similar
- Other cutting problems (growth stresses, resin, blunting etc)
- Drying issues
- Ease of treatment

Some things that matter to markets (1/2)

- Price
- Price
- Volume and continuity of supply
- Available sizes (cross-sections and lengths)

- Properties and performance
  - Knowledge / predictability of
  - Variation in
  - Consistency of

Some things that matter to markets (2/2)

- Price
- Knots
  - Number, size, distribution, appearance, live/dead/sound
- Generic market categories (e.g. C16)
- COSHH
- VOCs
- Maybe…is it local?

Properties and performance

- Strength (bending, tension, shear, perp to grain, fracture etc…)
- Stiffness
- Density (fasteners, charring rate, self-weight, calorific value…)
- Dimensional stability / distortion
- Durability
- Colour and colour change
- Creep
- Finishing, gluing, painting etc

What are new species anyway?

- Species for which we have little experience generally (includes species we already have in abundance, but don't use)
- Species for which we have some experience – but where the timber is grown elsewhere
- Species for which we have some experience, grown in the UK, but haven't used for a while
- Our usual species – but in the future

What might not be the same as same species grown elsewhere

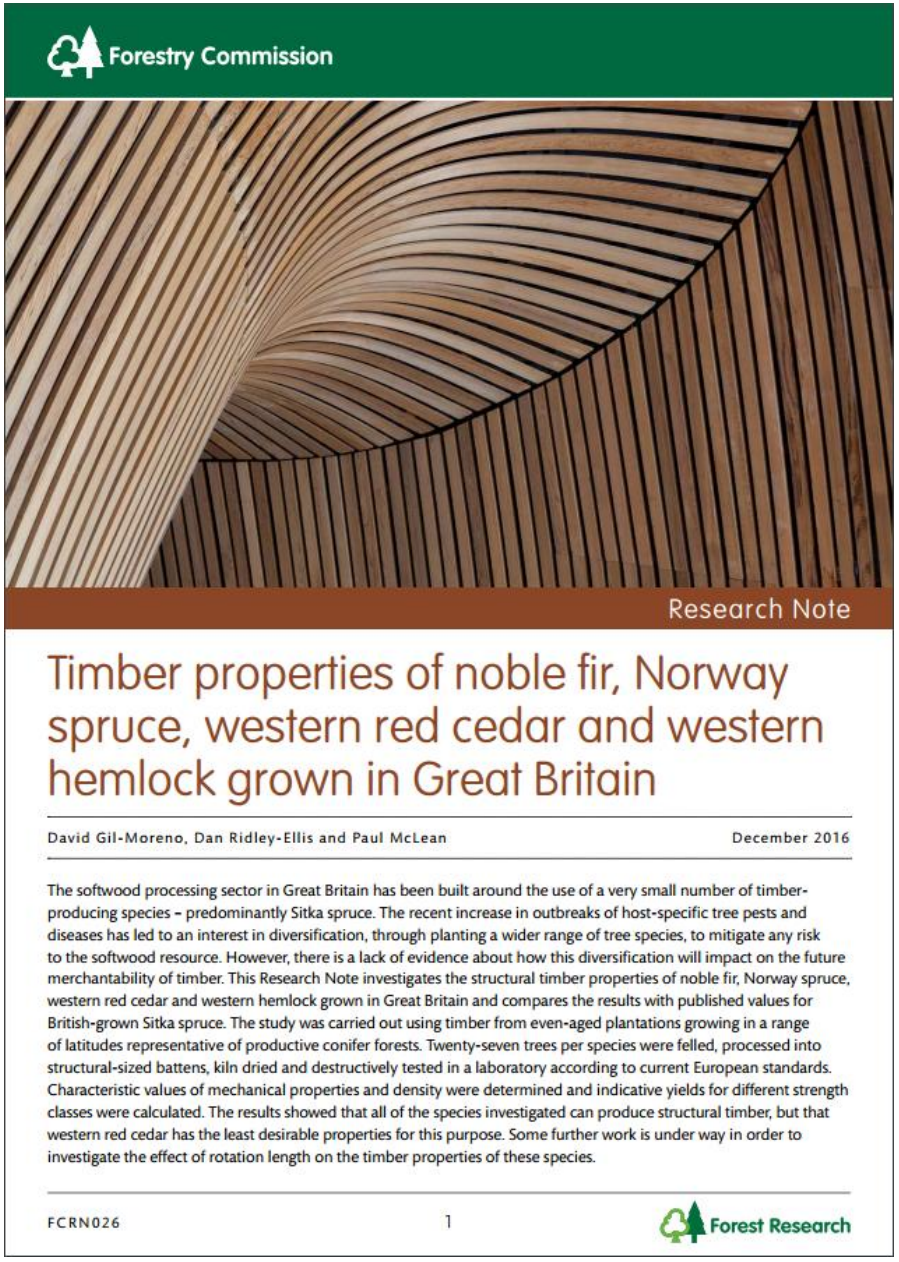
- Density
- Strength
- Stiffness
- Knottiness (and appearance)
- Durability
- Drying distortion
- Reaction wood, splitting
- Log sizes and form

"Sitka"

- **"British spruce" WPCS**

- Sitka spruce (*Picea sitchensis*) (PCST)
- Norway spruce (*Picea abies*) (PCAB)
- Typically graded C16/reject
  - But does contain potential for higher grades

- Maybe other species can be added?
  (doesn't need to be spruce, just needs to be similar enough)



Forestry Commission

Research Note

Timber properties of noble fir, Norway spruce, western red cedar and western hemlock grown in Great Britain

David Gil-Moreno, Dan Ridley-Ellis and Paul McLean

December 2016

The softwood processing sector in Great Britain has been built around the use of a very small number of timber-producing species – predominantly Sitka spruce. The recent increase in outbreaks of host-specific tree pests and diseases has led to an interest in diversification, through planting a wider range of tree species, to mitigate any risk to the softwood resource. However, there is a lack of evidence about how this diversification will impact on the future merchantability of timber. This Research Note investigates the structural timber properties of noble fir, Norway spruce, western red cedar and western hemlock grown in Great Britain and compares the results with published values for British-grown Sitka spruce. The study was carried out using timber from even-aged plantations growing in a range of latitudes representative of productive conifer forests. Twenty-seven trees per species were felled, processed into structural-sized battens, kiln dried and destructively tested in a laboratory according to current European standards. Characteristic values of mechanical properties and density were determined and indicative yields for different strength classes were calculated. The results showed that all of the species investigated can produce structural timber, but that western red cedar has the least desirable properties for this purpose. Some further work is under way in order to investigate the effect of rotation length on the timber properties of these species.

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Table 4 Indicative yields achieved for species with a rotation length restricted to a maximum of 45 years. Published values for Sitka spruce (Moore *et al.*, 2013) are included for comparative purposes.

	C14	C16	C18	C20	C22	C24
Sitka spruce	100%	100%	92%	75%	58%	29%
Norway spruce	100%	100%	98%	81%	62%	30%
Western hemlock	100%	100%	95%	81%	67%	40%
Noble fir	100%	96%	77%	62%	49%	30%
Western red cedar	100%	94%	56%	38%	25%	11%

N.B. These figures represent potential yields for any of the species, in the real world grading yields are variable even for one species.

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PhD of David Gil-Moreno

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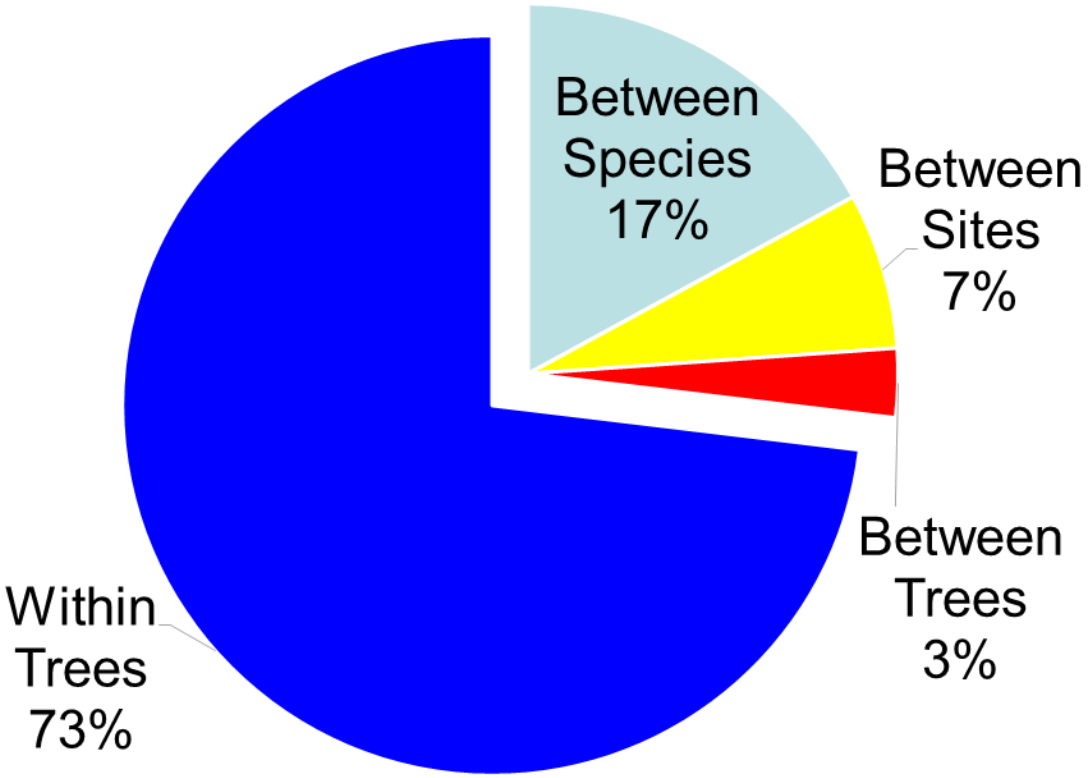
Norway spruce
Western hemlock
Noble fir
Western red cedar



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“Pine”

- **“British pine” WPNN**

Species codes in
EN 13556
EN 14081-1

- Scots pine (*Pinus sylvestris*) (PNSY)
  - Blue stain
  - Dead knots

- Austrian pine (*Pinus nigra*) (PNNN)
- Corsican pine (*Pinus nigra laricio*) (PNNL)?

“Larch”

- **“Larch” WLAD**
- Hybrid larch (*Larix x eurolepis*) (LAER)
- Japanese larch (*Larix kaempferi*) (LAKM)
- European larch (*Larix decidua*) (LADC)

- Durability
- But heavy
- Reputation for distortion, splitting

Douglas-fir

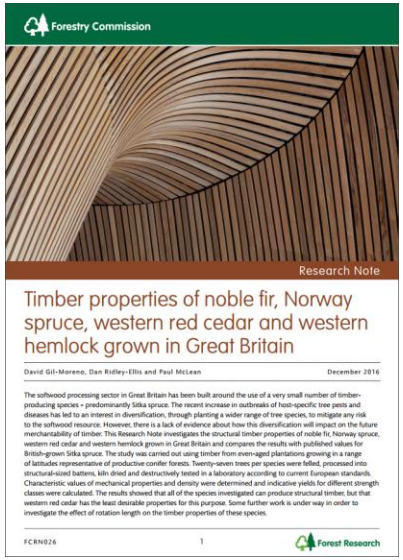
- Douglas fir (*Pseudotsuga menziesii*) (PSMN)

- Has visual grading assignments
- Grading settings coming…

- Used as imported construction timber, in combination with Western larch (*Larix occidentalis*) (WPSM)

Up coming…

- Noble fir (*Abies procera*) (ABPR)
- Western hemlock (*Tsuga heterophylla*) (TSHT)
- Western red cedar (*Thuja plicata*) (THPL)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Noble fir and western hemlock are included in the “Hem-fir” combination (WABA)

On the list

- European silver fir (*Abies alba*) (ABAL)
  - in European spruce and fir whitewood (WPCA)

- Pacific silver fir (aka amabilis fir) (*Abies amabilis*) (ABAM)
- Grand fir (*Abies grandis*) (ABGR)
  - Also in “Hem-fir” mix (WABA)

On the list

- Japanese incense cedar (aka sugi / Japanese red cedar) (*Cryptomeria Japonica*) (CYJP)

- Serbian spruce (*Picea omorika*)

Not forgetting hardwoods

- Sycamore (*Acer pseudoplatanus*) (ACPS)
- Birch (*Betula pendula/pubescens*) (BTXX)

Meanwhile elsewhere…

- Sweet chestnut (*Castanea sativa*) (CTST)
  - France, Spain, Italy
- European beech (*Fagus sylvatica*) (FASY)
  - France, Belgium


Based on testing
EN 408
EN 384
EN 14358

Routes for structural timber

- Routes for CE marking
  - Visual grading
    - No minimum requirement, but need some 200-400 pieces
  - Machine grading (machine control)
    - If machine already used, requires 450 pieces (ideally 1000)
  - Machine grading (output control)
    - Requires continuous testing, not suited to small volumes
- Expensive…requires lots of timber

Bypassing CE marking

- One off buildings
- Within a manufacturing process

- …but still need to be safe

- And convince an engineer

Declaration of performance usually via

Strength classes (or "grades")

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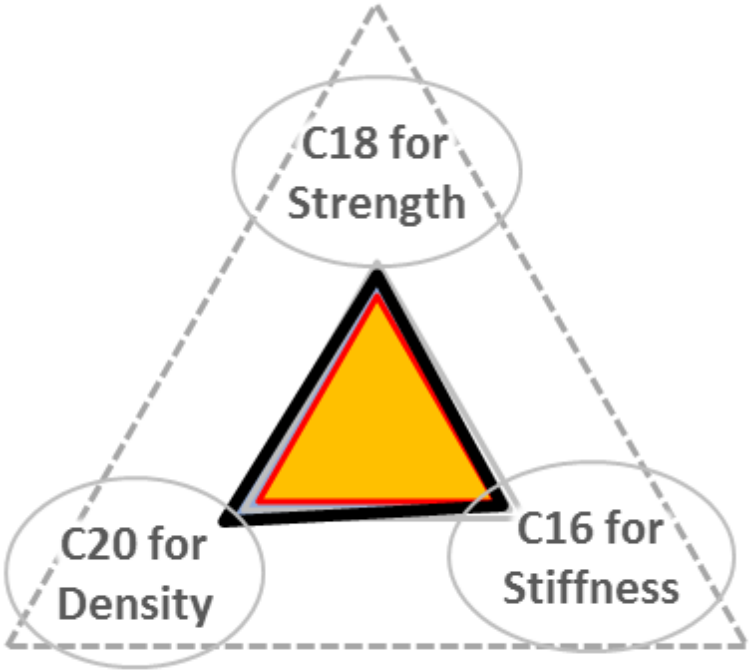
e.g. EN 338:2016

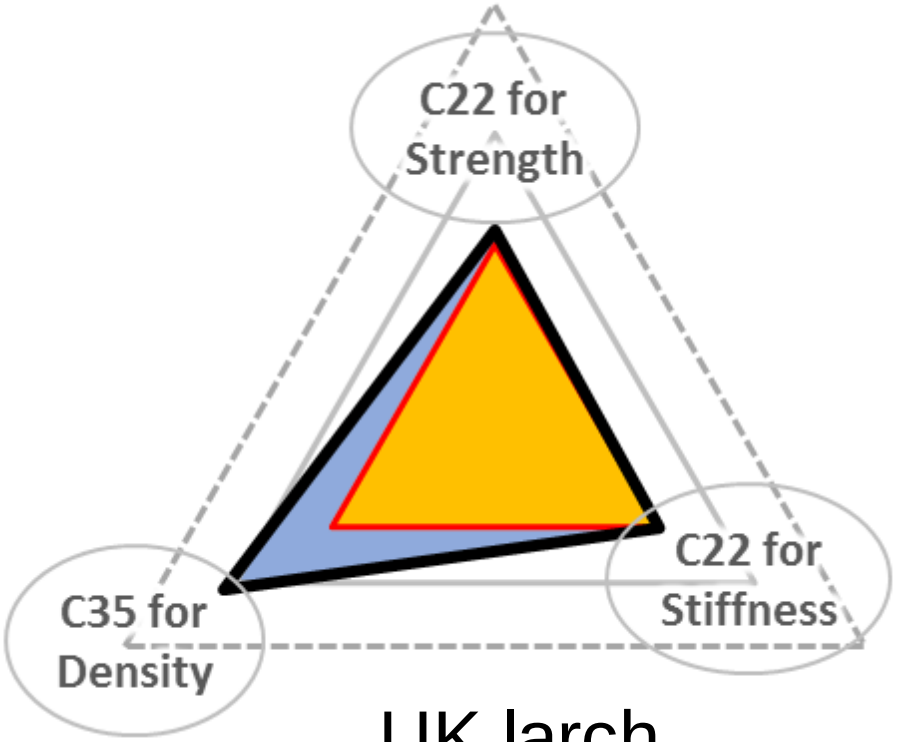
	Class	C14	C16	C18	C20	C22	C24	C27	
Strength properties in N/mm²									
Bending	$f_{m,,k}$	14	**16**	**18**	20	22	**24**	27	
Tension parallel	$f_{t,0,k}$	7,2	**8,5**	**10**	11,5	13	**14,5**	16,5	
Tension perpendicular	$f_{t,90,k}$	0,4	**0,4**	**0,4**	0,4	0,4	**0,4**	0,4	**0**
Compression parallel	$f_{c,0,k}$	16	**17**	**18**	19	20	**21**	22	**24**
Compression perpendicular	$f_{c,90,k}$	2,0	**2,2**	**2,2**	2,3	2,4	**2,5**	2,5	**2,7**
Shear	$f_{v,k}$	3,0	**3,2**	**3,4**	3,6	3,8	**4,0**	4,0	**4,(**
Stiffness properties in kN/mm²									
Mean modulus of elasticity parallel bending	$E_{m,0,mean}$	7,0	**8,0**	**9,0**	9,5	10,0	**11,0**	11,5	**1**
5 percentile modulus of elasticity parallel bending	$E_{m,0,k}$	4,7	**5,4**	**6,0**	6,4	6,7	**7,4**	7,7	
Mean modulus of elasticity perpendicular	$E_{m,90,mean}$	0,23	**0,27**	**0,30**	0,32	0,33	**0,37**	0,38	
Mean shear modulus	G_{mean}	0,44	**0,50**	**0,56**	0,59	0,63	**0,69**	0,72	
Density in kg/m³									
5 percentile density	ρ_k	290	**310**	**320**	330	340	**350**	36	
Mean density	ρ_{mean}	350	**370**	**380**	400	410	**420**	4.	

Commodity strength classes



British spruce (WPCS)

“C16+”



UK larch (WLAD)

Example, UK larch with MTG

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The Brookhuis MTG is a resonance type machine

User defined strength classes for home grown timber (can be graded with Brookhuis MTG960)

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Option 1 – approximately ¼ & ¾

C24	Strength > C24 Stiffness = C24 Density > C27	NapierSA	**British spruce** Sitka spruce (*Picea sitchensis*) Norway spruce (*Picea abies*) GB & IE
C16	Strength = C16 Stiffness = C16 Density = C18	NapierSC	
C30	Strength = C30 Stiffness = C35 Density > C50	NapierLA	**UK larch** European larch (*Larix decidua*) Hybrid larch (*Larix x eurolepsis*) Japanese larch (*Larix kaempferi*) GB
C18	Strength > C20 Stiffness = C18 Density = C40	NapierLC	

Option 2 – approximately ½ & ½

NapierSB	Strength = C22 Stiffness = C22 Density = C27	C22
NapierSD	Strength > C14 Stiffness = C14 Density = C16	C14
NapierLB	Strength > C27 Stiffness = C30 Density > C50	C27
NapierLD	Strength = C20 Stiffness = C16 Density = C35	C16

For information contact Dan Ridley-Ellis, Centre for Wood Science & Technology d.ridleyellis@napier.ac.uk http://blogs.napier.ac.uk/cwst/

What is going on to help?

- Opened up “softwood” C strength classes to allow hardwoods to be graded into them

- Need to better use recycled wood
- Revision of machine grading standards

- Move to offsite manufacturing, combined with new grading technology

What is not going on to help?

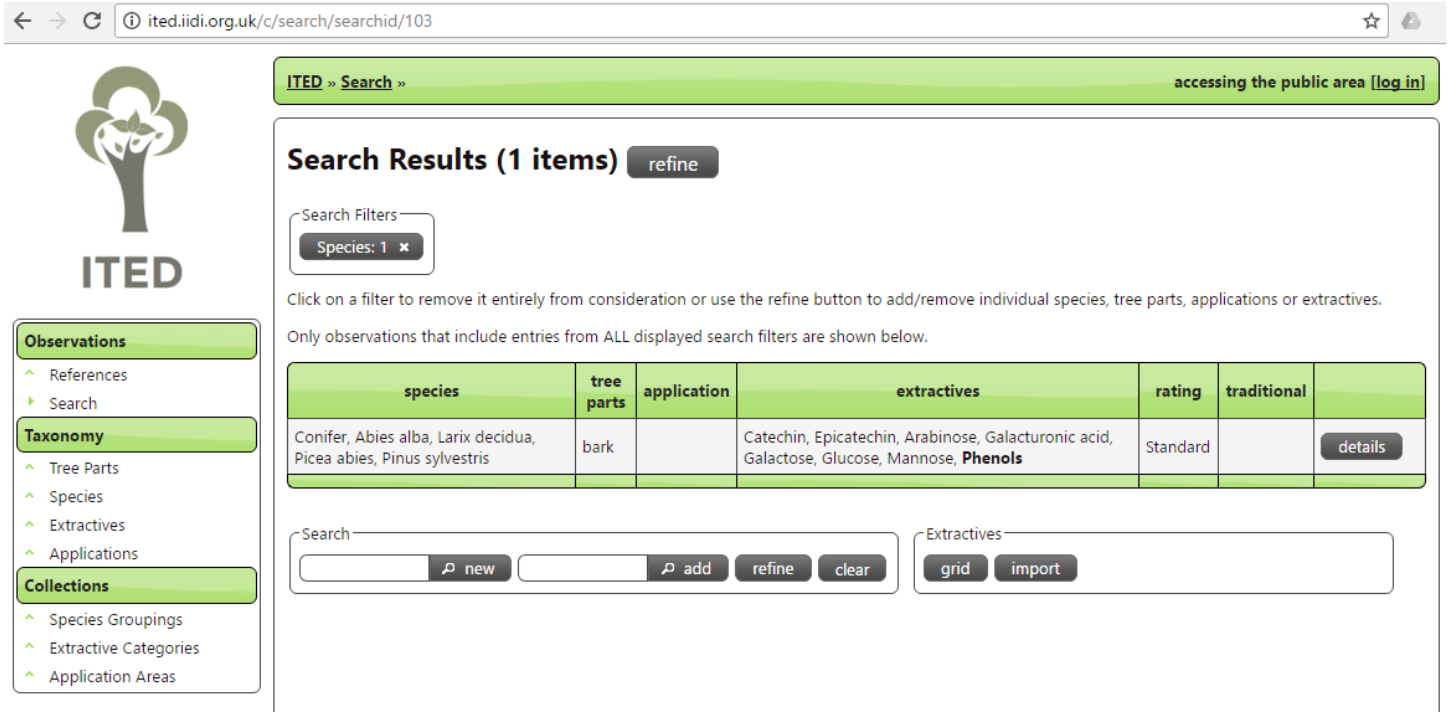
- Standardisation demanding more and more test information
- Unfamiliarity of engineers with wood
- Habitual specification of the usual species
- Over specification of grade

Other markets

- Panel products
- Modified wood
  - Thermal modification
  - Chemical modification
- Bioenergy

Other markets

- Biorefinery
  - Extractives
  - http://ited.iidi.org.uk/



Finally: it's what you do with it

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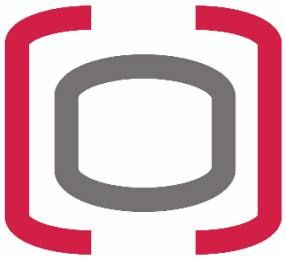

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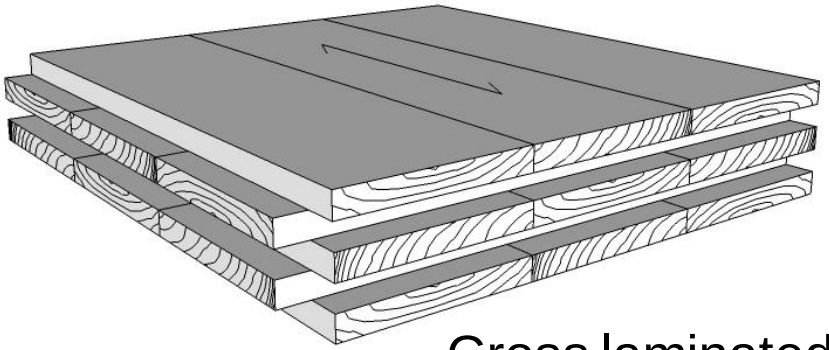
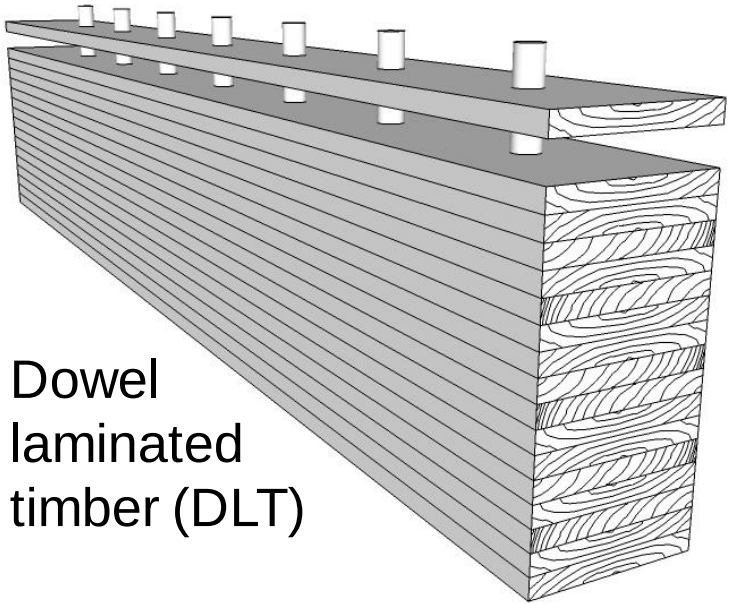
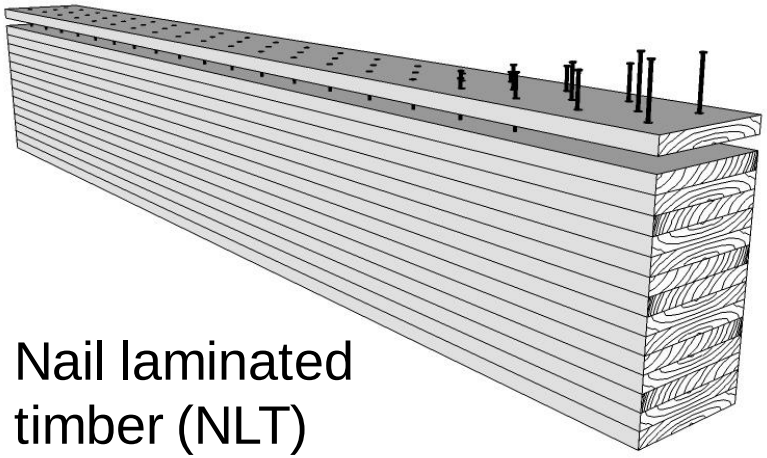
Laminated products



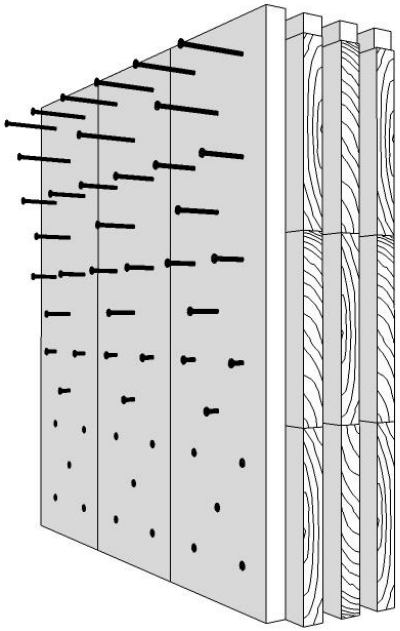
Cross laminated timber (CLT)



Dowel laminated timber (DLT)



Nail laminated timber (NLT)



Nailed cross laminated timber (nCLT)

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Dowel laminated timber (DLT)

Nailed cross laminated timber (nCLT)

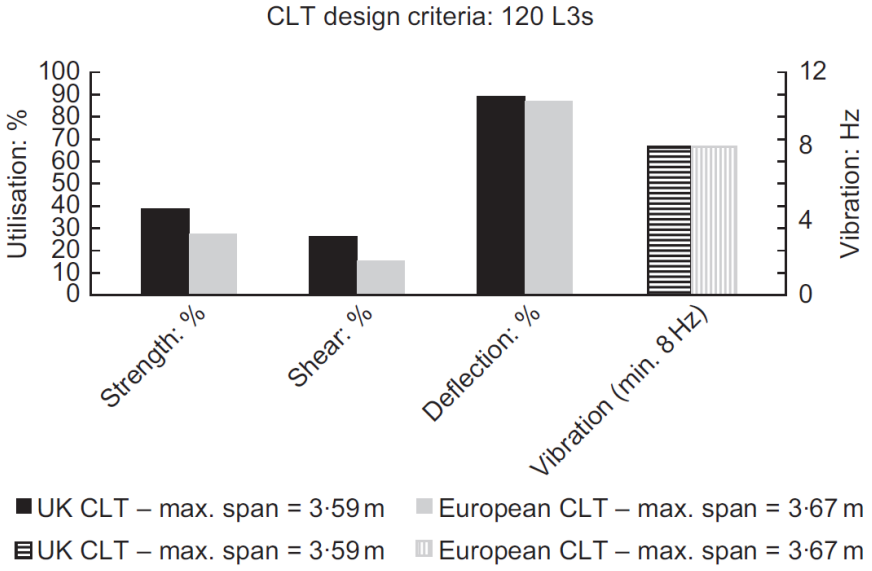
Cross laminated timber (CLT)

Journal:

- Crawford, D., Hairstans, R., Smith, S. & Papastavrou, P. (2015) "UK Cross-Laminated Timber (CLT): Market Assessment, Resource Compatibility and Structural Performance" ICE Construction Materials Volume 168, Issue 3.

Conference:

- Crawford, D., Hairstans, R. & Smith, R. (2013) "Feasibility of Cross-Laminated Timber Production from UK Sitka Spruce" COST Action FP1004 Focus Solid Timber Solutions – European Conference on Cross Laminated Timber, 23rd – 24th May, Graz University of Technology



Forest Research

Western red cedar - Dean

Forest Research

Noble fir - Wales

Forest Research

Norway spruce - Scotland

Forest Research

Western hemlock - Scotland