Sustainable Timber Construction:

Exploring Engineered Timber as a Climate Friendly Building Solution

WoodProps Programme

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OÉ Gaillimh

Edinburgh Napier
UNIVERSITY

Department of
Agriculture,
Food and the Marine
An Roinn
Talmhaíochta,
Bia agus Mara

Date: Thursday 31st October 2019, 09:00-13:00
Venue: The National Botanic Gardens, Glasnevin, Dublin 9

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Overall Aims:

- Characterisation of Irish structural timber
  - Timber Properties
  - Species
  - Grading in Ireland
- Knowledge exchange
  - Members of European Committees for timber
  - Use of EWP in modern timber construction
  - Dissemination of technical information

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NSAI Standards

Irish Standard
I.S. EN 14081-1:2016+A1:2019

Timber structures - Strength graded structural timber with rectangular cross section - Part 1: General requirements

Manufacturer name

Dry-Graded

European Standard applied

Species/Species combination

Machine graded

Strength class

Declaration of performance

Image: Courtesy of Dan Ridley-Ellis

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Sitka spruce C16, what's that?

- **Sitka spruce** (*Picea sitchensis* (*Bong*) Carr.) is a **conifer** (softwood) **species** that occupies **51.1%** of the forest area in Ireland.
- More than half of the output from Irish sawmills in 2015 was used in the construction sector.
- **C16** is the basic customary **strength class** used in Ireland (and the UK)

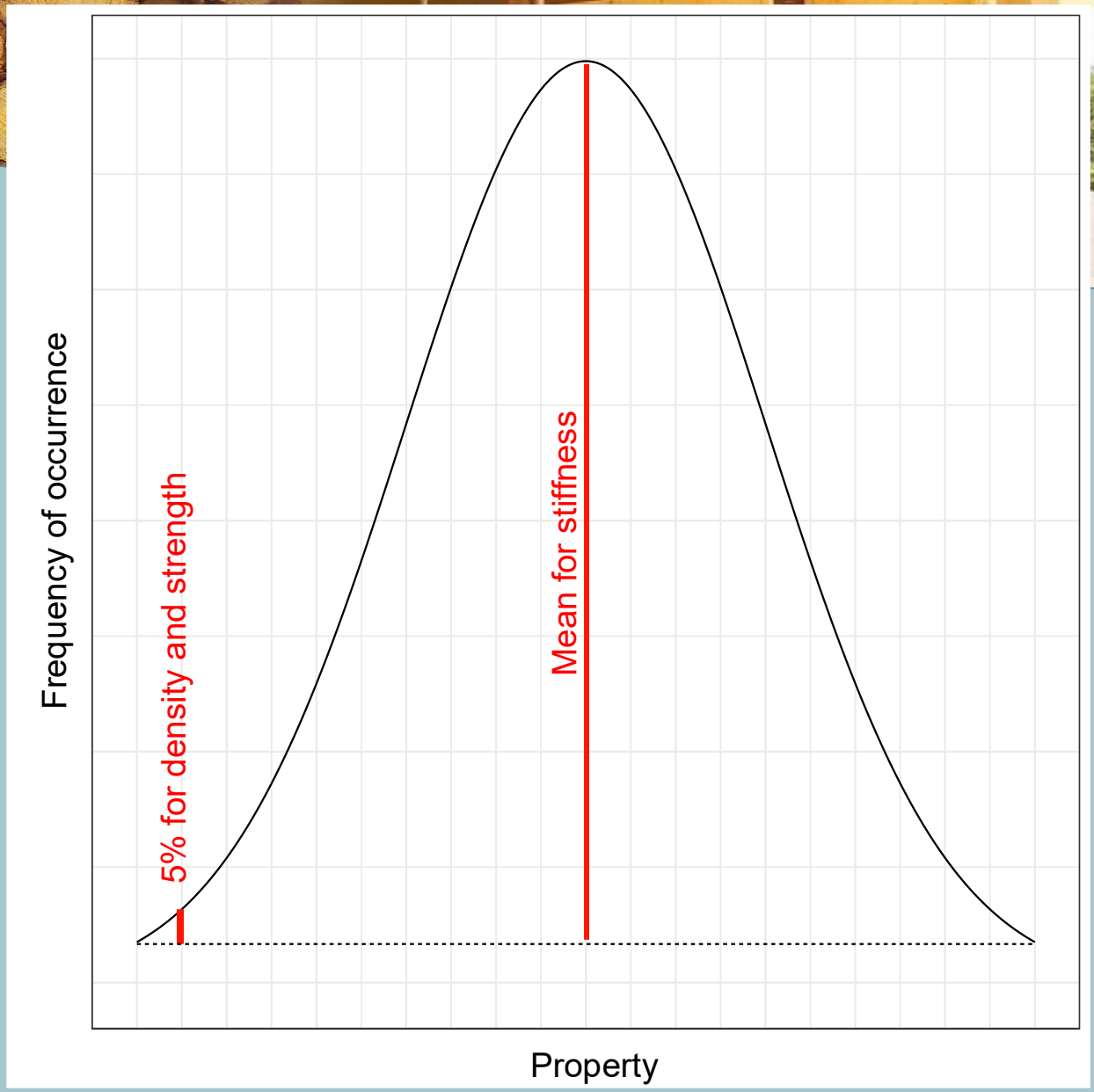
Is not it all the timber the same?

- Trees manufacture wood according to their needs, not to ours.

- Variations:
  - Between species
  - Between origins
    - Within growing regions
    - Within forests
    - Within stands
  - Between trees in a stand
    - Within a tree:
    - Within a board
  - With age
  - With management

How do we deal with that variation?

- Timber classified in “strength classes”
- Described by characteristic material properties, “characteristic values”
  - Stiffness, Strength and Density
  - Measured in bending or tension
- For hardwoods and softwoods (and Poplar and sweet chestnut)
- The aim is to have similar properties within the batch. You can mix species!



	Class	C14	C16	C18	C20	C22	C24	C27	C30	C35	C40	C45	C50
Strength properties in N/mm²													
Bending	$f_{m,k}$	14	16	18	20	22	24	27	30	35	40	45	50
Tension parallel	$f_{t,0,k}$	7,2	8,5	10	11,5	13	14,5	16,5	19	22,5	26	30	33,5
Tension perpendicular	$f_{t,90,k}$	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4
Compression parallel	$f_{c,0,k}$	16	17	18	19	20	21	22	24	25	27	29	30
Compression perpendicular	$f_{c,90,k}$	2,0	2,2	2,2	2,3	2,4	2,5	2,5	2,7	2,7	2,8	2,9	3,0
Shear	$f_{v,k}$	3,0	3,2	3,4	3,6	3,8	4,0	4,0	4,0	4,0	4,0	4,0	4,0
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	12,0	13,0	14,0	15,0	16,0
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	8,0	8,7	9,4	10,1	10,7
Mean modulus of elasticity perpendicular	$E_{m,90,mean}$	0,23	0,27	0,30	0,32	0,33	0,37	0,38	0,40	0,43	0,47	0,50	0,53
Mean shear modulus	G_{mean}	0,44	0,50	0,56	0,59	0,63	0,69	0,72	0,75	0,81	0,88	0,94	1,00
Density in kg/m³													
5 percentile density	ρ_k	290	310	320	330	340	350	360	380	390	400	410	430
Mean density	ρ_{mean}	350	370	380	400	410	420	430	460	470	480	490	520

Strength classes for softwood based on edgewise bending tests (EN 338:2016)

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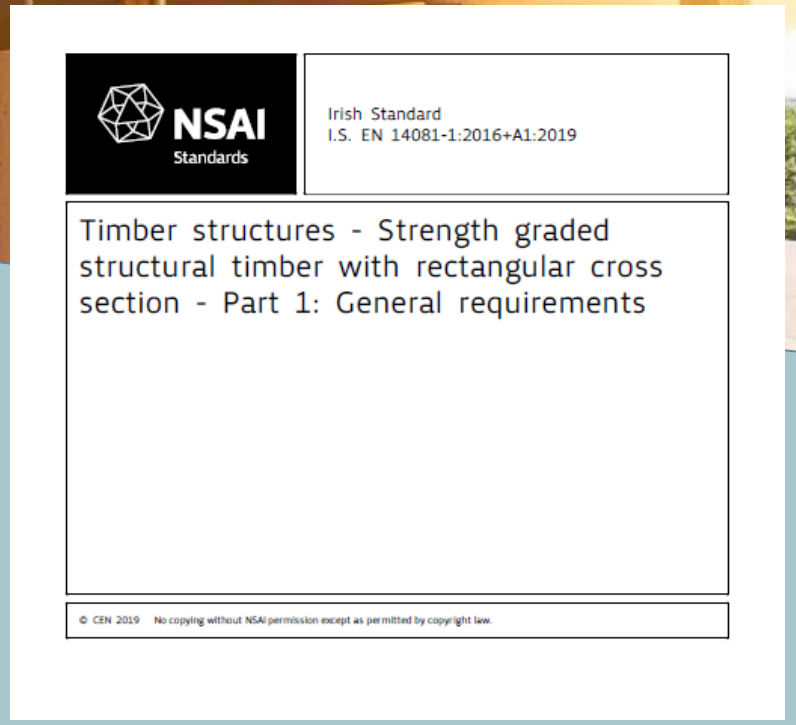
Systems of grading, governed by EN 14081


NSAI Standards

Irish Standard
I.S. EN 14081-1:2016+A1:2019

Timber structures - Strength graded structural timber with rectangular cross section - Part 1: General requirements

- Visual, trained operators
  - The grading rule in Ireland is I.S. 127:2015
- Machine (assignments less conservative than visual)
  - Machine control
    - One or more Indicating property (IP) is measured, and related to the grade-determining properties (strength, stiffness and density) using an statistical model
    - IP thresholds determine if the graded batch match the required strength classes
    - The IP thresholds change with species and growing regions
    - To comply with the grade, characteristic values must be reached. Strength grading is not only about strength!
    - For a species and grade combination (e.g. C16/Reject) usually one property is limiting
  - Output control
    - Initial settings from destructive testing and periodical checks of the performance


MICROTEC
X-ray Scanner
Inline
moisture metre

What can we grade in Ireland?

- Sitka spruce (and Norway spruce) and Douglas fir

British spruce		C14	C16	C18	C20	C22	C24	C27	C30
Strength	19.6 N/mm2	14	16	18	20	22	24	27	30
Stiffness	8.30 kN/mm2	7	8	9	9.5	10	11	11.5	12
Density	330 kg/m3	290	310	320	330	340	350	370	380
Potential grading yield		100%	100%	92%	75%	58%	30%		
Douglas fir		C14	C16	C18	C20	C22	C24	C27	C30
Strength	16.5 N/mm2	14	16	18	20	22	24	27	30
Stiffness	10.9 kN/mm2	7	8	9	9.5	10	11	11.5	12
Density	388 kg/m3	290	310	320	330	340	350	370	380
Potential grading yield		100%	100%	99%	95%	91%	87%		

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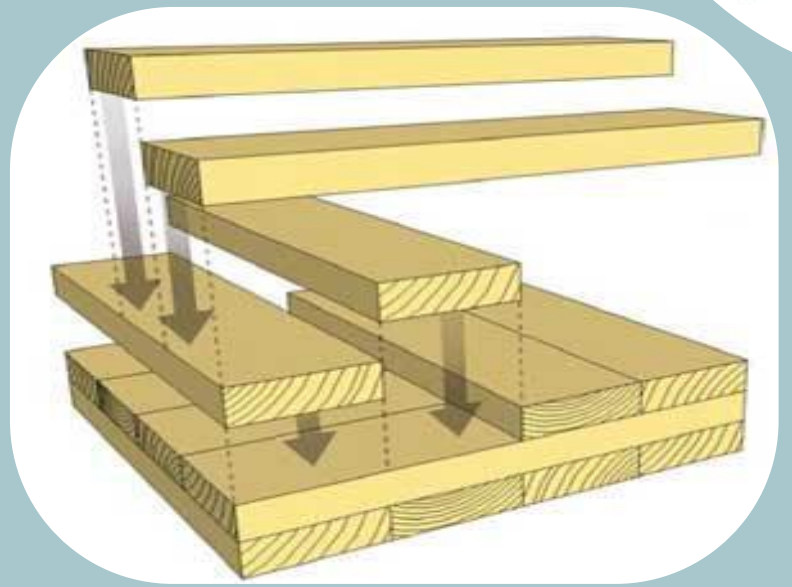
Summary:

- Pieces are individually assigned to strength classes but it is the population of timber that matters
- Timber can be graded to different strength classes
- Irish C16 is as good as Scandinavian C16
- Irish timber can be graded to C16, and higher
- Machine strength grading isn’t always about strength

Engineered Wood Products

- Multi-layer engineered wood product
  - Glulam
  - Cross Laminated Timber (CLT)
- Increased rigidity/homogeneity
- Simple connections
- Increased speed of construction



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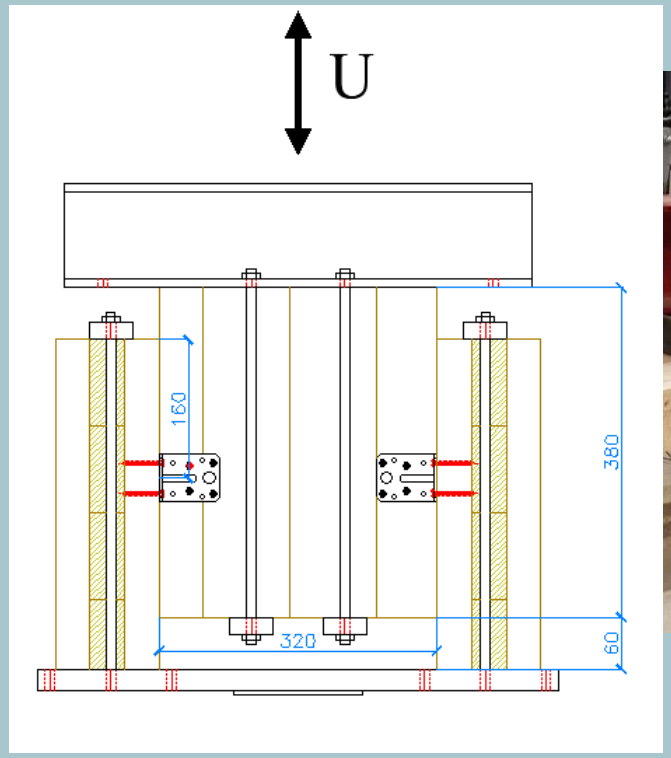
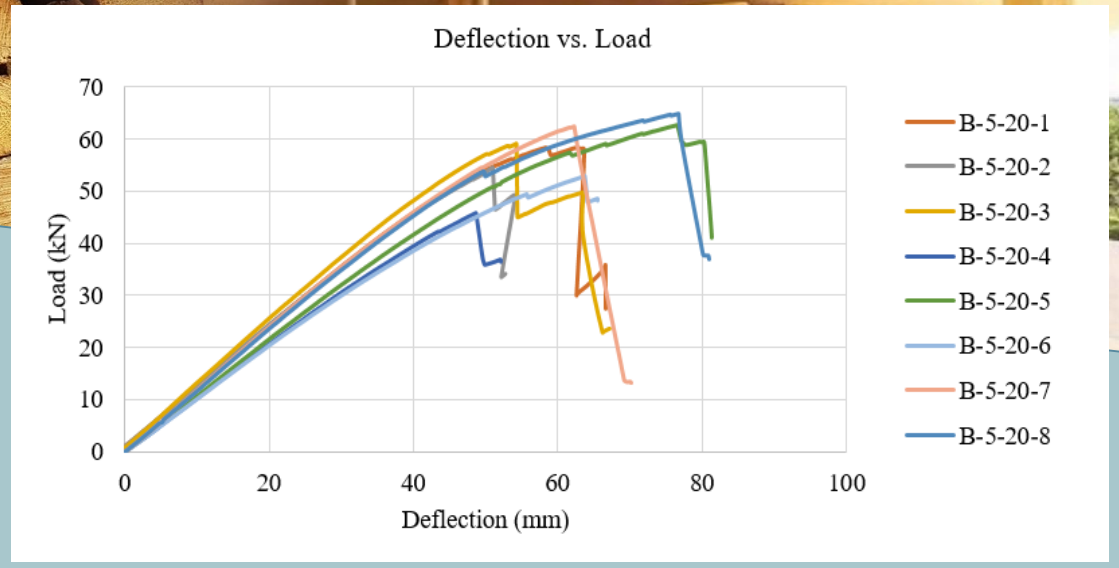
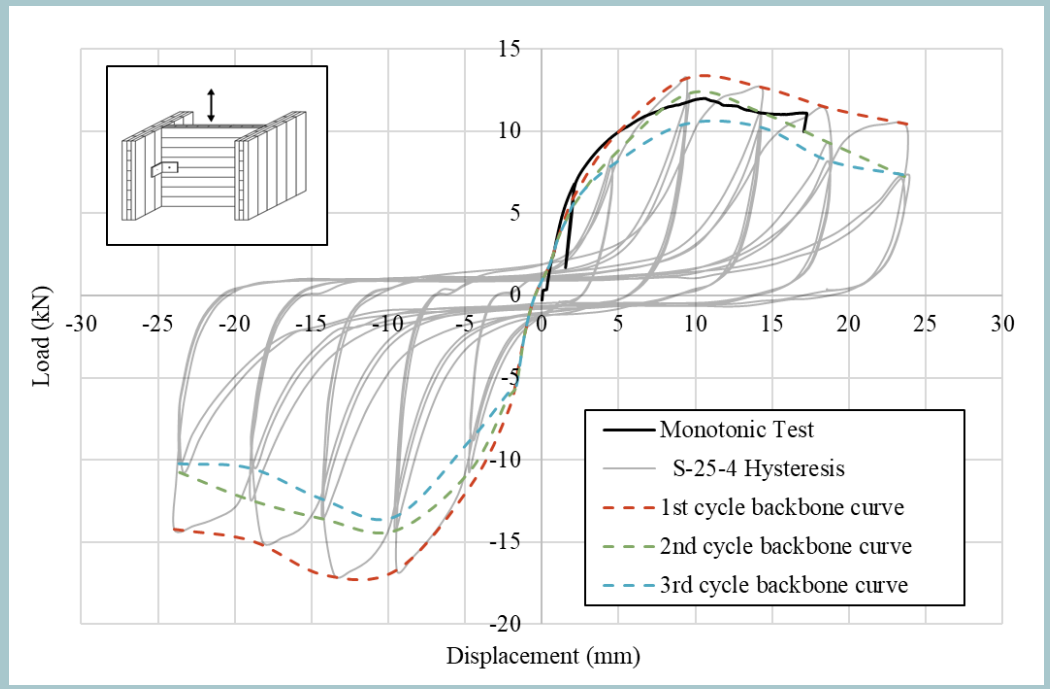
Engineered Wood Products







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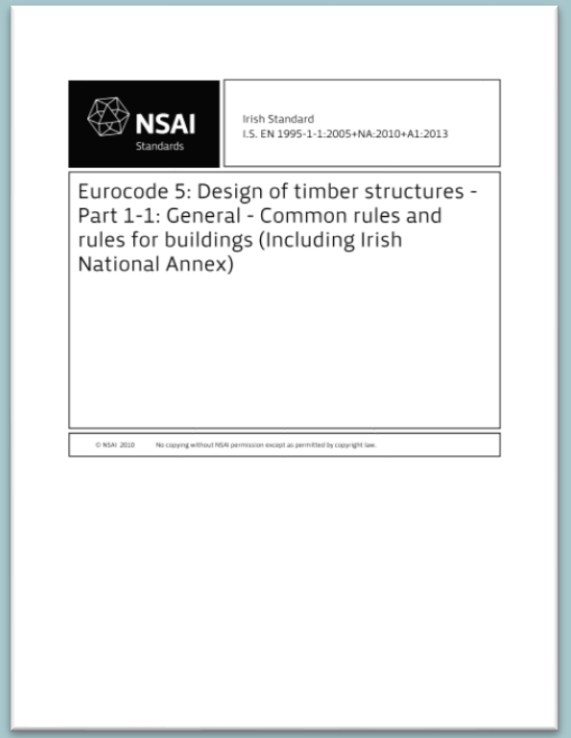
Mass timber buildings

- Mass timber buildings have been constructed around the world!
  - Sustainable and environmentally conscious materials
  - Advances in production of EWP and connection systems
- Future Eurocode 5 updates will include section on CLT
- CLT utilising C16 timber are available to use in Europe via ETAs


NSAI Standards

Irish Standard
I.S. EN 1995-1-1:2005+NA:2010+A1:2013

Eurocode 5: Design of timber structures - Part 1-1: General - Common rules and rules for buildings (Including Irish National Annex)

Mass timber buildings

- Brock Commons
  - Vancouver, Canada
  - 18 Storey
  - 53m tall
  - CLT wall and floors
  - Glulam columns
  - Structure-70 days

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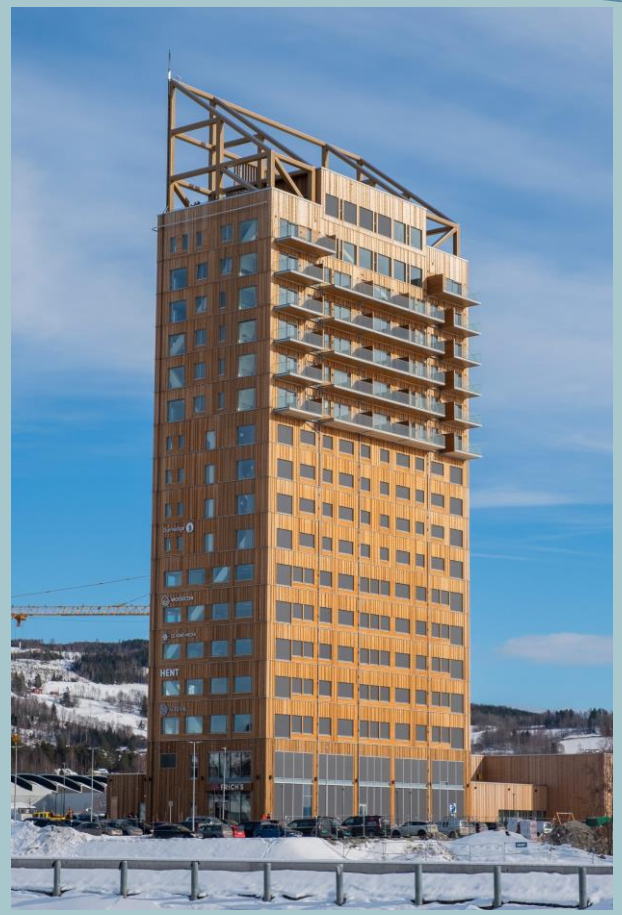
Mass timber buildings

- Mjøstårnet
  - Brumunddal, Norway
  - 18 Storey
  - 85.4m tall
  - CLT floors/lift shaft
  - Glulam columns
  - Current tallest!



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Mass timber buildings

- Puukuokka Block
  - Finland
  - 8 Storey
  - Prefabricated Modules
  - CLT wall and floors
  - 6 months/block

Interested in learning more?

WoodProps is focused on industry engagement and knowledge sharing related to timber quality, innovation in wood products and updates on standards development.

- Timber Information Resource Centre

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Timber Information Resource Centre

www.nuigalway.ie/terg/knowledge

The following topics are currently available with more under construction:

- Design Guidance
- Case Studies
- Design Tools
- Forestry
- Fire
- Connections
- Engineered Wood Products
- Cross Laminated Timber (CLT)
- Health and Wellbeing
- Climate Change
- Video Library
- Building Regulations

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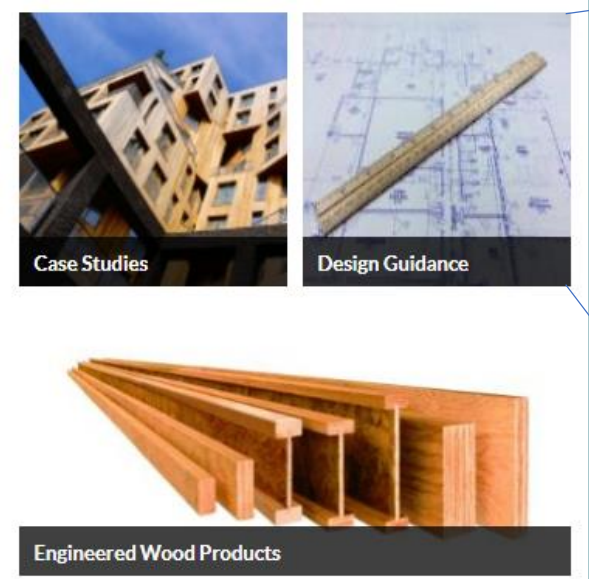
Timber Information Resource Centre

Simply search under your topic of interest!



Design Guidance

This section contains informative material and guidance in the design and detailing of timber structures

- Informative Articles +
- Structural Design Guidance +
- Fire Design Guidance +

Structural Design Guidance –

Design of Timber Structures Volume 1 (2016): Structural aspects of timber construction
Design of Timber Structures Volume 2 (2016): Rules and formulas according to Eurocode 5
Design of Timber Structures Volume 3 (2016): Examples
Produced by Swedish Wood, Published by Swedish Forest Industries Federation.

Building with CLT - Stora Enso
This document presents information on planning, design, detailing and commissioning of CLT buildings.

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Thank you for listening

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- TIRC: www.nuigalway.ie/terg/knowledge
- Join our Mailing List to keep up to date with the WoodProps!
- Twitter: @TERG_NUIG

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