PUNCH
consulting engineers

Bryan Carroll
bcarroll@punchconsulting.com

WoodProps Programme,
National Botanic Gardens, Dublin
31/10/2019

Learning from our neighbours: An Introduction to Cross Laminated Timber(CLT).

Image Source: StoraEnso

www.punchconsulting.com

PUNCH
consulting engineers

PUNCH
consulting engineers

RAMBOLL

PUNCH
consulting engineers

Cross Laminated Timber panels

What is CLT?

Where does CLT come from?

Structural Design of CLT

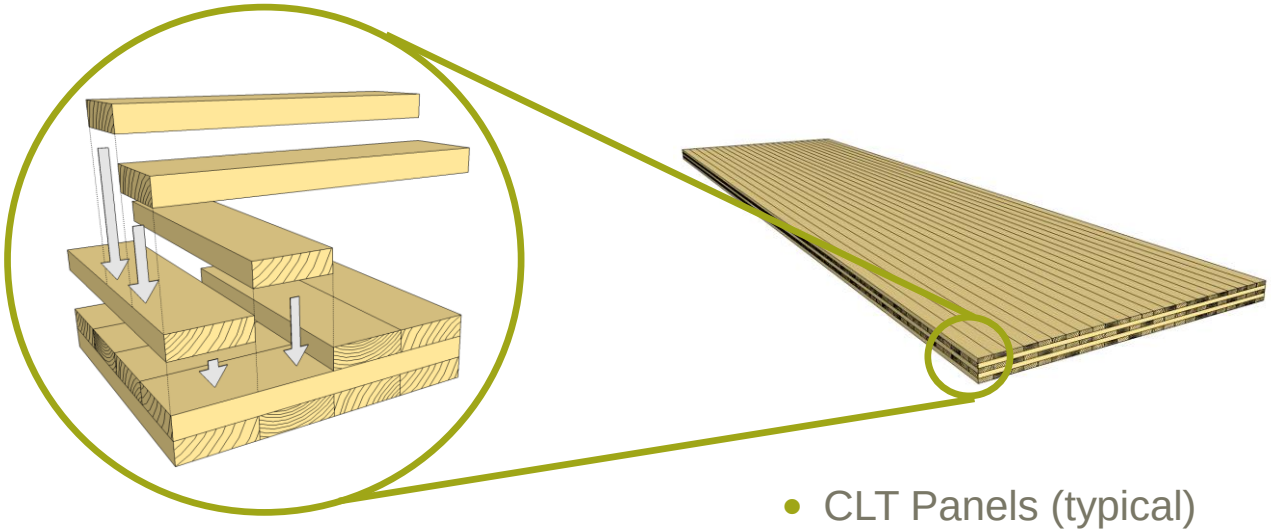
CLT in Ireland

What is CLT?

Image Source: RIBA Jou
Daniel Shearing

PUNCH
consulting engineers

Cross Laminated Timber panels



- CLT Panels (typical)
  - *50mm to 320mm thick (Vary 3,5 and 7 layers)*
  - *Typically 8m to 13.5m long*
  - *Cut to shape in factory*
  - *Standard widths 2.95m , 2.75m , 2.45m*

    (max. 3.5 ltd. Suppliers)

Suppliers generally have variations in dimensions, build-ups of layers and material properties so always consult the envisioned suppliers documentation

Image Source: Structures Magazine

PUNCH
consulting engineers

Cross Laminated Timber panels

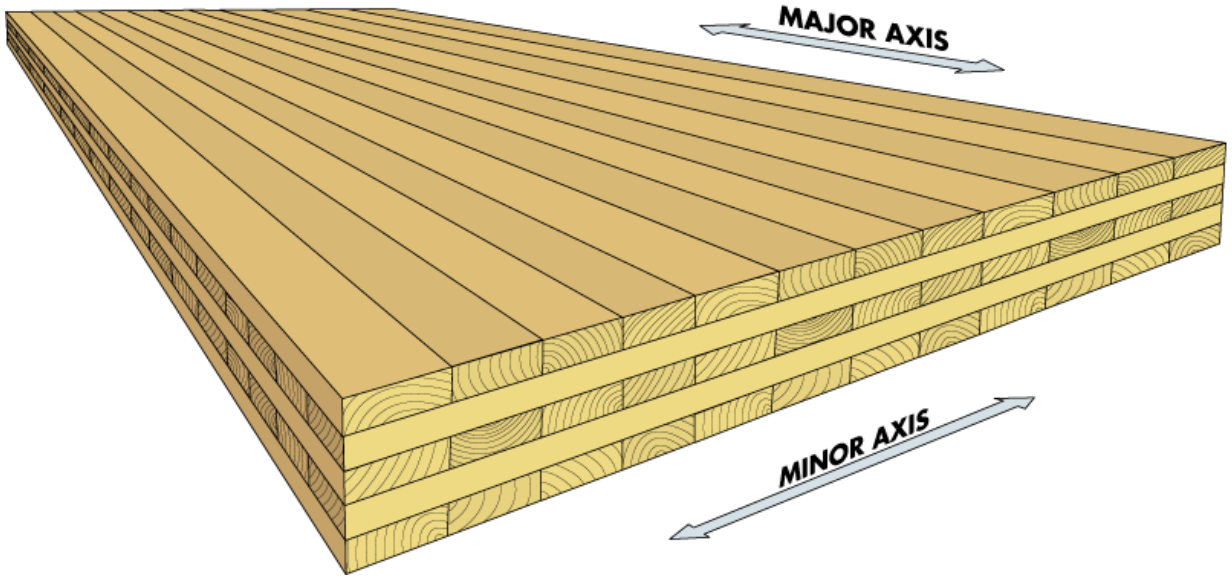
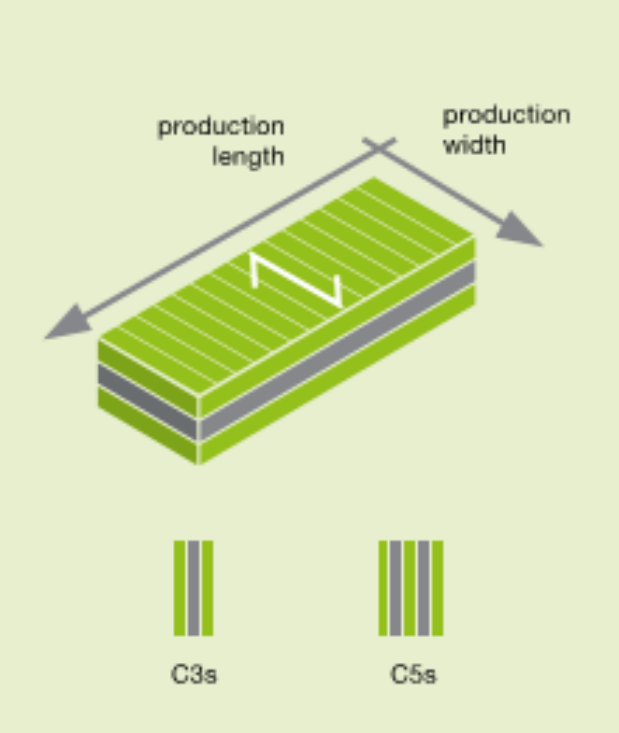
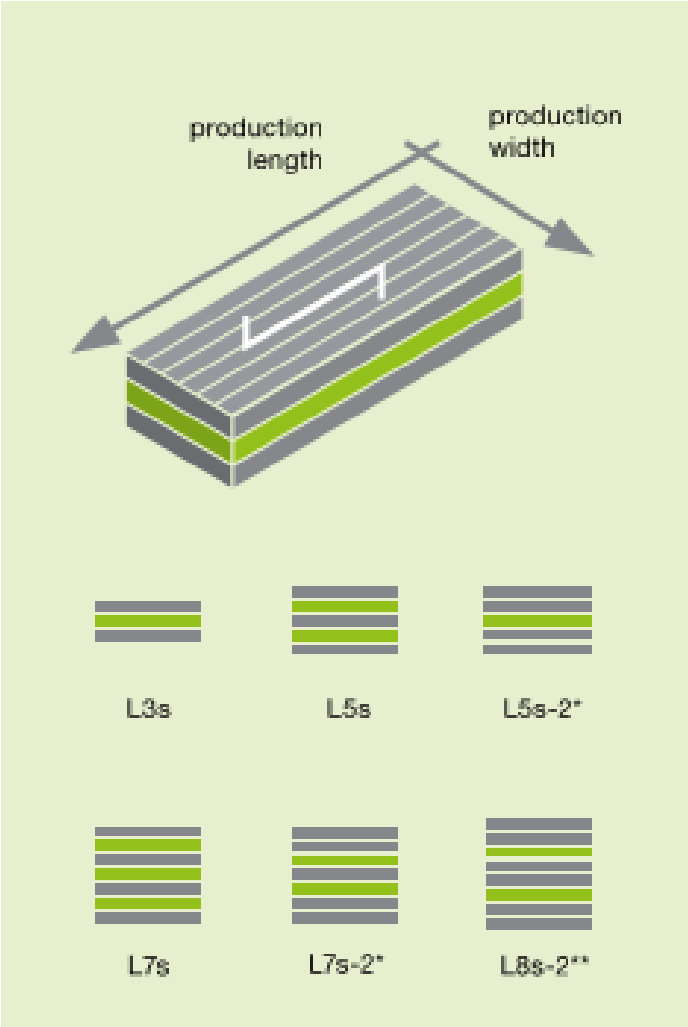


Image Source: Structures Magazine

Floor to Ceiling heights





Importance of floor to ceiling consideration for panels size and stability system.

Source: StoraEnso

Image Source: KLH

PUNCH
consulting engineers

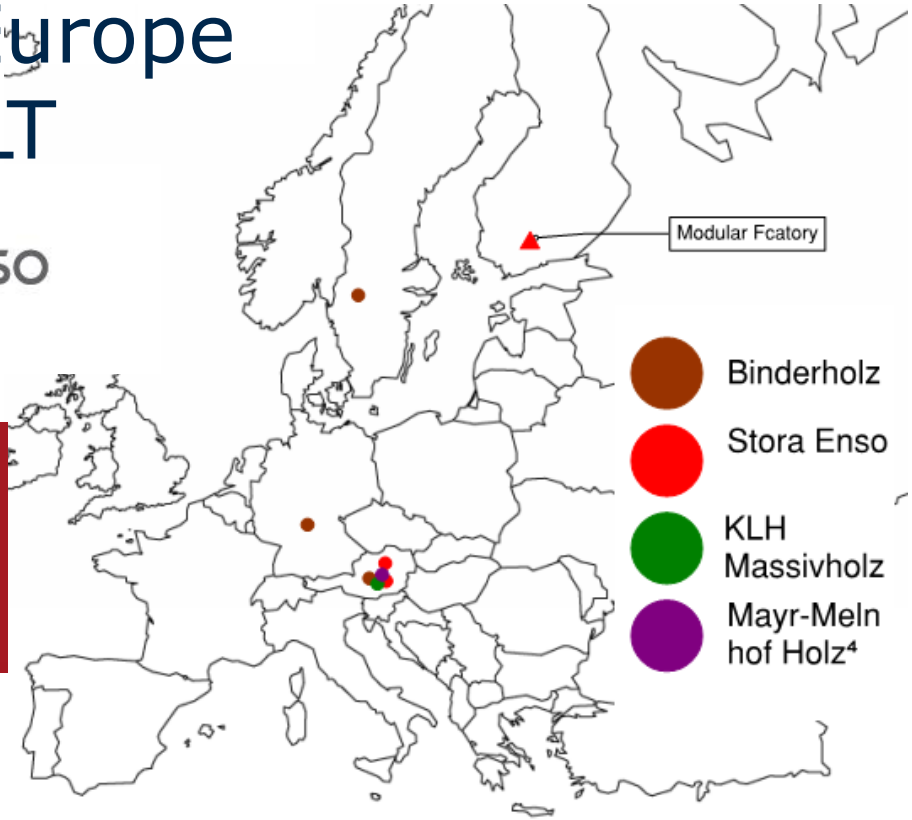
Typical CLT suppliers Europe /Erectors in Ireland-CLT

KLH UK

rethink. storaenso

binderholz
tiptop timber

MM
MAYR MELNHOF HOLZ



G-frame structures ltd

CEDARLAN

WiEHAG
TIMBER CONSTRUCTION

*There are many other suppliers available – but the above represents those I have predominantly come across to date in Ireland, please let me know others to be included

PUNCH consulting engineers

Suppliers-Brackets

rothoblaas

SIMPSON Strong-Tie®

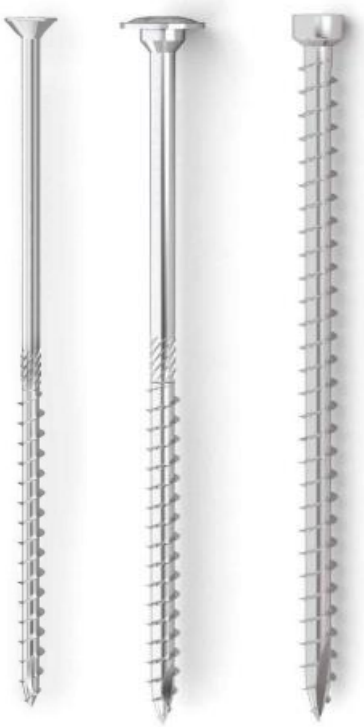


Image Source: Rothoblaas and SIMPSON Strong-Tie

*There are many other suppliers available – but the above represents those I have predominantly come across to date in Ireland, please let me know others to be included

PUNCH
consulting engineers

Structural Design of CLT

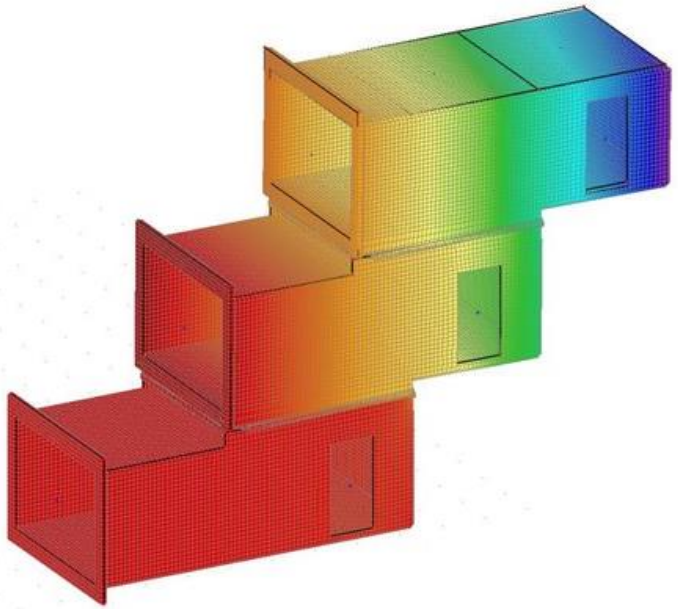
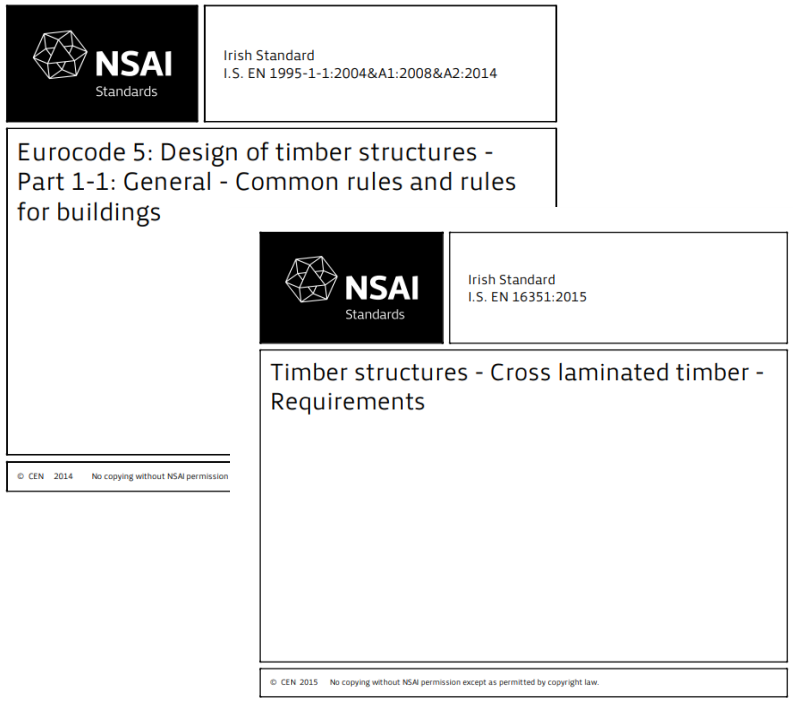


Image Source: http://www.designengineeringworkshop.co.uk/dyson-village

PUNCH
consulting engineers

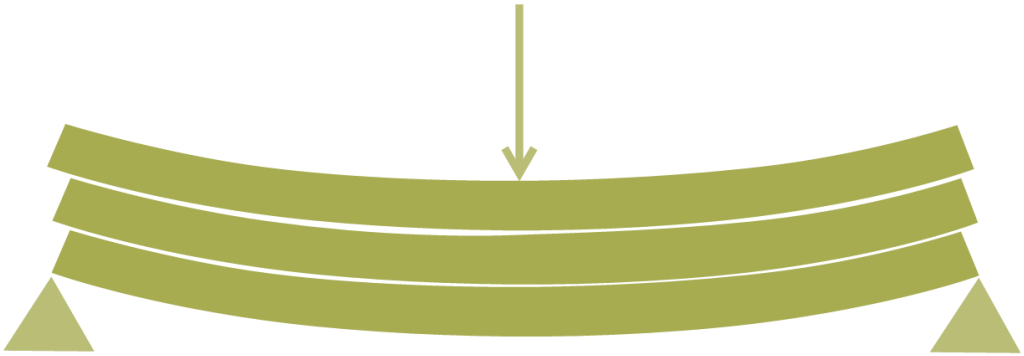
Approval and Standardisation

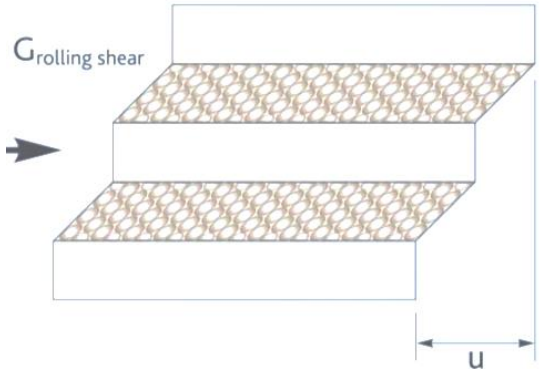


ETAs

EN1995 series and prEN16351

Geometrical Properties – Partial Interaction





When the panel bends the grain in cross layers perpendicular to the direction of span will want to role over each other this causes a slippage and therefore a loss of stiffness

Geometrical Properties – Gamma Method

$$EI_{eff} = \sum EI + \gamma EAa^2$$

$$\gamma_i = \left[1 + \pi^2 E_i A_i s_i / (K_i l^2)\right]^{-1}$$

si in the original is the spacing of the mechanical fastening, i.e. screw and Ki is the slip of the screw (i.e. N/mm)

Gr is the rolling shear value

hi is the depth of the "mechanical fastening"

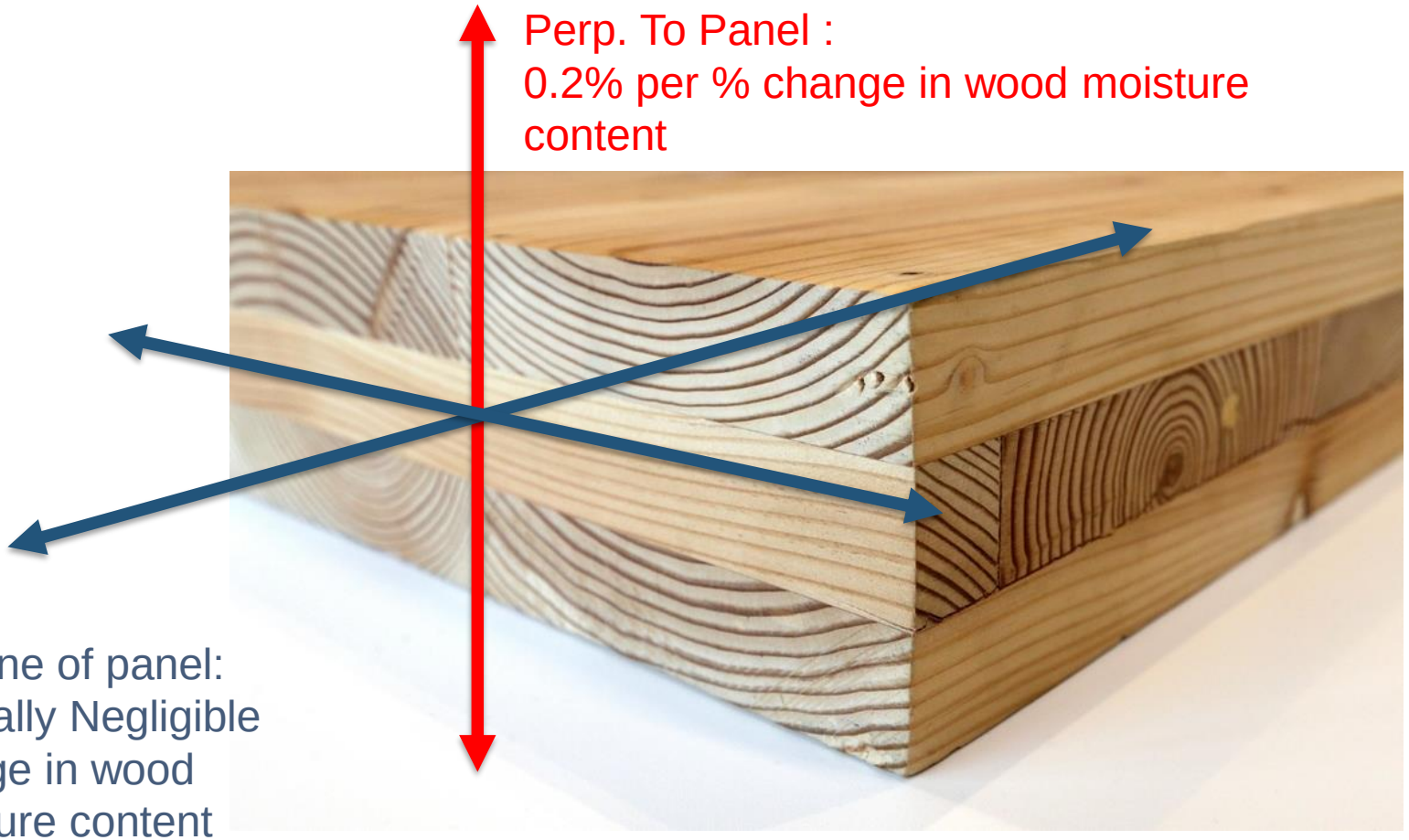
$$s_i / K_i = h_i / (b \times G_r)$$

We calculate the equivalent stiffness of the layer that will have rolling shear and replace the stiffness of a typical metal fasteners based connection

EN1995-1-1 Annex B adapted

PUNCH consulting engineers

Movement Due to Moisture

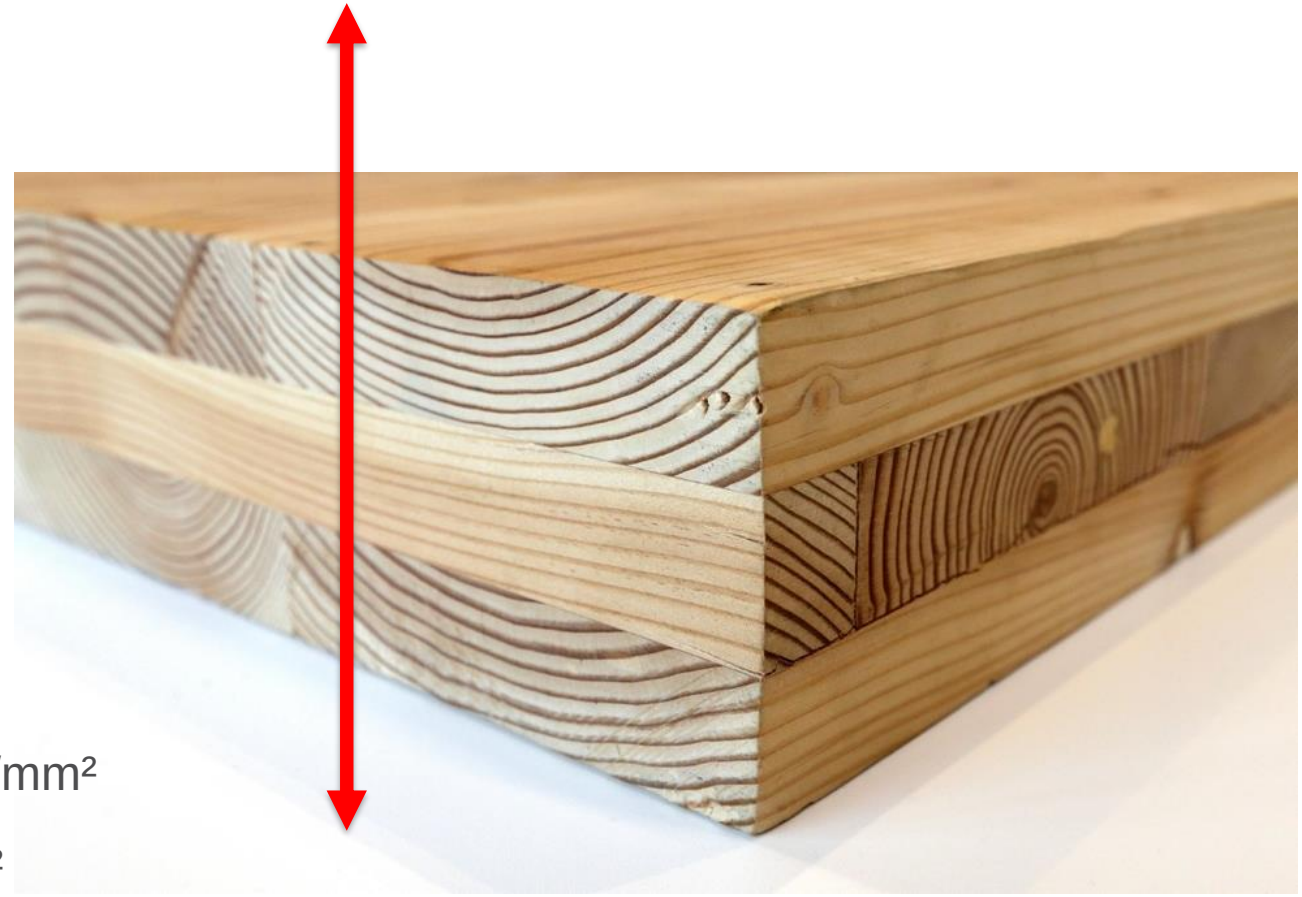


In plane of panel:
Typically Negligible change in wood moisture content

*Values above are from KLH ETA but always consult the ETA of the panel supplier

PUNCH
consulting engineers

Movement Due to Loading



E90,mean =0.37kN/mm²
vs
E0,mean = 12kN/m²

NB Kdef Factor

PUNCH
consulting engineers

Transferring High Compression Loads in Tall buildings through floor panel

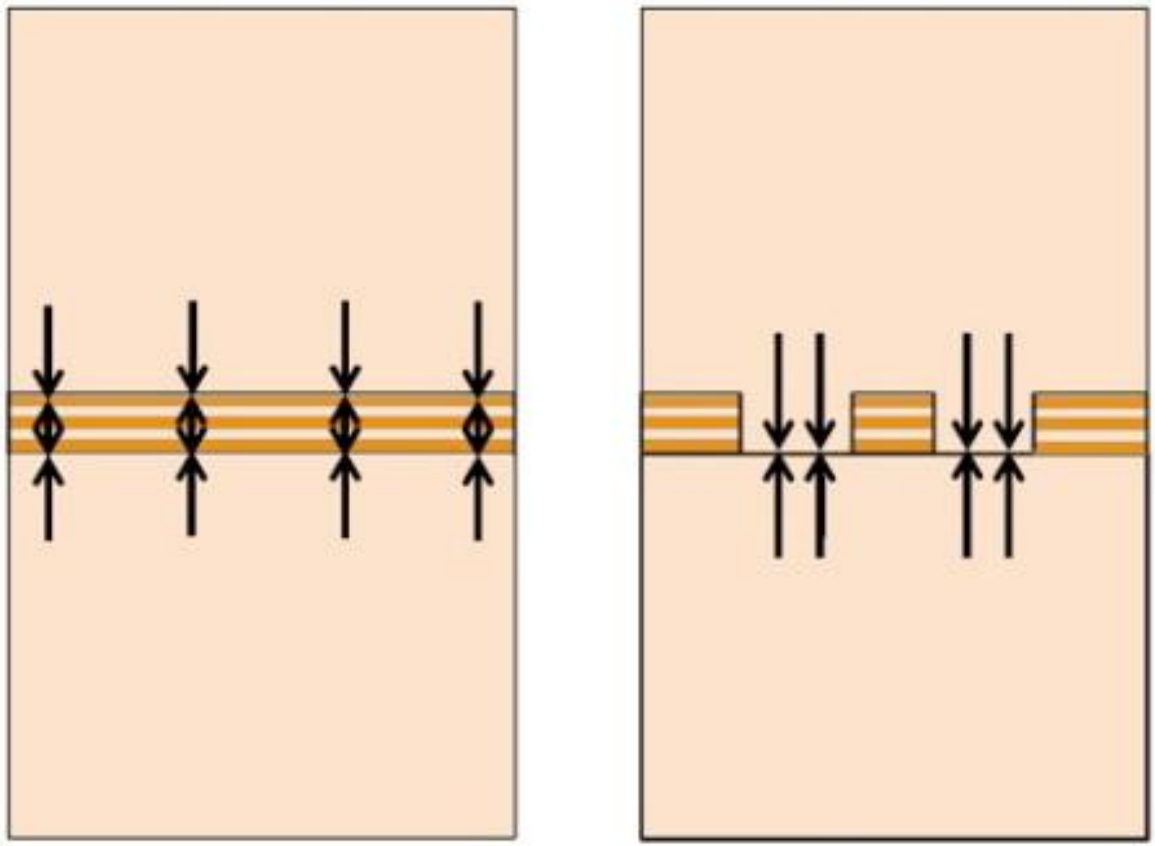
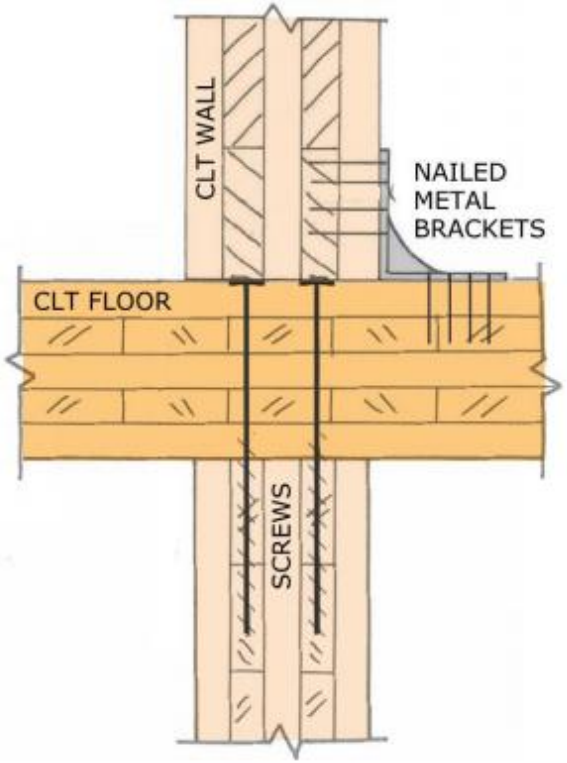
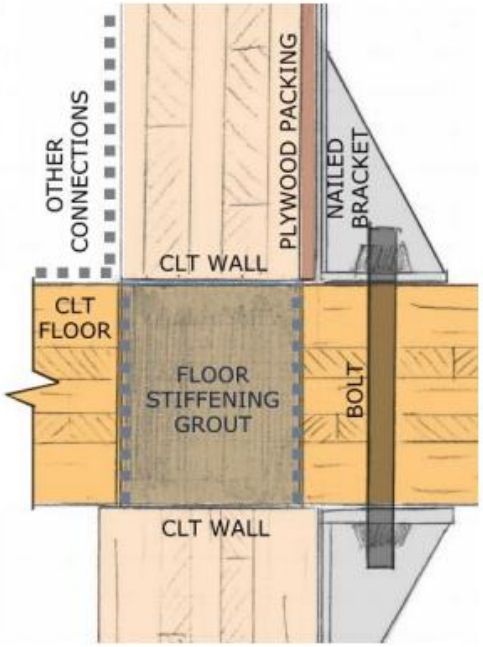


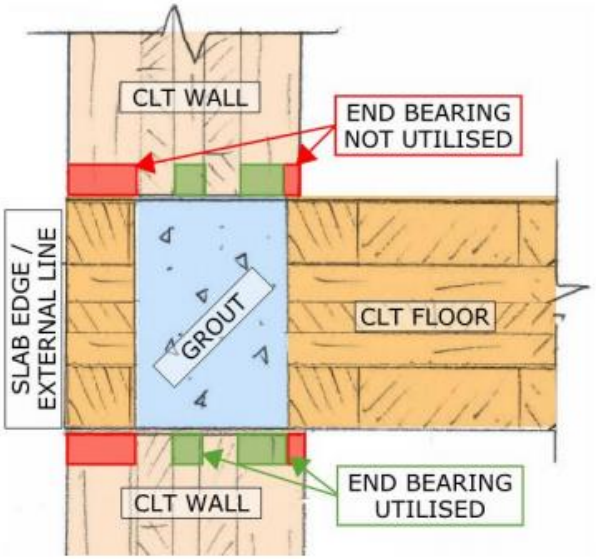
Image Source: *Harris R (2014) Innovative structural systems in timber*

PUNCH
consulting engineers

Transferring High Compression Loads in Tall buildings through floor panel



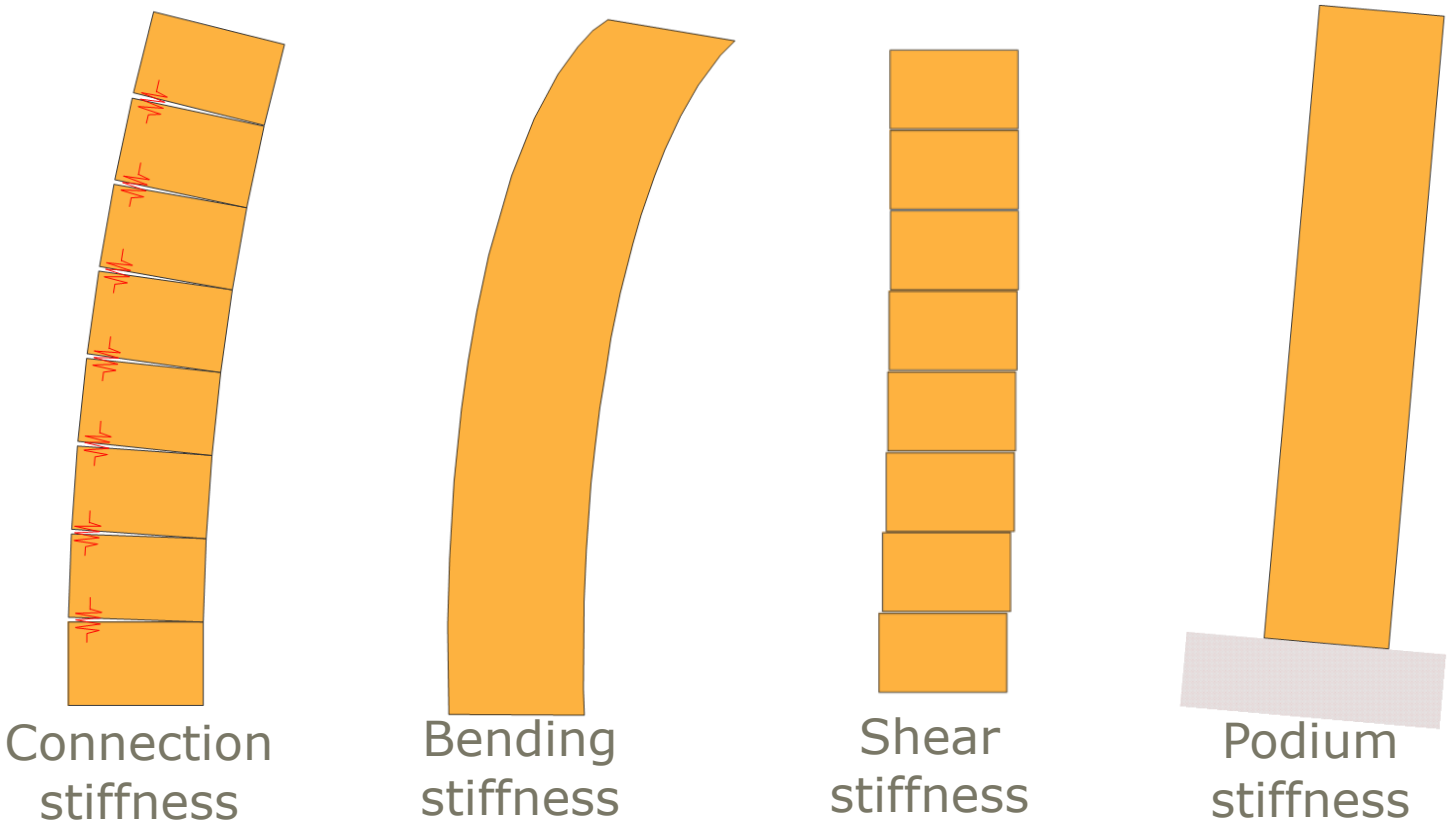




Source: WCTE 2016 PAPER - DALSTON LANE - THE WORLD'S TALLEST CLT BUILDING

Stability

Modes of movement to consider



Source: WCTE 2016 PAPER - DALSTON LANE - THE WORLD'S TALLEST CLT BUILDING

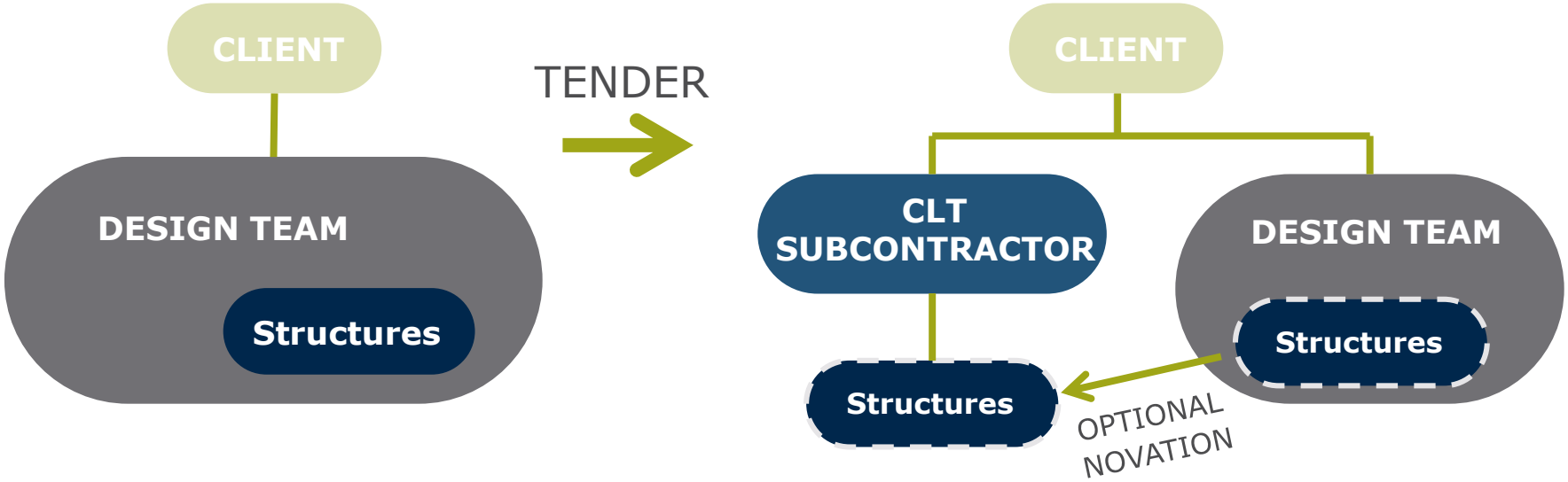

Precision
Two Way
Spanning

PUNCH consulting engineers

Typical contractual arrangement

RIBA stage 1-3

RIBA stage 4-6

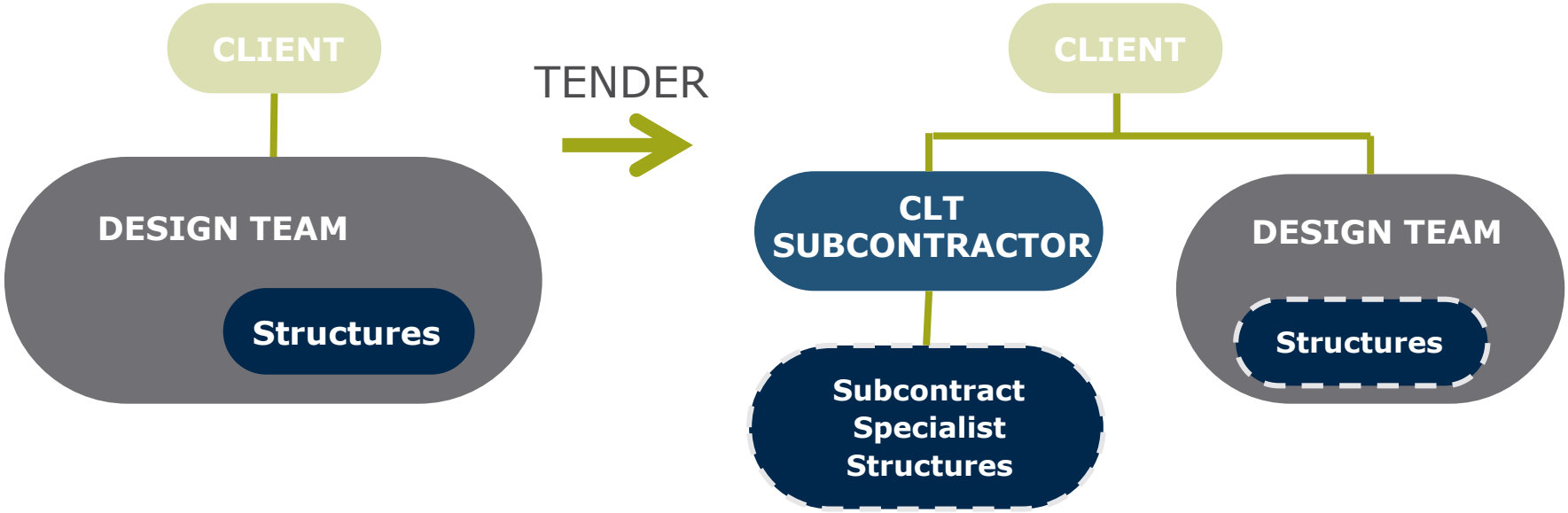


PUNCH consulting engineers

Typical contractual arrangement

RIBA stage 1-3

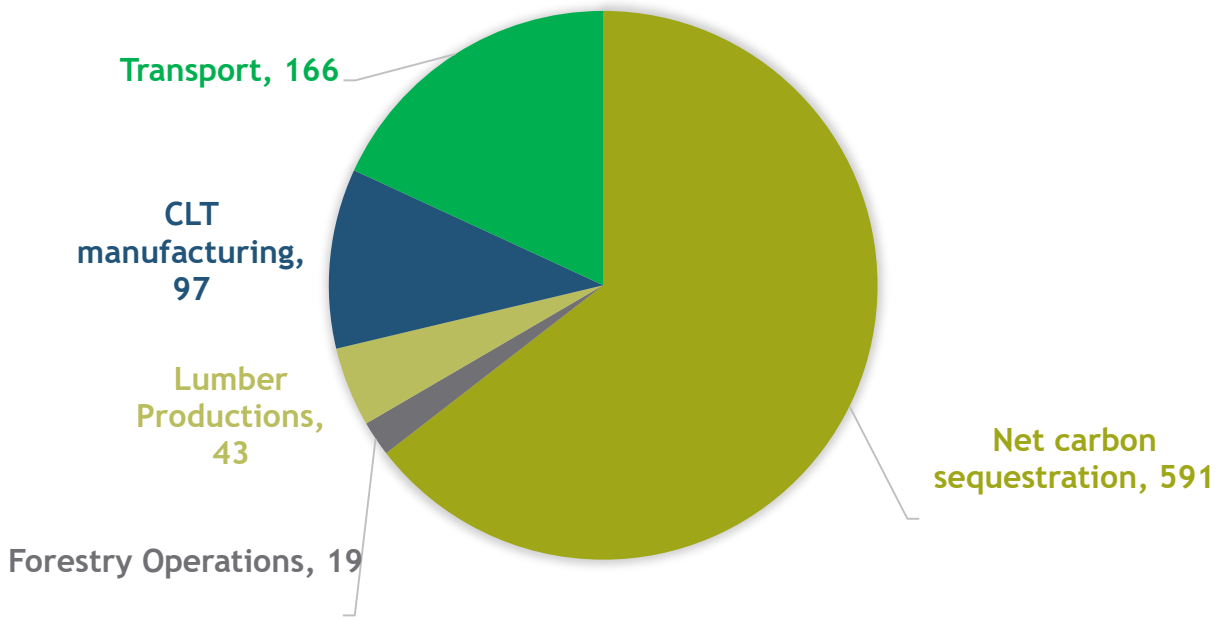
RIBA stage 4-6



PUNCH
consulting engineers

EQUIVALENT CARBON (KG/M³ OF CLT)

Gross carbon sequestration = 916kg/m³



These are some estimates of the carbon within the CLT, every project will vary and the references below are provided as a starting point for those looking to compare carbon of CLT to other structures types

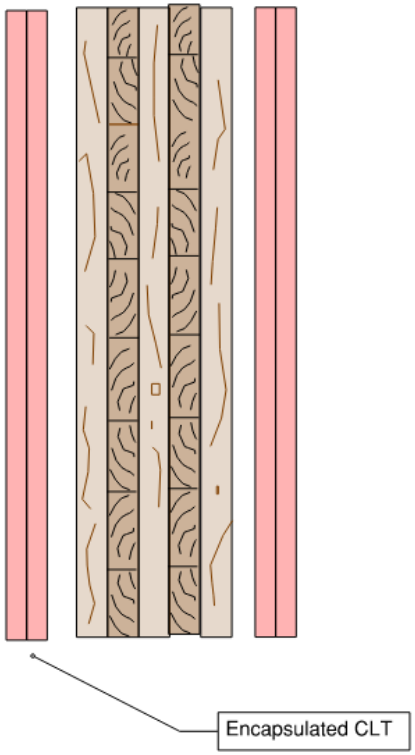
Sources:
CORRIM REPORT - Life Cycle Assessment of Cross Laminated Timbers Produced in Oregon PUETTMANN SINHA and GANGULY 2017

& Guidelines for Measuring and Managing CO2 Emission from Freight Transport Operations

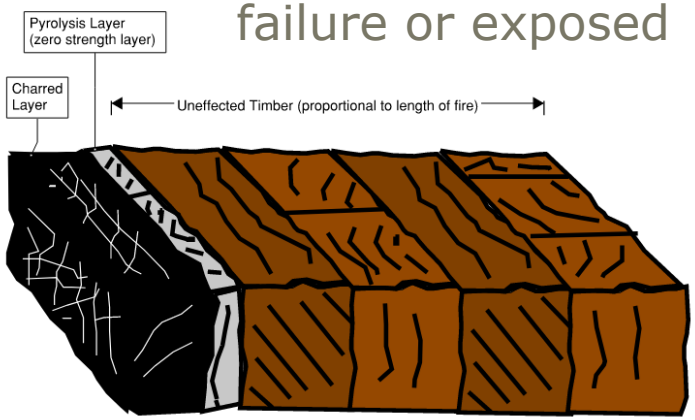
PUNCH consulting engineers

Structural Fire Resistance

Plasterboard Protection



Charring of timber post plasterboard failure or exposed



Zero strength layer assumed to be 7mm (as per glulam). However ZSL thickness is probably higher for glulam and CLT; based on current research.

Important considerations of fall of rate depending on orientation and glue type once exposed. Note generally plasterboard encapsulation used for up to 60mins resistance

PUNCH
consulting engineers

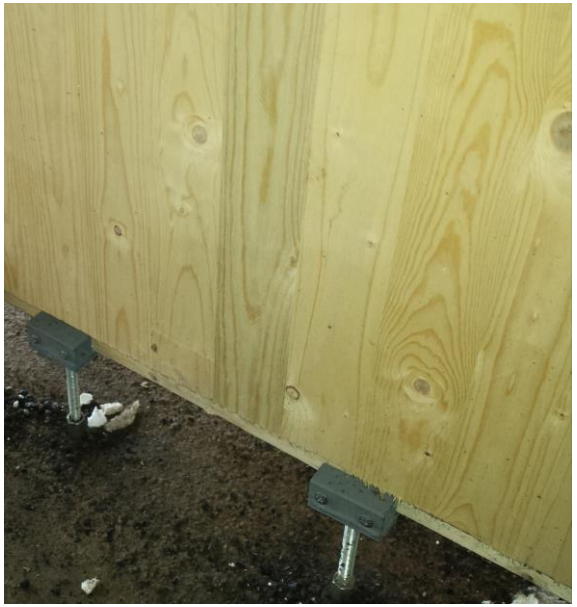
Material Cost
vs
Programme Savings & secondary partitions

It is always worth engaging a contractor at an early stage to get an idea of costs and programme

Source: Gframe

PUNCH
consulting engineers

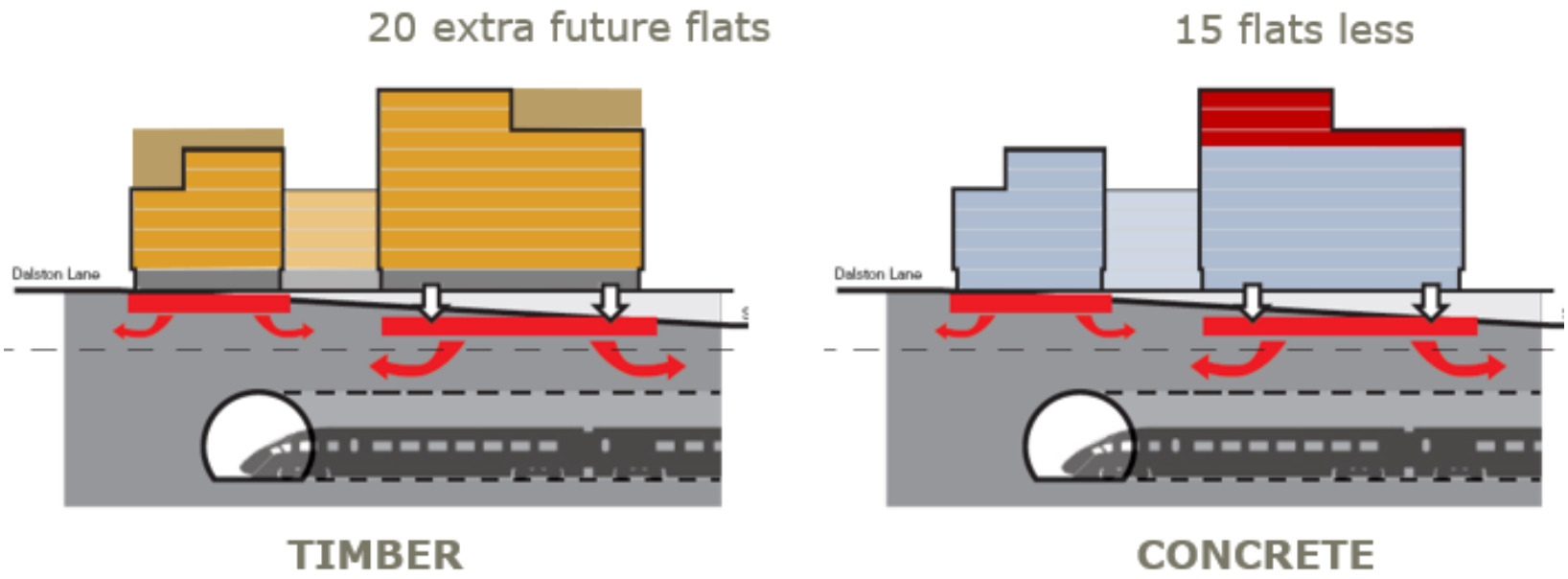
Lightweight material used to extend two floors onto existing building



Source: Gframe


P&K
STRUCTURES
OPTIMISED OFFSITE SOLUTIONS
binderholz
tiptop timber
WAUGH THISTLETON
ARCHITECTS
RAMBOLL

Foundations + Flexibility



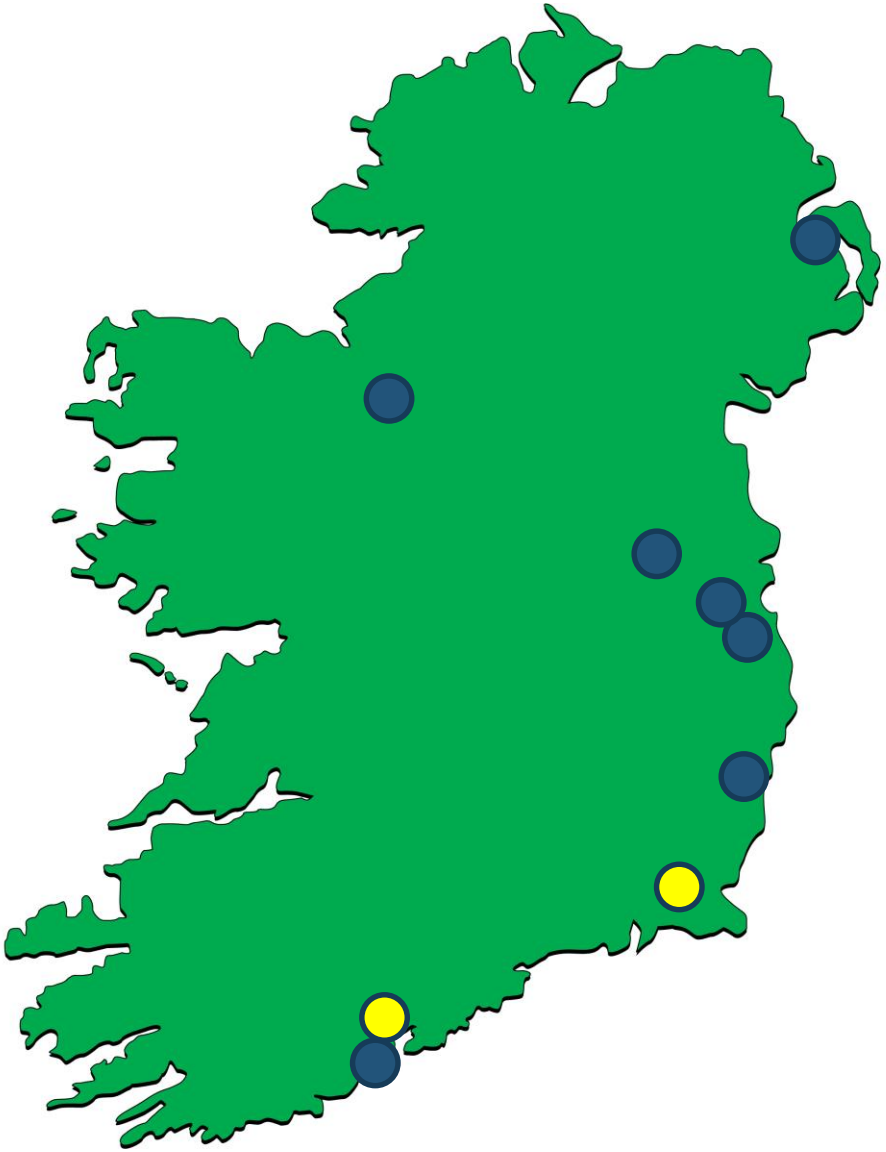
Light weight nature of the structure increased the benefit to the client by including more units, due to the load restrictions imposed on ground loading

Image Source: WCTE 2016 PAPER - DALSTON LANE - THE WORLD'S TALLEST CLT BUILDING

BUILDABILITY

Source: B&K STRUCTURES

PUNCH
consulting engineers



CLT in Ireland

Distributor

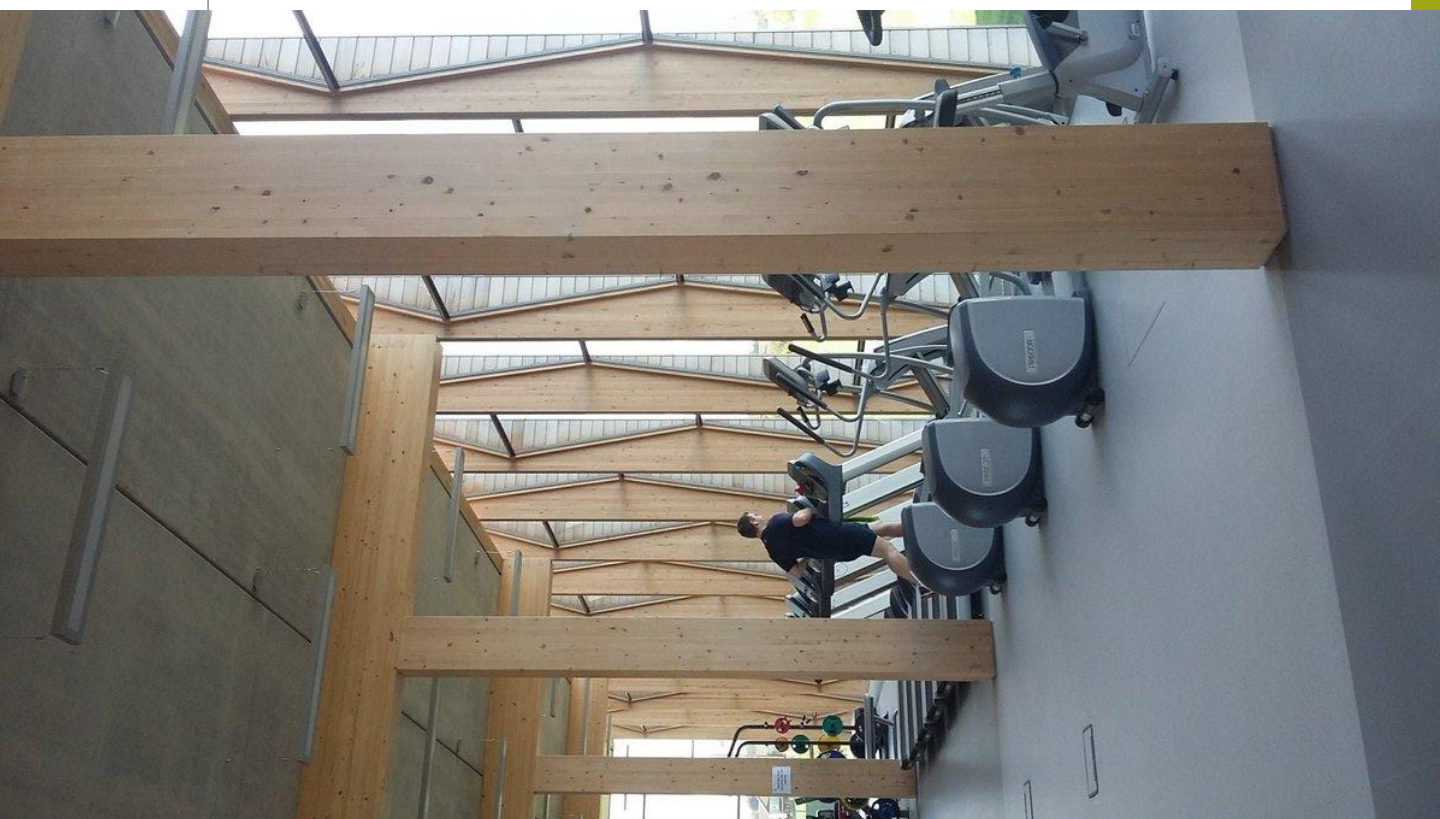
Projects

This map is a work in progress so please let us know if there any buildings you know about built with CLT in Ireland. Some photos on the next few slides show examples of these projects.

CLT has many typology uses, but will not always be the best option in buildings and if you have a project you are considering doing in CLT please consult an experienced industry member to steer you towards the correct solution

Samuel Beckett Civiv Campus Phase 1 (Dublin DLRCC)
Source: Bucherholz McEvoy Architects

Samuel Beckett Civiv Campus Phase 1 (Dublin DLRCC)
Source: Bucherholz McEvoy Architects



Home in Crosshaven
Source: Cedarlan

Ballyogan-operations-and-maintenance-depot(Dublin)
Source: Bucherholz McEvoy Architects


G-frame
structures ltd

PUNCH
consulting engineers

This presentation have been uploaded in good faith for the sharing of information. PUNCH or the presenter cannot guarantee any details within the presentation and it is the responsibility of the designer or other user to confirm information that will be relied upon. The presentation was accompanied by additional context on the given date.