Timber & Design

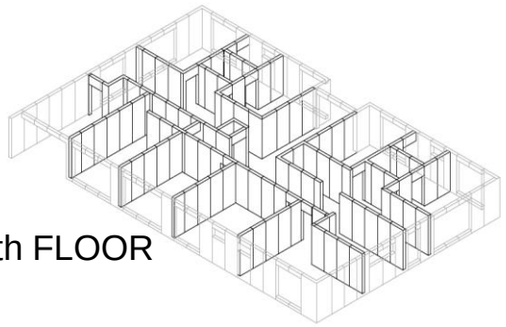
dr. David Bylund
Architect

“The best friend of man is the tree.
When we use the tree respectfully and economically, we have one of the greatest resources on the earth”
Frank Lloyd Wright

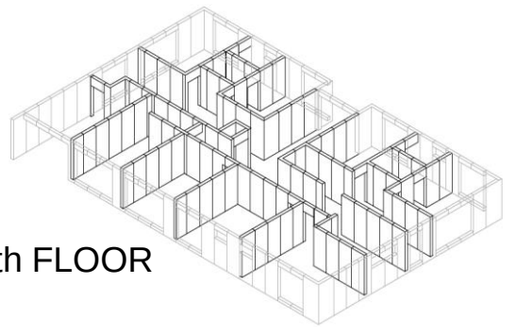
A Comparative Study of the Swedish and Australian Timber Construction Sectors

leading to

The Development of a Prefabricated Parallel Timber Wall System



5th FLOOR



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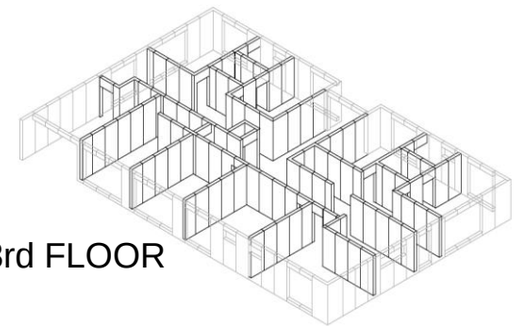
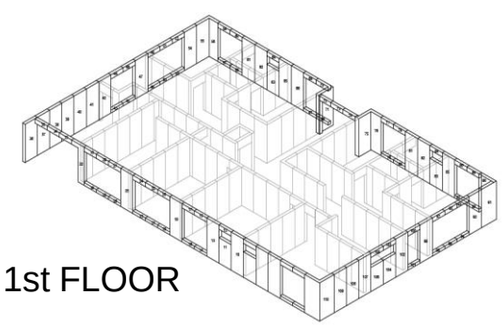


3rd FLOOR

2nd FLOOR



1st FLOOR

LEGEND

200 mm (+ LINING) DOUBLE SKIN STRUCTURAL GUN-NAILED PARALLEL LAMINATED (GPL) WALL

90 mm (+ LINING) TIMBER FRAME WALL

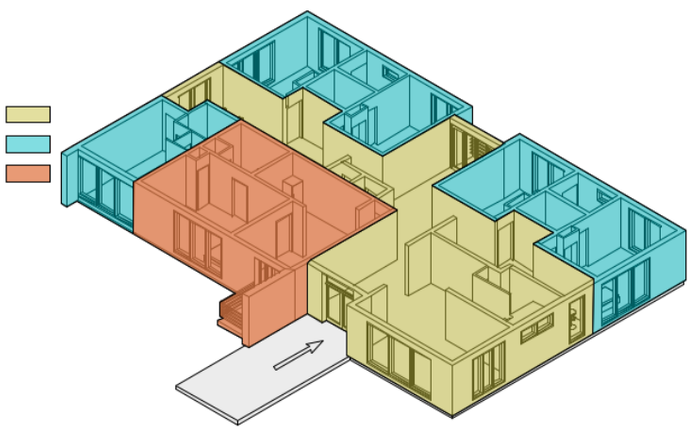
PUBLIC/CIRCULATION AREAS

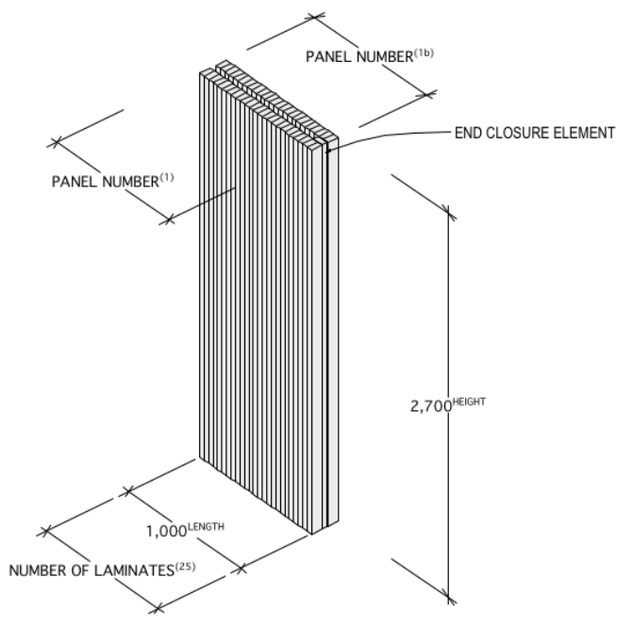
1 BED APARTMENT

SELF CONTAINED APARTMENT

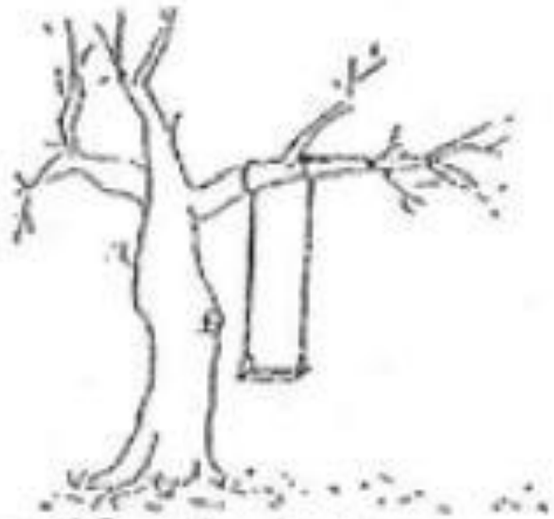
GROSS INTERNAL FLOOR AREA - 314m2

CEILING HEIGHT - 2700 mm

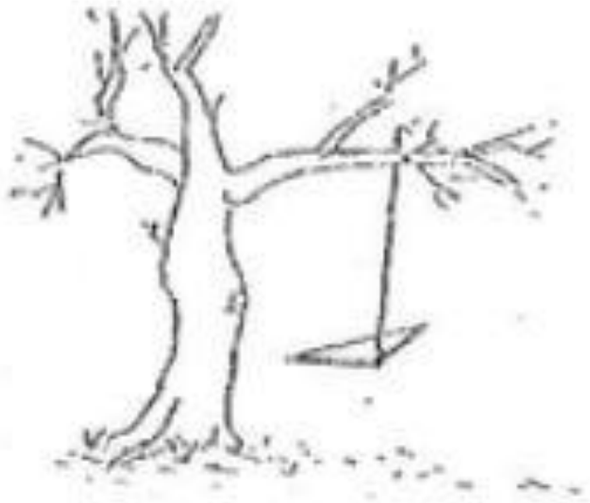




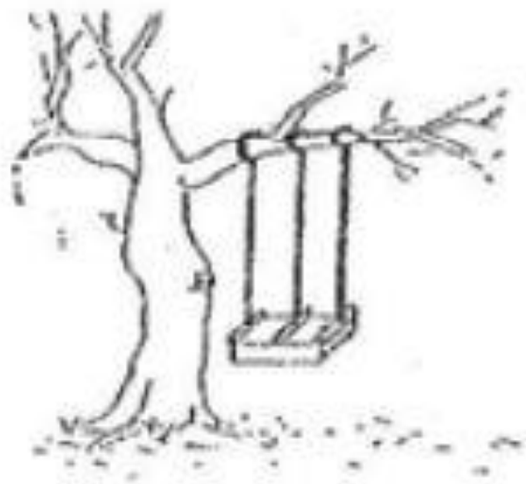
Timber and Design:



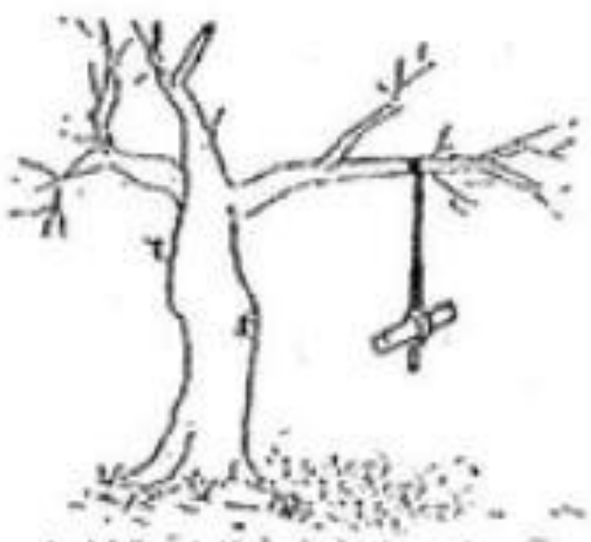
1. What the customer asked for



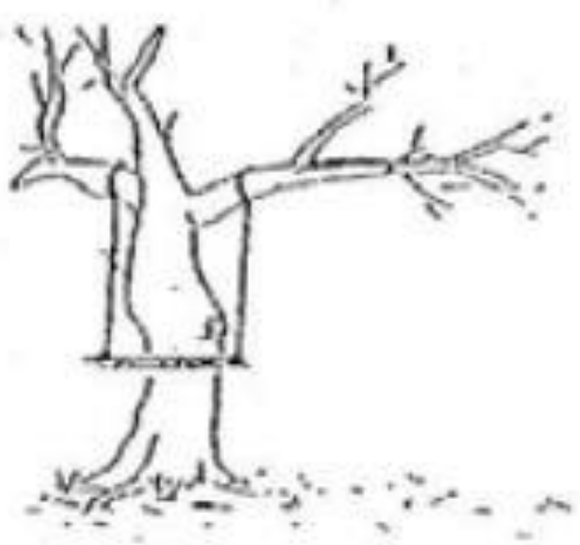
2. What the architekt proposed



3. What the engineer proposed



4. What the contractor proposed



5. How it was built

Timber and Design:

Get the right team:

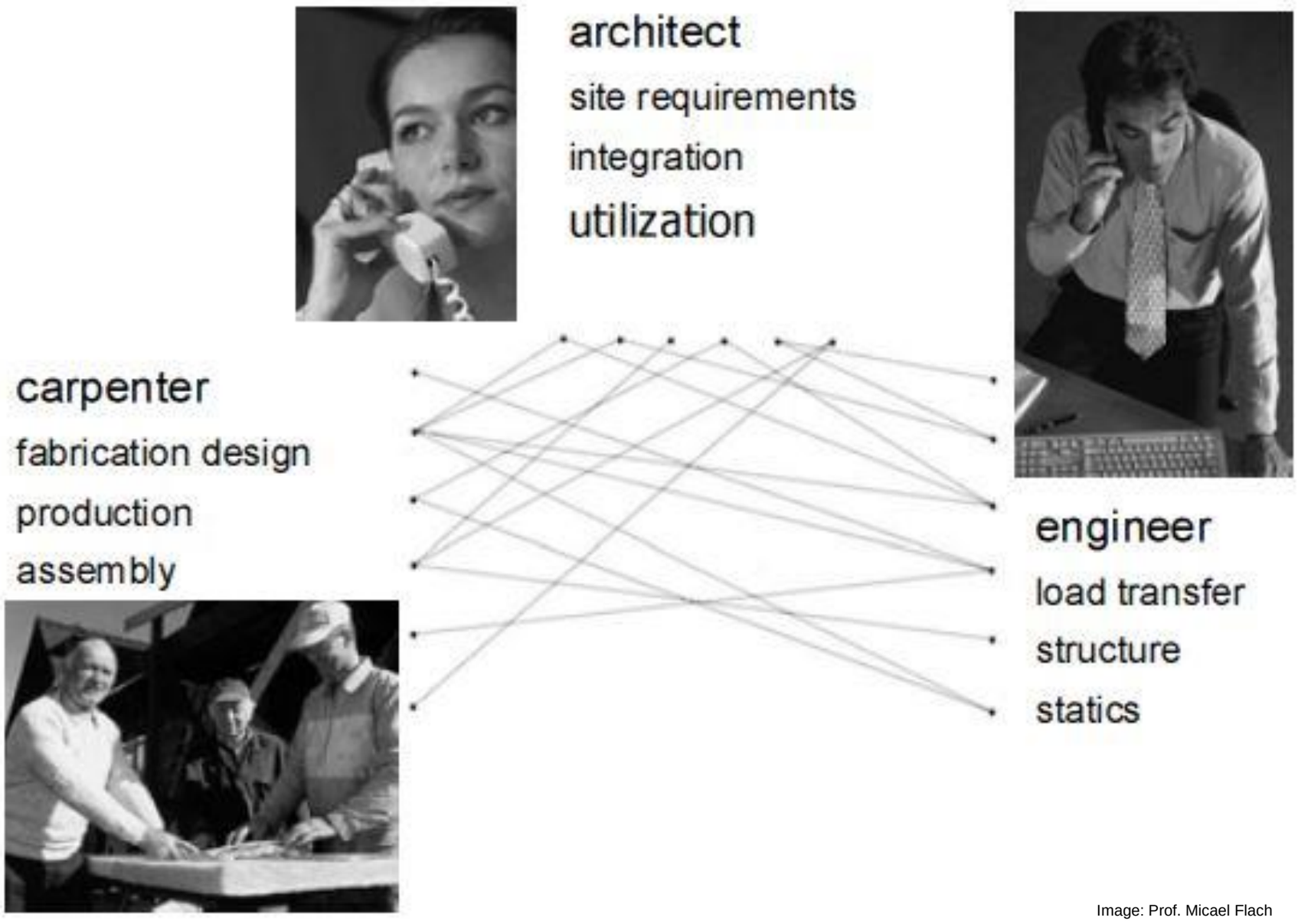
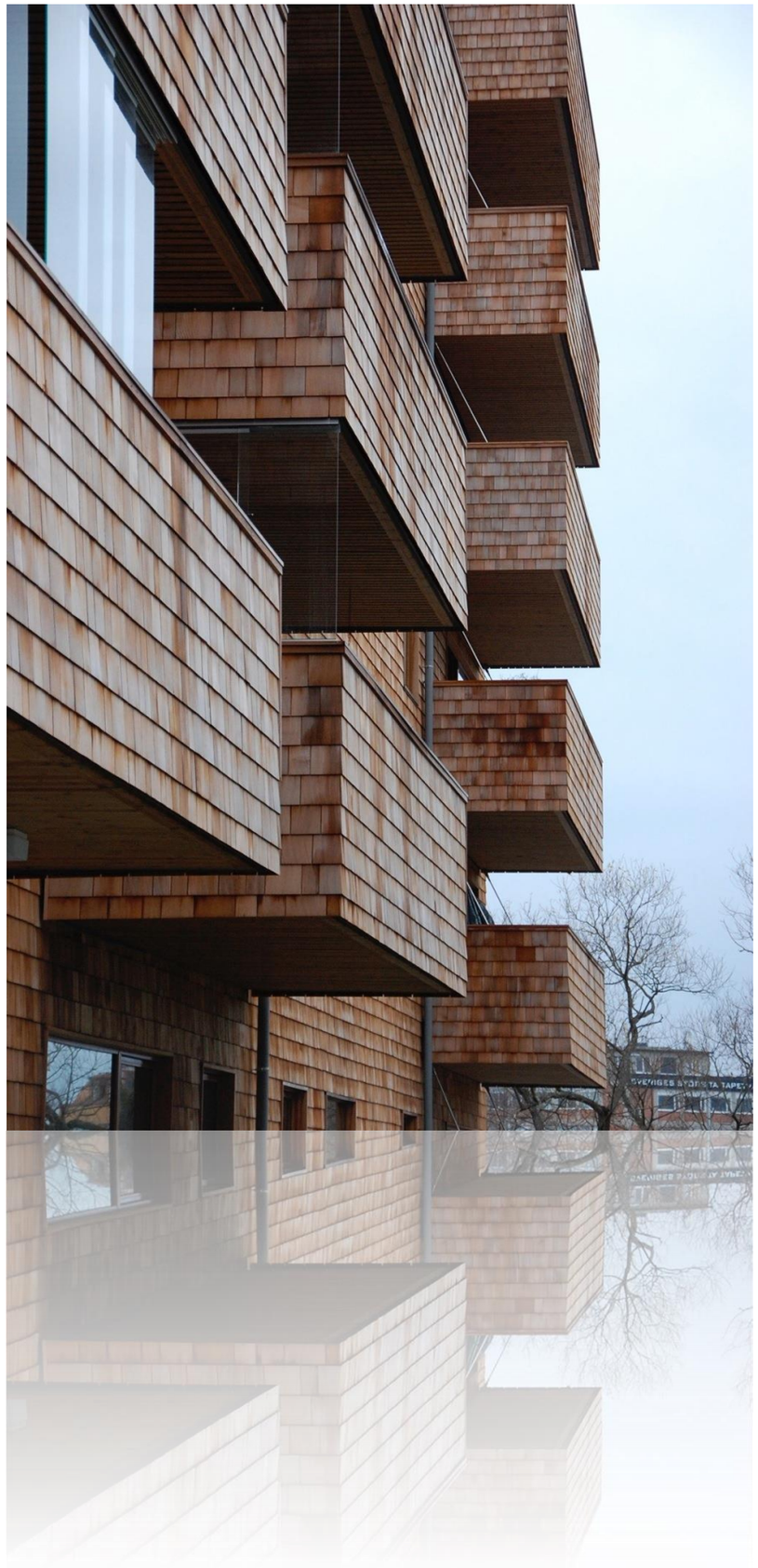


Image: Prof. Micael Flach

Designing with Timber:

Some things to consider as the architect:

1. Source from sustainably managed forests & choose the right material for the job.
2. Keep the wood dry or detail so as to avoid water pooling.
3. Large loads need large members.
4. Timber support systems typically have deeper cross sections than steel or concrete.
5. Creative geometry requires complex connections.
6. High quality finishes are less important if members are viewed from distance (e.g. 5m or more).
7. Large scale/long span buildings require an effective design and fabrication team.
8. High structural demands require quality raw materials and supervision of manufacturing and construction.



Timber as Modern Building Material:

But what about…

- Fire Performance (doesn't wood burn?)
- Longevity (rot, white ants etc. - will it last?)
- Acoustics (great for concert halls but...)
- The Environment (but isn't cutting down trees bad?)
- Regulatory Compliance (BCA/NCC building approvals)

Timber as Modern Building Material:

Wood - What is it?

- Naturally occurring material with structural properties suitable for a wide range of applications.

- Wood is **anisotropic -** Properties that differ according to direction of measurement.

  (Steel is isotropic meaning its structural properties are identical in all directions)

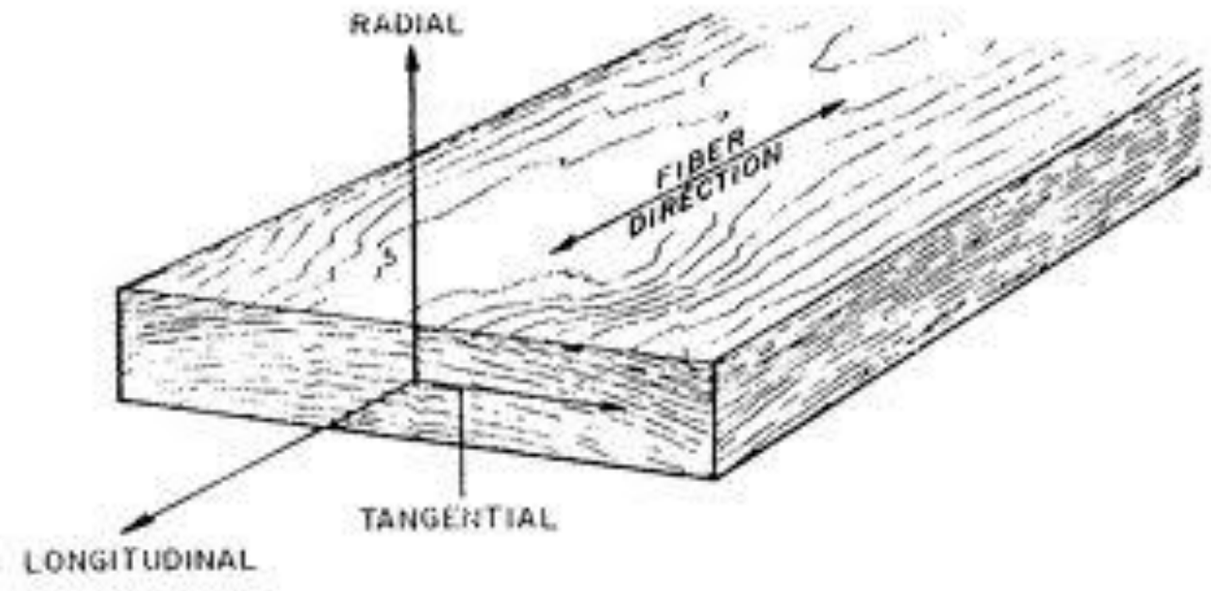
- It has Three different orientations:

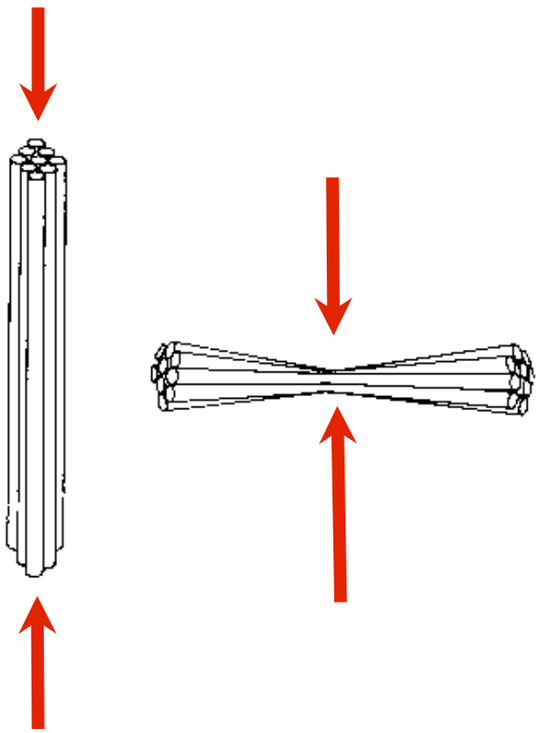
  Longitudinal - parallel to the grain

  Radial - across the growth rings

  Tangential - tangent to the growth rings

- Timber is up to 5 to 10 times stronger parallel to grain than across the grain.





Timber and Fire:

Three common methods of regulatory compliance:

- 1. Charring protects the inner core of a timber post, panel or beam allowing a structure to remain standing in a fire for a known period of time.

  (Charing is unique to timber. Steel softens, melts and collapses. Concrete explodes!)

- 2. Encapsulation

  (Layers of Gyprock [e.g. Fyrechek] or water based fire retardant, intumescent coatings.

- 3. Sprinklers

  (Becoming quite common in buildings. Often included so no longer considered an extra cost burden)

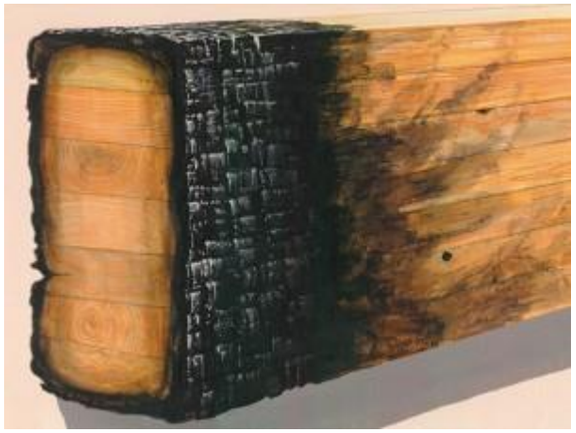
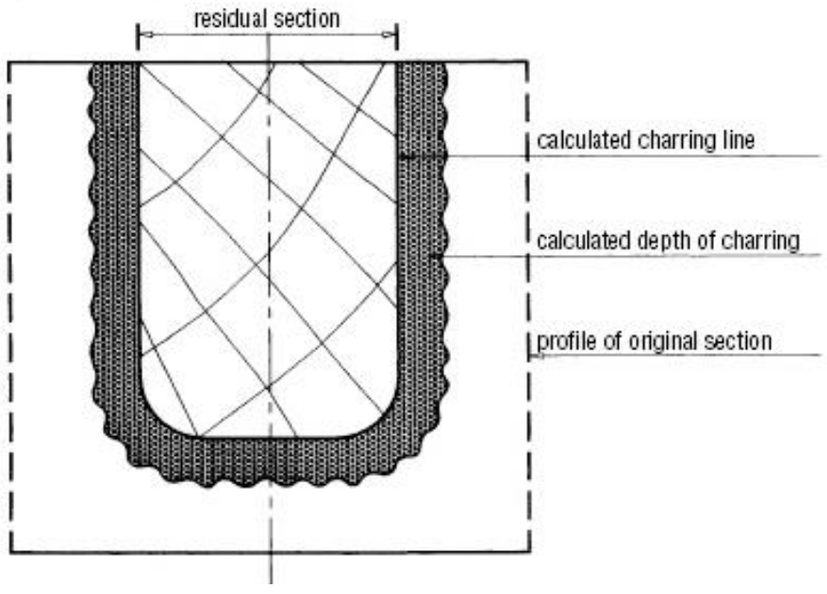


Image: *structuremag.org/?p-1129*



Timber and Termites:

The risk of major damage termite damage is very low... but all types of timber are at risk from termite attack.

The key to reducing putting your building at risk of termites is:

- Select naturally termite resistant timbers or appropriately treated timbers
- Keep it dry
- Maintain scheduled inspections
- Maintaining physical and chemical barriers and avoid potential bridges

Image: *timberinfo.com.au*

Application	Treatment Level
Interior, above the ground	H2 or H2F*
Exterior, above the ground	H3
Exterior in ground contact	H4 or H5

*South of Tropic of Capricorn only.

AUSTRALIAN STANDARDS:

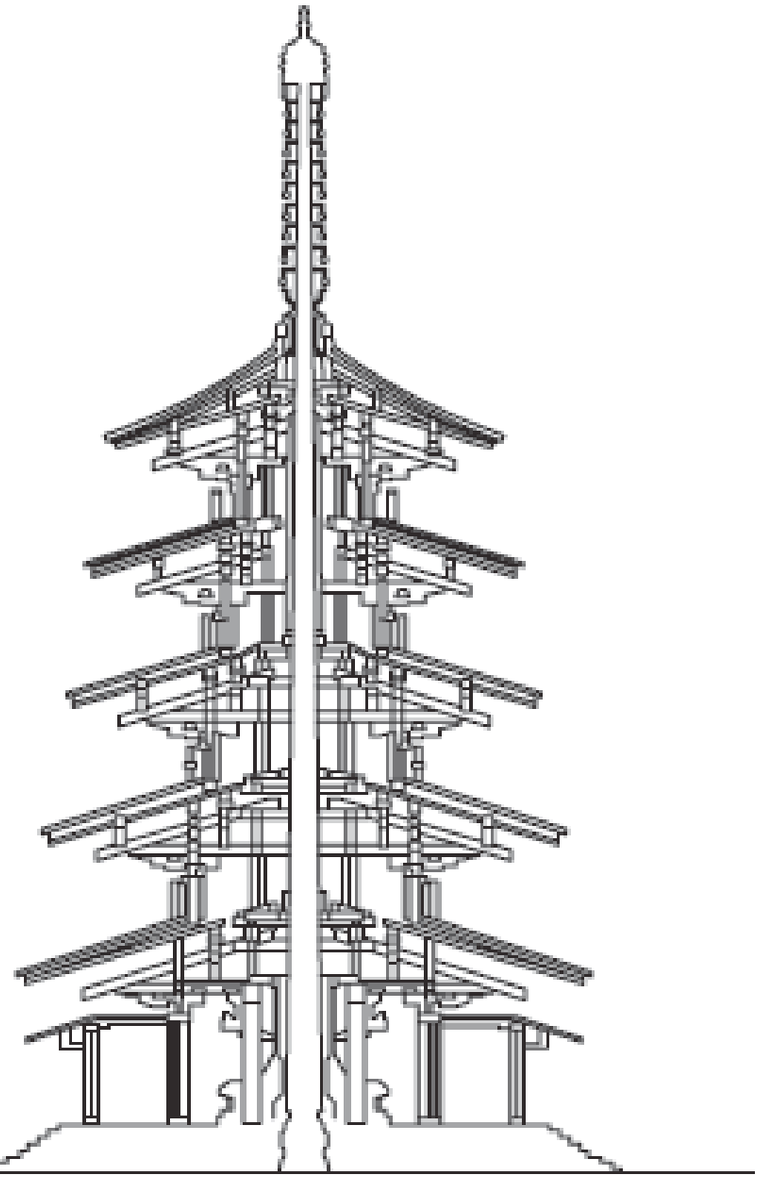
- AS 3660.1-2000 : Termite management - New building work
- AS 3660.2-2000 : Termite management - In and around existing buildings and structures - Guidelines
- AS 3660.3-2000 : Termite management - Assessment criteria for termite management systems
- AS 4349.3-1998 : Inspections of buildings - Timber pest inspections

Timber Rot:

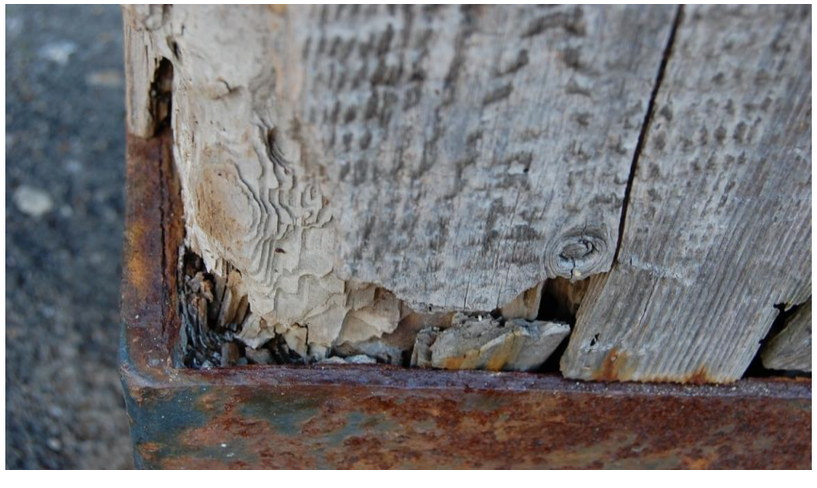
The key to timber's longevity is to keep it dry!

Remember – No wet horizontal surfaces = no problem

Image: Barry Philips Smith – bps eco



Horyu-Ji Temple, Nara Japan. Built in 607AD
As of 2015 = 1,408 years old!!!



Timber and Acoustics:

Different classes of buildings within the Building Code of Australia have different acoustic standards and need different solutions.

Sources:
- External Noise
- Inter tenancy/apartment noise
- Airborne sounds and impact sounds

Methods:
- Structural/Acoustic Isolation - Discontinuous Isolation
- Acoustic Dampeners
- Incorporate mass into the structure

TIMBER FRAMED WALLING

70 x 45 mm F5 staggered timber studs at 600 mm centres both sides on 120x35 mm F5 timber plates with—

(a) one layer of 16 mm fire protective grade plasterboard on both faces; and

(b) 50 mm glass fibre batts.

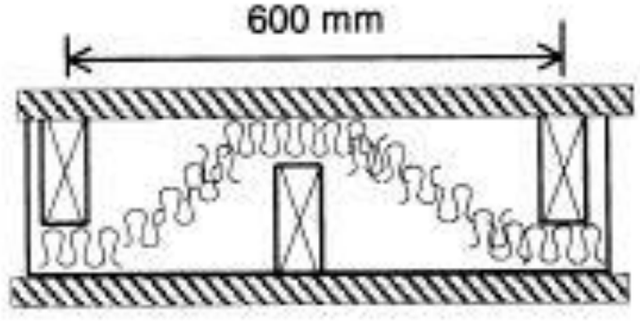
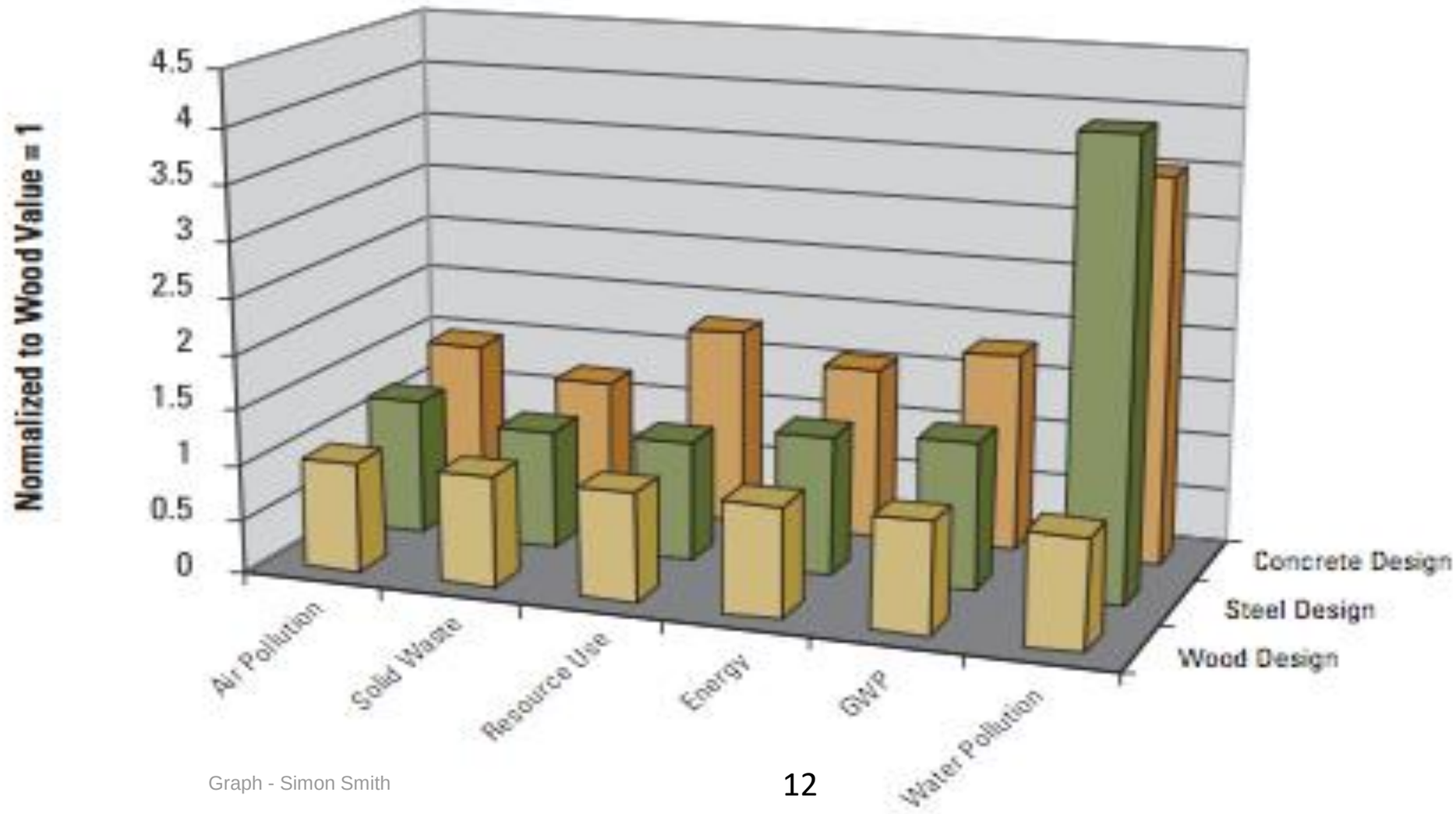


Image: BCC

Timber and the environment:

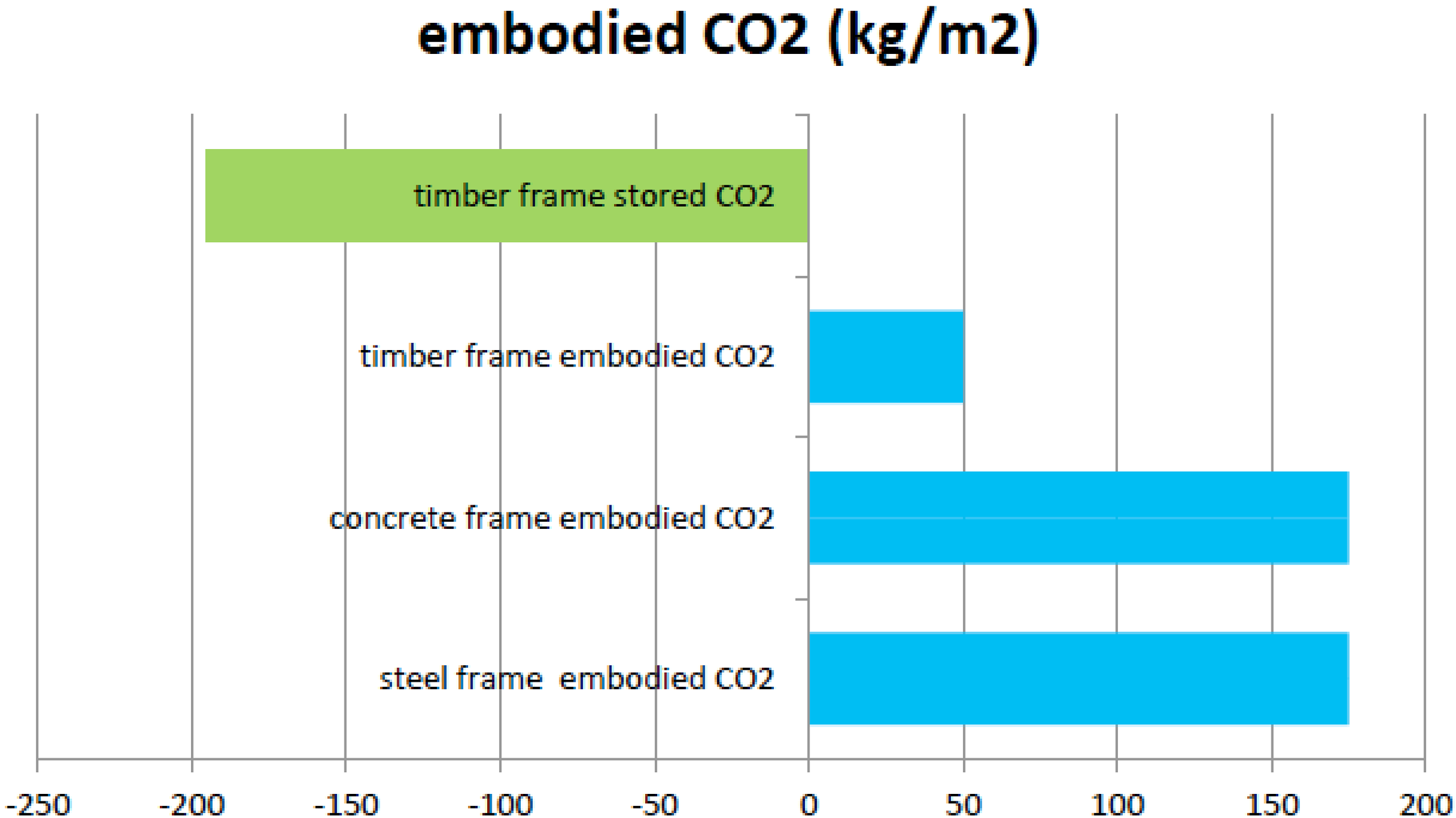
Timber:

- Our only conditionally renewable building resource:
- Reusable – Recyclable - Biodegradable
- Wood products require far less energy to manufacture than other non-wood building materials
- Growing trees reduces greenhouse gases
- Wood structures store carbon (wood is typically 50% carbon)



Graph - Simon Smith

Timber and the environment:



Graph - Simon Smith

Timber and Regulatory Compliance in Australia:

BCA/NCC and timber.

- Deemed-to-Satisfy solution for any two storey building
- Up to three storeys for Class 2 Residential building.

Can be timber if invoking the ‘conditional concession’ clause for light timber frame in-lieu of using a ‘non combustible’ material and ground floor built is with non combustible.

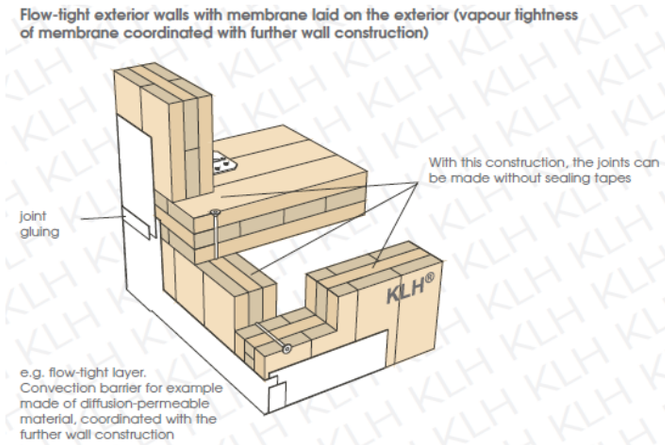
- Three stories and above Performance Based Solution via Codemark

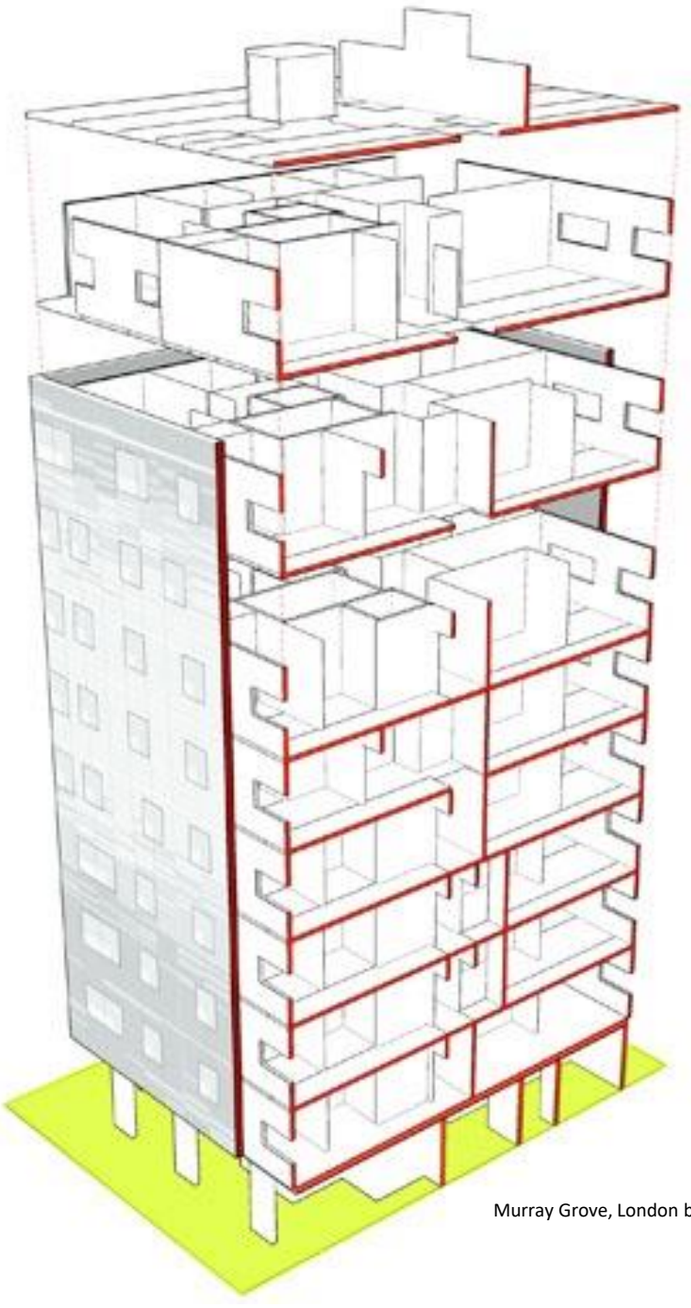
(Assessed by registered certification bodies such as SAI Global, Global-Mark or CertMark Australasia.).

- Local government approvals

Assessors may be unfamiliar with new engineered systems such as Cross Laminated Timber (CLT) etc.

Timber and Modern Methods of Construction:



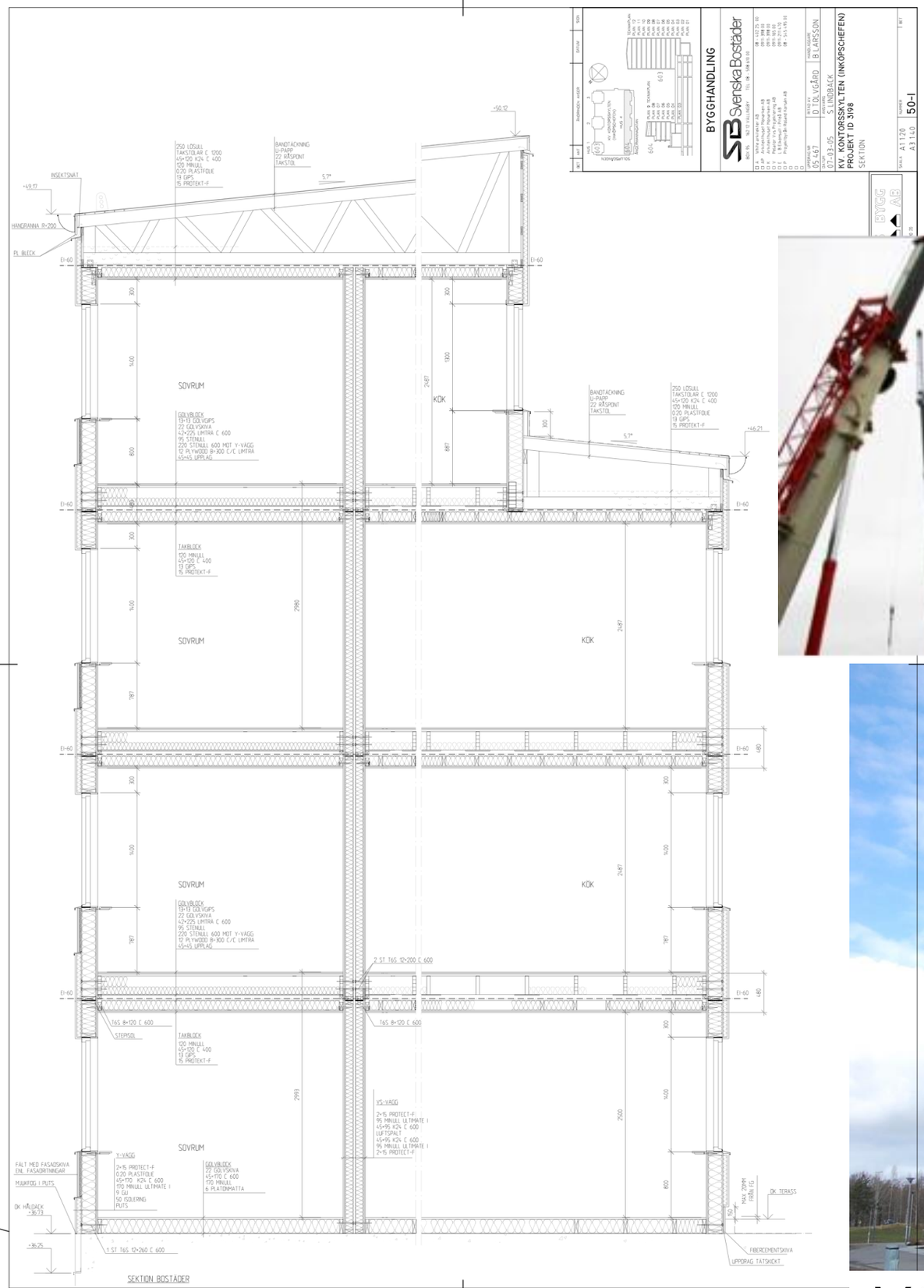


PLANAR - CROSS LAMINATED TIMBER

Images - KLH and D.Bylund

Murray Grove, London by Waugh Thisleton Architects

Timber and Modern Methods of Construction:



VOLUME MODULE CONSTRUCTION

Timber Structures:

Portal Frame Systems with Solid Sections

- **Glulam** – can be curved
- **Laminated Veneer Lumber** (LVL)

Portal frames have large bending moment near knee and apex

Gunns Veneers, Boyer, Tasmania.
Photos: Greg Nolan

Showground buildings, Sydney

Timber Structures:

Portal Frame Systems with Hollow Sections

Box beams

- High strength top and bottom flanges and plywood webs.
- Good torsional stiffness and strength.
- Can reinforce and thicken critical knee region.
- Lightweight structural system.
- Hollow sections can conceal wiring and services.

MOTAT Museum Auckland. Images: *architravel.com*

Timber Structures:

Dome Systems

- Reticulated domes have many members.
- Very efficient – high span to member depth ratio > 50.
- Gravity loads give compression, wind also gives bending
- Many members and many connections.
- Some repeated but often complex detailing.
- Connection capacity can be critical.
- Construction sequence may be crucial for stability






Exhibition buildings, Homebush Sydney. Images: Geoff Boughton

Timber Structures:

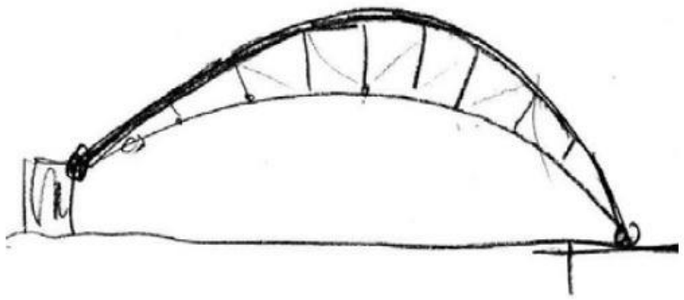
Tree Systems

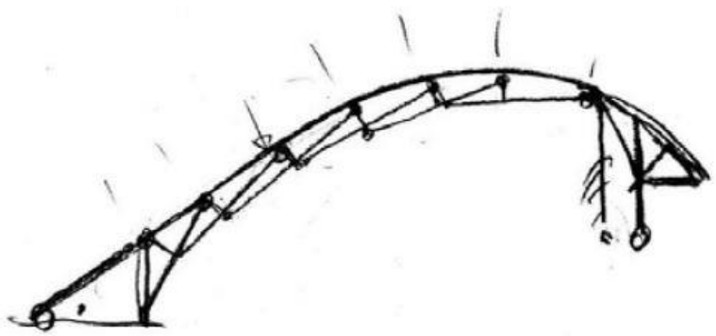
- Branching network carries loads to large central columns.
- Balanced horizontal forces at base.
- Complex connection at base.
- Compression members require bracing or large section (e.g. combined elements).

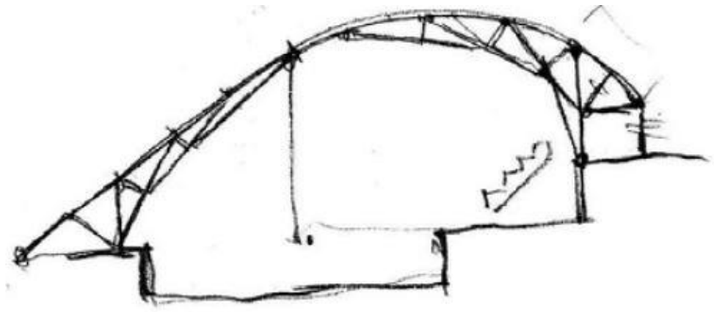
Swimming Pool Structure. Sete, France. Images: Michael Flach

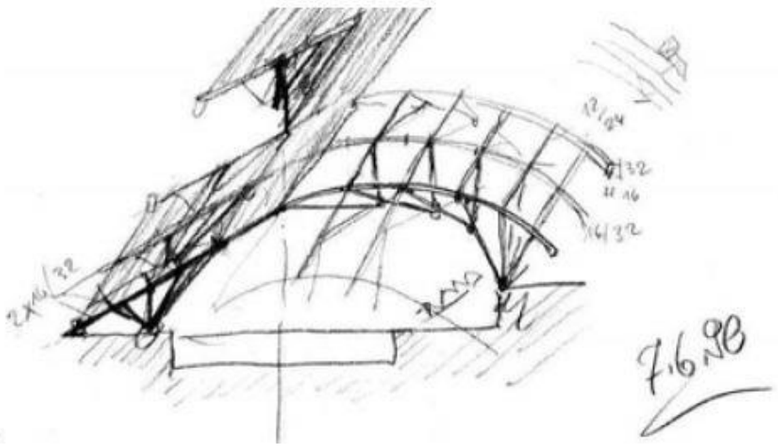
Timber Structures:

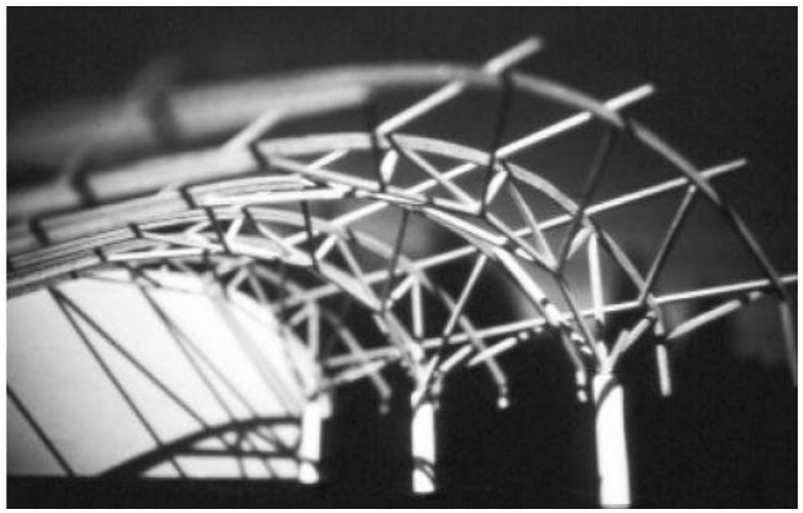
Curved Glulam, Truss and Tree Systems combined – Sete Swimming Complex, France

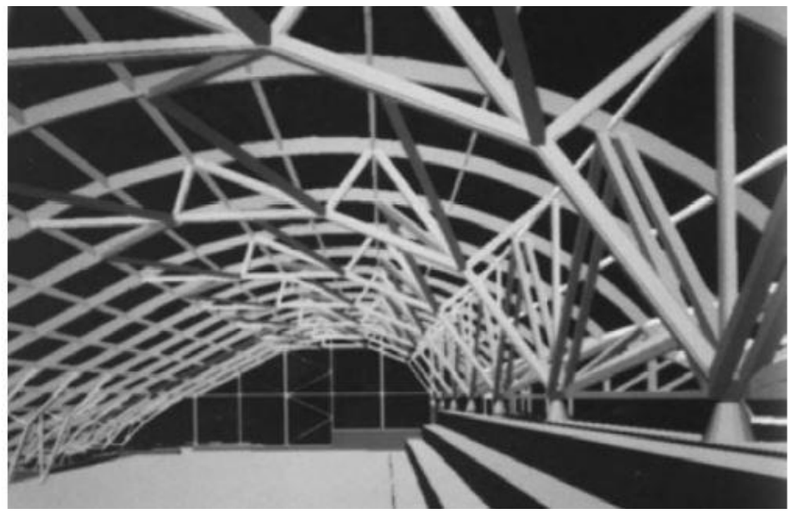












Swimming pool structure design and construction images: Michael Flach

Image: gosouthfrance.com

Timber Structures:

Free Form and Gridshells

Grid Toroidal roof. St Quentin, Paris. Images: Michael Flach

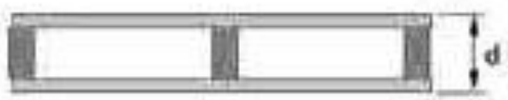
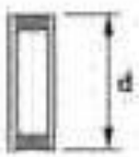
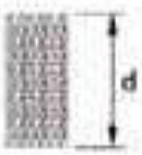
Weald and Downland Grid Shell. Images: Edward Cullinian Architects

Saville Garden Grid shell. Images: Green Oak Carpentry

Masseria Ospite. Images: inhabit.com

Timber Structures:

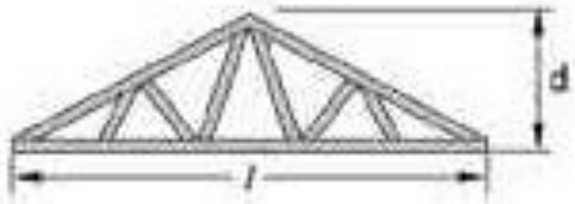
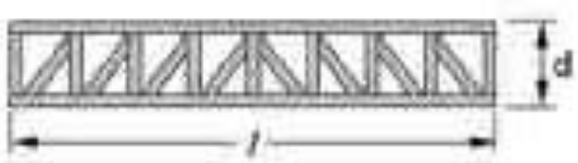
Timber Roof Structure – Estimated span ratios for various structural systems

Decking, joists and beams		Typical spans, m	Approximate span to depth ratio (l/d)
Wood decking		1 to 2.5	25 to 35
Panels		0.3 to 0.6	20 to 40
Dimension Lumber		3 to 7	15 to 25
Wood I-joists		6 to 10	20 to 25
Stressed-skin panels		3 to 7	24 to 30
Plywood box beams		4 to 9	18 to 20
Parallel strand lumber		4 to 18	18 to 20
Laminated veneer lumber		4 to 18	18 to 20
Glulam		4 to 25	18 to 20

Source: Canadian Wood Truss Association (cwta.net/structural)

Timber Structures:

Timber Roof Structure – Estimated span ratios for various structural systems

Trusses and Arches		Typical spans, m	Approximate span to depth ratio (l/d)
Pitched trusses		6 to 30	2 to 5
Parallel chord trusses		6 to 30	10 to 15
Bowstring trusses		20 to 50	5 to 10

Source: Canadian Wood Truss Association (cwta.net/structural)

Timber Resources:

- Wood Solutions - woodsolutions.com.au
- Timber Building Australia - oak.arch.utas.edu.au/tbia
- Tall Wood. The Case for Tall Wood Buildings, M.Green,2012 wecbc.smallboxcms.com/database/rte/files/Tall Wood.pdf
- The Australian Timber Data Base www.timber.net.au
- The Australian Timber Design Awards: www.timberawards.com.au

THANKS FOR LISTENING

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