INTRODUCTION

IMAGINE + CREATE + ENGINEER

engenuiti
INTRODUCTION

Perceptions of Timber Construction?

Architectural / Bespoke / Expensive / Green-wash / Fire / Insurances
Perceptions of Timber Construction?

Structural / Modular / Fast-Build / Cost Efficient / Fire Resistant / Normal
ENGINEERED TIMBER

TYPES OF ENGINEERED TIMBER
CLT – MAKING THE PRODUCT
CLT – MANUFACTURERS & CONTRACTORS
CLT – ADVANTAGES & OPPORTUNITIES
CLT – WATCH OUT FOR...
PROCUREMENT
Types of Engineered Timber

- Glue Laminated Timber (Glulam)
- Laminated Veneer Lumber (LVL)
- Stressed Skin Cassettes
- Cross Laminated Timber (CLT)
- Composite & Hybrid Products
- CLT has created new possibilities
ENGINEERED TIMBER

CLT – Making The Product
CLT – Manufacturers & Contractors

Approx 12 CLT Panel Manufacturers (Europe)

6 ‘Major’ Manufacturers:

- Stora Enso 700,000 m²
- KLH 500,000 m²
- Binderholz 400,000 m²
- Mayr Melnhof-Kaufmann 300,000 m²
- Merk Finnforest 200,000 m²
- Schilliger 200,000 m²

Specialist Contractors (UK)

- KLH
- Eurban
- B&K Structures
- Constructional Timber
CLT - Advantages & Opportunities

Airtightness

- CLT structures typically offer higher levels of airtightness than traditional construction (Passivhaus approach).

Quality

- Surface grade finish of boards can be specified for exposed finish.

Services Installation

- CLT forms an easy surface to fix to and services installation is likely to be quicker when compared to conventional construction.

Secondary Structure

- Secondary framing or brackets are virtually eliminated in CLT structures.

Embodied carbon

- A typical CLT structure will require significantly less energy to manufacture than a steel or concrete building.
- For every 1000m² of building built in CLT instead of steel or concrete, up to 350t of CO₂ is saved/stored (this could represent up to 10 years of operational CO₂ emissions).
CLT - Advantages & Opportunities

Programme
• To optimise programme advantage maximise repetition and adopt rectilinear forms.
• Early weathertight date allows ‘vertically stacked’ programme (follow-on trades).

Arrangements and Spans
• Plan with 2.5m heights where possible (up to 2.95m possible but transport cost increases).
• Limit spans to 7.5m where possible (greater spans >230mm thick panels).

Loadbearing facade
• Use loadbearing CLT façade structure, preferably with a punched window approach.
• Windows are pre-ordered as CLT tolerances are high.

Roof
• A simple CLT roof profile also aids an early watertight date (slight falls if possible).

Foundations
• Shallow strip foundations are more likely possible if a load bearing wall structure is adopted.

Waste
• You pay for holes, plan board layouts to suit opening where possible.
• Construction waste associated with the structure is virtually zero.
CLT - Watch Out For...

Design Responsibility
• Engineers should design CLT
• Knowledge/understanding CLT supply chain
  (design using standard panel sizes)

Building Services
• Early and detailed design coordination is required
  (prior to panel fabrication).

Acoustics
• Strategy should be determined at early design stage.

Floor Vibration
• Determine design limits for intended use (e.g. 8Hz natural frequency)

Thermal mass
• CLT has less thermal mass than exposed concrete soffits (nat vent)

Exposed Finishes
• Early attention to details required (fixings)
• Board grade (cost allowance for upgrade)
• Staining (rain + UV)
• Drying shrinkage (gradual commissioning of building heating system)

Fire
• Fire engineered approach - exposed CLT panels can be engineered for 1hr fire resistance.
• Exposed CLT will require a spread of flame treatment (UK).

Cost Comparison
• Not just capital cost of frame – consider additional inherent benefits of CLT ie programme, foundations, façade, secondary structure, wet trades etc
• Knowledge of benchmark cost data of CLT structures: £/m2 GIFA, £/m3 CLT
Procurement – UK Current Model

**Designer / Engineer**
- Concept Design
- Coordination
- Detail Design
- Element Layout
- Connection Design
- Construction BIM Model
- Construction Drawings

**Specialist Contractor**
- Contract Management
- Erection Sequence
- Loading Sequence
- Erection

**Timber Manufacturer**
- Fabrication Drawings
- Manufacture
- Cutting Patterns
- Fabrication
- Transport

**Client**

Engineering Expertise does not get worked into concept / scheme design stages
FURNESS ACADEMY
TIMBER AS STRUCTURE
TIMBER / STEEL HYBRID FORMS
LEVEL 2 BIM FOR COORDINATION
Furness Academy is a new build facility that brings together two existing schools on to a state-of-the-art new campus. The Academy specialises in an arts-based curriculum and the design has focused on these aspects. The building features teaching faculties in flexible spaces, including TV studios and dance studios.

The project is the largest Cross Laminated Timber (CLT) school in the UK to date. The design features a hybrid steel / CLT frame in long-span areas to produce the most efficient design.

The project exposes the visual quality of the material in specialist use spaces such as the sports hall and assembly halls. In these areas, double-height walls are combined with glulam or steelwork to create light and flexible facilities for the school.

- Original CLT / Glulam scheme too expensive
- Proposal for CLT / Steel Hybrid made scheme viable
- Move from timber as architecture to timber as structural frame
- Level 2 BIM led by engenuiti for coordination
WENLOCK ROAD
TEN STOREYS RESIDENTIAL TOWER
HYBRID FORMS
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- Architectural concept too complicated for CLT only scheme
- Proposal for CLT / Steel Hybrid made scheme viable
BSKYB OFFICES
MAJOR OFFICE DEVELOPMENT
GLULAM AND CLT SCHEME
BSKYB OFFICES
TIMBER FUTURES

Until recently, the idea of using renewable materials in high-rise construction was viewed by many as the realm of fantasy. However, in recent years the use of timber has been emerging as a practical option.

Over the past twelve months we have been applying our knowledge and expertise to the use of Cross Laminated Timber (CLT) frames in high-rise construction. We have been able to put this research into practice and have undertaken several feasibility studies and concept designs for clients for timber frames between six and twelve storeys. So what is next for timber frame construction? There are a number of technical challenges, including fire risk, robustness and acoustics that are benefiting from industry wide research in which we are fully engaged.

With these issues being addressed, the residential sector can benefit greatly by using CLT framing systems. We are seeing Planning Authorities looking to introduce planning requirements for timber buildings and clients seeking to capitalise on these opportunities.

But how high can we go? Currently the world’s tallest CLT building is the ten-storey Forne Building in Melbourne. However, there are several recent studies, including those by MGB Architects in Vancouver, and Cambridge University, which suggest thirty to seventy storeys are possible if hybrid structural forms and chemical modification of timber are explored. We have had fun exploring the possibilities and currently have a twenty-storey CLT building and a thirty-storey CLT / concrete hybrid building on our sketch wall. Just looking for the right moment!
Towers Built Out of Wood, Not Steel

By HENRY FOUNTAIN

The movement to construct tall buildings largely with wood as an environmentally friendlier alternative to steel and concrete has received a boost from an unusual source—a leading architectural firm known for its towers of steel and concrete.

Skidmore, Owings & Merrill, the Chicago-based firm that has designed a long list of skyscrapers, including the new One World Trade Center in Lower Manhattan, has developed a structural system that uses so-called mass timber—columns and thick slabs that are laminated from smaller pieces of wood. In a report this year, the firm showed how the system could be used to build a 42-story residential tower that would have a lower carbon footprint than a conventional structure.

“We wanted to see what we can do to help on the sustainability side,” said William F. Baker, a partner in the firm. “With its system, about 70 percent of the structural material is wood; most of the rest, including the foundation, is concrete.”

Benton Johnson, an engineer who worked on the report, said wood-construction could help solve the problem of providing adequate housing to the billions of people living in cities—while also addressing climate change.

“We know that we need to build a lot more buildings,” Mr. Johnson said. “And we know that we need to lower CO2.

Until now, tall wooden buildings had been championed by architects and engineers mostly from smaller firms outside the United States. They welcomed the Skidmore, Owings & Merrill report.

Michael Green, an architect in Vancouver, British Columbia, who helped devise a different structural system for wooden towers that was detailed in a report last year, said: “This is the first new way to build in a hundred years.”

Few modern tall wooden buildings have been built around the world, and only one, an apartment building that was completed this year in Melbourne, Australia, has reached 10 stories. Mr. Green’s design of a 37-meter mixed-use building in Prince George, British Columbia, will make it the tallest wooden building in North America when it is completed next year.

Constructing more and taller towers will require changes in building codes—most of which limit wood structures to four stories or fewer—and construction methods. Architects, engineers, contractors and, crucially, developers will have to be convinced that wooden buildings can be safe, attractive and profitable. Production of steel and concrete produces significant amounts of greenhouse gas carbon dioxide, while wood holds the carbon from CO2 removed from the atmosphere through photosynthesis. So using wood in the structural elements can help offset the carbon emissions from the other parts of the construction process and from the operation of the finished building.

Wooden high-rises would have a smaller carbon footprint.

Making a Case for a Timber Tower

Engineers are developing ways to build skyscrapers largely of timber, which would reduce construction-related carbon dioxide emissions compared with conventional structures of concrete and steel. They designed a timber tower based on an existing conventional 42-story apartment building, and compared the two.

PROPOSED STRUCTURAL SYSTEM

TIMBER COLUMNS

TIMBER FLOORS, 20 CM THICK

SOLID TIMBER WALLS FOR STABILITY

Typical floor

The tower would be approximately 70% timber and 30% reinforced concrete.

A timber tower would be lighter so the foundation does not have to be as massive as for a conventional structure.

COMPARING TIMBER AND CONVENTIONAL STRUCTURES

PROPOSED timber structure

BENCHMARK concrete structure

VOLUME OF MATERIALS

BILDING WEIGHT

ESTIMATED CO2 EMISSIONS

Steel

Wood

Concrete

This is not conventional frame construction, in which thin elements are nailed together, but more akin to building with concrete slabs. Mr. Baker said as long as forests were managed, sustainable wooden buildings should not have much of an impact. There are also millions of fir trees in North America that were killed by a beetle infestation and that could be used to produce the timber panels.

The Skidmore, Owings & Merrill system uses a type of engineered wood called glued laminated timber, or glulam, for the building columns, and cross-laminated timber slabs for the central core, floors and shear walls, which provide stiffness against wind loads. But the concept calls for concrete beams along the perimeter of each floor and elsewhere to allow for longer spans and more flexibility in layouts.

Mr. Green, in his report, presents a system that could be used to build towers in seismically active areas like Vancouver. Rather than concrete, he uses some steel beams to allow the building to better respond to earthquake forces.

Andrew Waugh, a British architect whose nine-story apartment building in London, completed in 2006, has become a showpiece of the wooden-tower movement, said both reports would help build momentum for buildings taller than 10 stories.

“It’s such an exciting time,” Mr. Waugh said. “It feels like the birth of flight—it’s one of those kinds of moments in engineering.”
34 Storey Tower – Berg / CF Moller Architects
20-30 Storey Tower – MGB Architects, Canada
20-30 Storey Tower – MGB Architects, Canada
14 Storey, 20,000m2 Residential Development, St Petersburg, Russia – Engenuiti
HYBRID FORMS

When we talk to developers, architects and contractors they are often amazed at the opportunities opened up by steel and timber hybrid structural forms for office and residential buildings. Our ideas slice months off more traditional construction programmes, remove all wet trades, reduce costs and have a significant effect on reducing the carbon content of the building. But how have we got here?

When we first established Engenuiti we were drawn to Cross Laminated Timber (CLT) as a new material and the possibilities it presented for innovation in structural form, as well as how it could be applied to different building types. We set out to become experts in the design and engineering of CLT so that we could exploit its full potential and influence its future use in the industry.

In the UK the use of CLT as a structural material has evolved from a bespoke, architecturally and sustainability-led design option to an industry-wide structural frame solution. However, most design solutions have been limited by the industry supply chains where there is a bias towards timber structural frame solutions. Over the past two years we have worked closely with specialist contractors, fabricators and suppliers to introduce steel framing to the solid timber solution where this provides the most economic overall package. We have since designed and supervised construction on several of the biggest hybrid steel/timber buildings in the UK including the world’s tallest CLT tower under construction in London.

We are now in a position where we can apply this knowledge of the design, fabrication, linking of supply chains and construction to all building types - and the benefits to developers and constructors are there to be explored. We look forward to talking to you...
VIRTUAL INSANITY?

There has been a step-change in industry interest in Building Information Modelling (BIM) over the past few years. BIM is an area that we have been championing and we are now moving towards BIM at Level 3 for our Advanced Timber Engineering Projects in Solid Wood. Our structural models have several object based attributes for each element, including type of panel, thickness, member directions, surface finish, and cost data.

That model file is shared directly with the supply chain partners who then add connection detailing, fabrication cuts and joints. Fabricated elements laser cut in the factory allow construction sequences and material supply logistics to be monitored in real-time. We really are moving from Virtual Insanity to Reality...