Mid-rise Timber Construction in Australia

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Engineer: Irwin Consult
Builder: Australand
Location: Parkville, Vic

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Architect: Bates Smart
Engineer: Aurecon
Builder: Lendlease
Location: Bowen Hills, QLD

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1. Introduction

The 2016 National Construction Code (NCC) introduced Deemed-to-Satisfy (DTS) provisions for 'fire protected timber', allowing timber building construction in Class 2 (apartments), Class 3 (i.e. hotels) and Class 5 (office) buildings up to an effective height of 25 m (from here on referred to as 'mid-rise' timber construction). The 2019 NCC expanded these provisions to all Building Classes, further increasing the opportunities for adopting DTS timber construction systems for schools, aged care buildings and every other typology.

These NCC changes have lead to substantial opportunities for the cost-effective delivery of mid-rise timber buildings, and as such generated significant interest from building professionals. There are significant efficiency, speed and cost benefits in using timber structural systems compared to alternative materials, including:

- reduced on-site construction infrastructure (preliminary costs) such as fixed cranes, site accommodation, scaffolding and edge protection, hoists, etc.;
- direct savings from faster methods of construction compared to traditional steel and concrete structures due to: increased scope for off-site prefabrication and lighter and more easily maneuvered and installed materials;
- reduced foundation requirements due to a lighter above-ground structure;
- significantly reduced on-site costs and Work, Health and Safety (WHS) issues, particularly with a shift to more prefabricated solutions;
- increased ability to commence follow-on trades earlier in the construction process, reducing the overall construction time;
- significantly lower impacts of noise and site activities on local neighbourhoods (less truck movements and construction operations requiring large plant); a major benefit for suburban developments.

The NCC requires that all buildings are designed and constructed to comply with the stated Performance Requirements. The NCC Performance Requirements can be met by using either the Deemed-to-Satisfy (DTS) provisions or a Performance Solution. Designers often use a combination of DTS and Performance Solution to deliver the most cost-effective overall building result.

Further details on the Performance Requirements and Deemed-to-Satisfy solutions for mid-rise timber buildings are provided in *WS TDG#37 'Mid-rise Timber Buildings'.*

Mid-rise timber construction can provide significant efficiency, speed and cost benefits compared to alternative materials and methods

Project: 25 King
Architect: Bates Smart
Engineer: Aurecon
Builder: Lendlease
Location: Bowen Hills, QLD

2. Mid-rise Timber Buildings A System Based Approach

With mid-rise timber buildings it's not just about the wood products. Mid-rise timber constructions systems require a 'systems-based approach' to deliver the required level of structural, acoustic, fire and thermal performance. All of these components need to be correctly specified and properly installed to ensure that the systems perform to the level required. When looking at the structure of a building, the system employed may be (but are not limited to) post and beam structures utilising Glue Laminated Timber and/or Laminated Veneer Lumber, panelised structural systems utilising massive timber and/or lightweight framed wall and floor panels, or a combination of both. These solutions demonstrate the fundamental meaning of a system, comprising a variety of different elements such as timber products, brackets, nails, screws, and bracing elements which individually are of little use, but when combined can effectively function as the structure of the building.

As the elements of a system function together to perform the task of the system, different systems can work synergistically to enhance the efficiency of the building as a whole. For example, the additional fire protective linings required over structural timber elements in a Deemed to Satisfy solution or extra thickness of charring timber where a Performance solution not only contributes to the functioning of the fire response system, but also adds extra mass or thickness to the structural element which in turn improves its acoustic performance. By understanding the build up and interaction of these systems designers are able to deliver high performing, high quality, cost efficient buildings.

In this section we discuss the main structural systems seen in contemporary timber designs. A common theme through each system, timber structures are uniquely predisposed to prefabrication. With structural timber products typically manufactured or fabricated in a factory environment, it is a small step to add value prior to delivery to site. For example, it is relatively simple for lightweight timber stud frames and floor cassettes fabricated off-site to be lined with fire protective linings and acoustic insulation systems. This addition of materials in a safe, clean, well lit and supervised off site location reduces both the number of deliveries to site, and the amount of labour completed in the high-risk on-site environment, ultimately improving safety, build times, and overall costs.

This section provides a succinct overview of various materials and structural systems typically utilised in mid-rise timber construction. More information on all of these products or systems is available from the Technical Design Guides in the WoodSolutions resource library, which can be accessed for free at www.WoodSolutions.com.au/publications

Mid-rise timber projects feature a variety of systems, working synergistically to provide high performance, safe, and comfortable indoor environments

Project: Mid-rise Demo Model
Architect: WoodSolutions
Engineer: Vistek
Builder: Sinjen
Location: Chadstone, Vic

3. Timber Construction System Options

A range of structural timber system options are available for the construction of mid-rise timber buildings, providing a variety of ways to optimise the needs of a specific project. For further information refer to WoodSolutions Technical Design Guide #46 - Guide to Wood Construction Systems.

3.1 Lightweight Timber Framed Systems

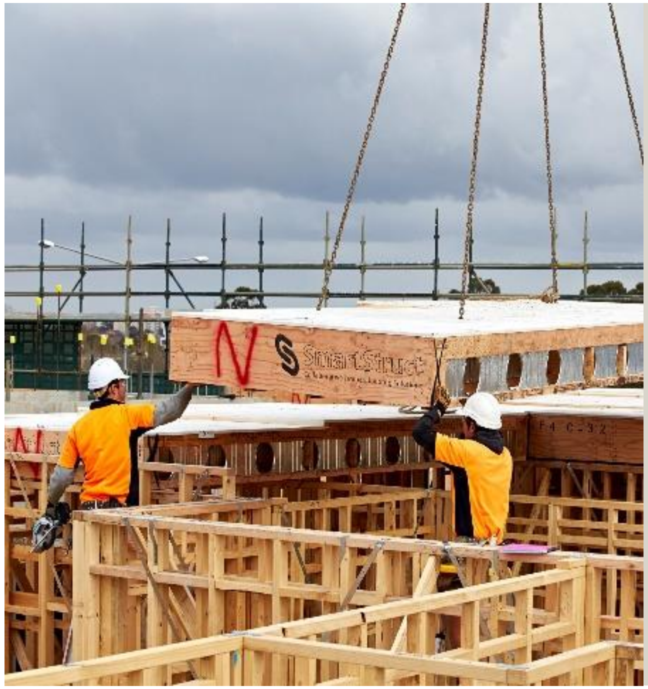
For mid-rise timber buildings up to around 6 storeys, where structural timber does not need to be exposed for aesthetic reasons and therefore can be encapsulated within fire-rated linings, traditional lightweight timber framed construction is likely to provide the most cost-effective option.

Lightweight timber-framed construction uses commonly available structural timber framing products such as sawn softwood and hardwood timbers, floor joists, I-beams, and laminated veneer lumber (LVL) elements, assembled into lightweight system elements such as wall frames, floor and roof trusses, and prefabricated cassette floor modules.

Lightweight timber-framed construction is predominately supplied by traditional frame and timber truss manufacturers and specialty timber system suppliers. To maximise speed of construction onsite, lightweight timber-framed system elements (floors, walls, roofs and shafts) can be prefabricated offsite to a variety of different prefinished levels including open frames, partially enclosed elements and fully enclosed elements. System elements that can be added off-site include fire-rated linings, acoustic components, thermal products, non-combustible external claddings, windows, doors, temporary protection systems, amongst others.

Offsite fabricated panelised lightweight timber framed wall systems

Project: Phoenix Apartments
Architect:
Engineer: TTW
Builder: Strongbuild
Location: Rouse Hill, NSW



Prefabricated timber floor cassette systems – a very quick and safe installation method

Project: The Green
Architect: SJB
Engineer: Irwin Consult
Builder: Australand
Location: Parkville, VIC

3.2 Post and Beam Timber Systems

Post and beam construction utilises columns, beams and floor systems acting in an open frame which can provide open and flexible functional areas. This system can be used effectively in Class 2 buildings with non-loadbearing fire and acoustically rated infill walls separating apartments; but it is particularly relevant to Class 5 (offices) and 6 (retail) buildings and Class 9 (educational) buildings where larger open spaces are generally required and there is often a desire to expose the structural timber for aesthetic and biophilic occupancy benefits.

Columns are regularly spaced on a grid determined by the most efficient beam and floor system elements spans; most timber lightweight cassette or panel floor plate systems are one-way spanning systems. Glued laminated timber (GLT), or LVL is generally used for the columns and beams, and also often for diagonal bracing elements (see photo below).

In all of these buildings, the columns, beams and floor plates must comply with stringent regulatory requirements for fire resistance determined by whether these elements will be fully encapsulated by fire rated linings (potentially a Deemed to Satisfy Solution) or exposed (a Performance Solution).

Structural timber elements complement, and even form part of the internal fit out

Project: 25 King
Architect: Bates Smart
Engineer: Aurecon
Builder: Lendlease
Location: Bowen Hills, QLD

Exposed glued laminated timber (GLT) beam and column elements combined with precast concrete floors

Project: RMIT Garden Building
Architect: NMBW Architecture Studio
Engineer: Tim Gibney & Assoc
Builder: Lendlease
Location: Melbourne CBD, Vic

Exposed glued laminated timber (GLT) columns, beams, and diagonal 'K' braces

Project: International House
Architect: Tzannes
Engineer: Lendlease Designmake
Builder: Lendlease
Location: Barangaroo, NSW

3. Timber Construction System Options

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3.3 Massive Timber Panel Systems

Massive timber engineered wood panels (minimum 75mm in thickness under the NCC) such as LVL, Cross-Laminated Timber (CLT), Nail Laminated Timber (NLT), or even large format Glued Laminated Timber (GLT) can be used to form complete mass panel floors, walls and roofs.

Panels are prefabricated off-site and lifted quickly and efficiently into place on-site by crane. The timber panels weigh just 20% of concrete panels of the same size, resulting in easier assembly, smaller crane requirements, reduced permanent loads on the structure and footings, and improved building system seismic performance – all providing project cots savings. Massive timber panel wall systems are well suited to taller buildings, larger structures and heavier loads. Massive timber floors panels can usually deliver shallower floor depths for a given span than lightweight floor trusses and provide excellent resistance to concentrated loads.

Massive panels also have excellent fire-resistance and in many situations panels can be designed to be left exposed to provide a finished ceiling or wall element. High levels of thermal performance are also achievable due to the solid abutting nature of the panels and the ability to seal panel joints – see images below.

CLT panels can be used for both load bearing walls and floor elements in a 'honeycomb' type structure

Project: Aveo Norwest
Architect: Jackson Teece
Engineer: TTW
Builder: Strongbuild
Location: Sydney, NSW

Cross Laminated Timber (CLT) construction used for the structure are in many areas left exposed for its aesthetic and biophilic benefits

Project: Gillies Hall
Architect: Jackson Clements Burrows
Engineer: Aecom
Builder: Multiplex
Location: Frankston, Vic

3.4 Optimised Systems and Hybrid Construction

Most building projects are likely to use a mix of different system approaches to provide the most optimised form of construction. Optimisation may be undertaken based around overall material cost, structural efficiency, and/or speed of assembly and simplicity to construct. On some projects it may be beneficial to use hybrid-based optimised systems involving other construction materials such as concrete, steel, aluminium or composites.

For optimised timber buildings, lightweight framed mid-rise structures might utilise mass timber or concrete lift/stair shafts; or taller mid-rise buildings might use lightweight faming in the upper storey walls and then mass panel framing in the lower levels where the vertical and lateral loads are higher.

Mid-rise buildings will quite typically utilise mass panel walls along with lightweight floor cassette systems; for larger span floors timber-concrete composite or timber-timber composite floor slab systems can be used to keep the overall floor depth down.

Where mid-rise construction takes place below grade (footings, basement car parks, etc.) it is recommended that concrete is utilised rather than timber. These areas experience an increased risk of ground water exposure, and with significant loads and high consequences of degradation it is recognised that reinforced concrete is the best solution here. Often with apartment projects the ground floor level may also be mixed Class (i.e. including retail), in this instance concrete is often utilised for a podium structure, above which timber systems are then constructed. The raised podium also assists by providing a separation of the timber structure from the ground thereby reducing ongoing water related or insect attack durability issues, while the lightweight nature of timber structures above can significantly reduce the costs of the foundations, basement and podium.

Prefabricated timber-concrete composite floor panel

Project: RMIT Garden Building
Architect: NMBW Architecture Studio
Engineer: Tim Gibney & Assoc
Builder: Lendlease
Location: Melbourne, Vic

Massive CLT panels being installed over a first floor concrete podium

Project: Forte Living
Architect: Lendlease
Engineer: Lendlease
Builder: Lendlease
Location: Docklands, Vic

4. Structural Considerations

Structural engineering fundamentals are no different for timber to concrete or steel, but in addition to sound Structural Design – a multi-disciplinary understanding of durability, fire, acoustics, design for manufacture and assembly (DFMA), building codes and supply will add significant value to a mid-rise timber project.

A typical process for design of a mid-rise timber building, from a structural engineering perspective is as follows; it is acknowledged that design is generally an iterative process, rather than linear process shown here, however the following serves to spell out the general design steps required.

Phase 1: Preliminary Design

Step 1: Overall building layout and performance considerations

The architect identifies the building area functions, for example: sole occupancy units (SOU), common areas, corridors, stairs for access and egress, and the use category for any activities on the roof of the building. At this stage load paths should be investigated and where misaligned load paths exist, they should if possible be removed.

Step 2: Preliminary structural design – including Early Supplier Involvement (ESI)

Usually based on early architectural planning drawings information for 'preliminary costings' are developed by the Costing Consultant or Engineer. Usually this involves providing preliminary advice on: the structural approach used (lightweight framing, mass-panel, post & beam, or optimised), structural element layout (floors, walls, cores, bracing walls, transfer structures, etc.) and initial member sizing information.

Timber Floor System Options for Mid-rise Construction

Lightweight cassette floor panels

LVL based cassette floor

CLT floor panels

Timber-concrete composite floor

4. Structural Considerations

Phase 2: Detailed Design

Step 3: Vertical load – Roof and floor design

The floor and/or beam members are designed with the acoustic and fire requirements considered (possible multiple layers of fire-rated ceiling) . These members are typically governed by deflection or vibration. Consequently the effective stiffness (EI) is the critical structural floor property for floor and beam members, protection systems, amongst others.

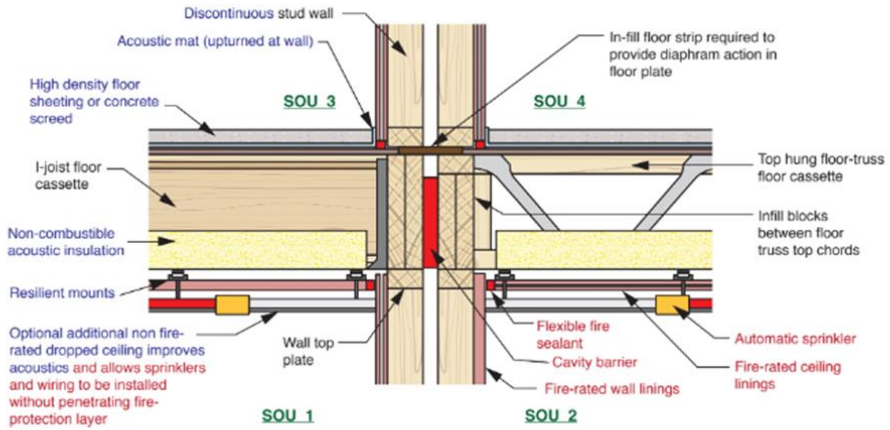
Step 5: Vertical movement design
The vertical movement within the building can have various unintended impacts on the building, including buckling of linings, services cracks, fall of balconies etc. The movement characteristics differ for the parallel grain (walls) to the perpendicular grain (floor) elements and is a function of both shrinkage (due to the change in water content) and deformation (due to loading). The absolute and differential movement should both be considered.

Step 6: Lateral load – Stability design
As buildings increase in height, the overturning forces increasingly become a critical factor for the stability design of mid-rise timber buildings. Therefore, lateral load distribution to the shear walls and tensile forces back to the base structure may be critical. The relative stiffness of each shear wall determines the lateral load distribution, which is largely a function of the connections specified, and properties of the panel designed.

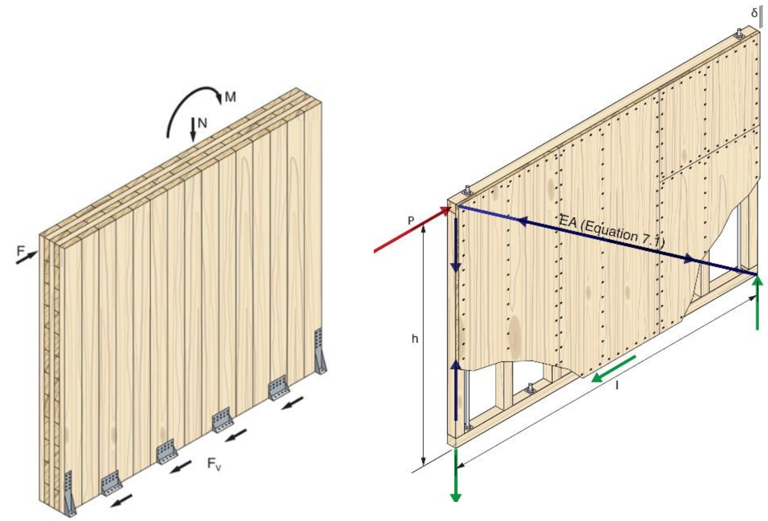
Step 7: Robustness
Special consideration needs to be taken into the alternative load paths (catenary actions, deep beams etc) and connection capacity for NCC Robustness requirements.

Step 8: Other details for consideration
The structural engineer should pay attention to the durability of the building to achieve the required design life - see WoodSolutions Technical Design Guide #05 - Timber Service Life Design. If elements are prefabricated, design for manufacture and assembly (DfMA) principles must be considered to ensure time and cost efficient processing and installation.

Step 9: Engineering drawings and documentation for certification
Engineer's drawings and computations are certified for construction.



Floor/ceiling and wall connection illustrating fire, acoustic, and structural elements



CLT and Timber-framed Shear Walls

5. Acoustic Design

Designed and built correctly, timber systems are capable of achieving high standards of acoustic performance in both wall and floor/ceiling systems. This outcome has not only been predicted by advanced modelling programs but has also been proven in several laboratory and on-site acoustic tests in Australian projects (see WoodSolutions Technical Design Guide #44 – CLT Acoustic Performances).

For an acoustic design to be successful it must address three main measures being: airborne noise (Rw), impact noise (Ln), and structure borne or “flanking” noise. These measures can typically be addressed through two methods including: (1) the addition of mass to a timber element to insulate against airborne noise, and (2) the introduction of a damping layer or structural separation to minimise the transfer of impact noise and vibration.

These fundamental principles can be applied in a variety of wall and floor/ceiling systems. The highest rated wall systems are typically discontinuous between faces, comprising two separate wall elements with a gap between them. Where a lower acoustic performance is acceptable, staggered stud walls or a wall panel with a resilient channel have been shown to perform well, while significantly reducing the number of elements to be installed on the critical path (see images below).

Mass is simply added to wall elements through the use of fire rated or acoustic plaster boards.

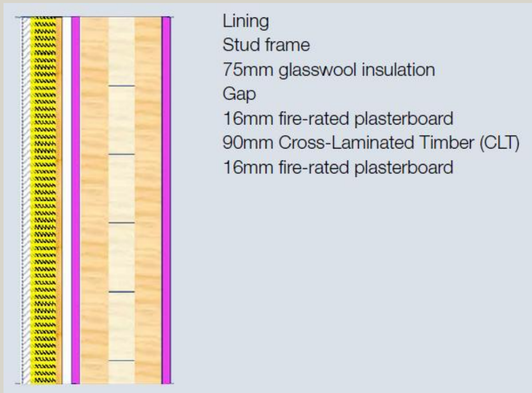
Floor elements can be treated in much the same way as walls, however discontinuity and the treatment of vibration is typically achieved via the installation of resilient mounts between floor joists and the ceiling lining rather than complete structural separation of the element. Mass can also simply be added to floor elements through the installation of fire protective linings to the soffit, and the application of acoustic build-ups to the top of the element. For example, a compliant and high performance floor system may feature an acoustic build up comprising two layers of 19mm particle board on a 10mm acoustic mat, and two layers of 16mm fire rated plaster board fixed to the with resilient mounts.

Designing buildings for acoustic performance has a major impact on the overall satisfaction of occupants. Laboratory and field tests have already shown that timber assemblies can effectively provide high quality sound insulation, and this continues to contribute to the use of timber for more projects. While the currently available systems are cost efficient and high performing, a greater number of buildings will generate more knowledge and more field tests, and result in an expanding inventory of cost-efficient acoustic assemblies and details.

Acoustic Approaches for Wall Systems

Discontinuous stud wall frame

Staggered stud wall frame



Discontinuous mass timber wall

Single stud walls with resilient supports

6. Fire Performance

Used in the construction of structures for millennia, the behavior of timber under fire conditions is more studied and better understood than perhaps any other material.

Centuries of experience show that massive timber elements are naturally resistant to fire, with ignition only occurring once the surface temperature exceeds 300C° (or higher with some species). Once ignited, timber forms a self-insulating layer of char, which slows the impact of the fire, and without an external fuel source often causes it to self-extinguish. This phenomena can be observed in any wood fire, but perhaps the easiest identifiable is the domestic wood fire traditionally used to heat internal volumes. Anyone who has attempted to light one of these understands the amount of care and attention the fire requires to keep it alight, and the variety of different products required to do so (e.g. fire lighters which provide an external source of fuel).

With this unique characteristic noted, the National Construction Code (NCC) provides two pathways to fire design compliance in mid-rise timber structures. The first pathway is known as the Deemed to Satisfy (DtS) solution and relies on the complete encapsulation of structural timber elements in fire protective linings (along with proper use of fire sprinklers, cavity barriers, and non-combustible insulation, and a maximum effective building height of 25m). This solution ignores the impressive properties of the structural timber product, instead wholly relying on various other systems, with in built levels of redundancy to ensure acceptable performance in fire conditions. These requirements exceed the standards of many other major developed economies and ensure Australian projects are some of the safest in the world.

The second pathway detailed in the NCC is that of a ‘Performance Solution’. This solution is applicable to all mid-rise timber designs which fall outside of the DtS, and calls for a Fire Engineer to design and certify the fire systems in the project. For example, it is common for mass timber projects to feature some level of exposed structural timber, whether this is the columns and beams in an office project, or slab soffits in a multi residential project. In these circumstances a fire engineer commonly has enough product information and test data to complete the design successfully, however further tests may be required for unique situations or complex designs.

WoodSolutions offers a range of Technical Design Guides which discuss this topic in depth, all of which are available for free from www.WoodSolutions.com.au/publications

Deemed to Satisfy requirements for a mid-rise timber building

Fire Sprinklers

Non-combustible insulation

Encapsulated timber structure

Cavity barriers as required

7. Building Envelope and Thermal Performance

Timber projects have demonstrated similar or superior thermal performance to buildings utilising traditional construction methods. Depending on the materials and systems employed, timber projects may either utilise a curtain wall façade system, a window wall facade system, or a loadbearing wall façade system. While the envelope in a curtain wall and window wall façade system is dependent on the façade system and not the timber, the loadbearing wall system directly benefits from both the natural properties of timber, and the precision of the construction process.

Timber is renowned for its low level of conductivity, with a thermal conductivity value of just .15-.16 watts/meter-Kelvin (compared to .6-1.8 w/mK for concrete, and up to and over 54 w/mK for steel). This resistance to the transfer of heat creates a high quality insulative envelope, with weak points of heat transfer limited just to penetrations through the wall such as windows or doors. Lightweight framed walls can utilise non-combustible insulation placed within the wall. Mass wall systems utilise the insulation placed on the outside of the wall. For all projects it is recommended that an analysis is conducted to determine the most appropriate wall system build up for the buildings respective climate zone to minimise any potential long term condensation or moisture issues (as experienced on all buildings)

While the characteristics of timber as a material naturally boost the thermal performance of a building envelope, this performance is also supported by the level of air-tightness achieved through the precise cutting and installation of timber components. Indeed, with timber elements cut to size with a computer numerically controlled (CNC) cutting machine, a tolerance of less than 1mm is common (unless the designer purposefully designs in more tolerance). What's more, once installed it is standard practice for all joints to be sealed with an adhesive air tight tape, improving the performance of the envelope further. Installed correctly, this system can easily provide unrivaled levels of air tightness, allowing the designer to focus their attention on more significant thermal weak points such as door and window fittings, and other penetrations.

Whether a project is targeting Passive House certification or is simply seeking improved levels of efficiency in operation, it is undeniable that panelized timber facades are a simple and effective option for achieving your goals.

Example buildup for an external mass timber wall featuring fire protection, a vapour permeable membrane, external insulation, ventilated cavity, and the rainscreen façade finish

Project:	Mid-rise Demo Model
Architect:	WoodSolutions
Engineer:	Vistek
Builder:	Sinjen
Location:	Chadstone, Vic

It is best practice to seal joins between mass timber panels with proprietary tapes to minimise air and water leakage

Project:	Unknown
Architect:	Unknown
Engineer:	Unknown
Builder:	Unknown
Location:	Unknown

8. Off-site Timber System Prefabrication

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One of the key benefits of constructing mid-rise timber buildings compared to concrete structures is the ability to prefabricate many of the building elements off-site and to rapidly assemble the systems on-site with a small assembly team; resulting in cost savings, reduced risk exposure, and higher quality due to the considerably lower construction times.

A wide range of prefabricated system elements are available for floor, wall and roof systems which can be manufactured to tight tolerances within highly controlled factory environments providing superior levels of quality, simply unachievable with traditional site construction. For floor systems prefabricated elements could include:

Lightweight floor cassette panels. Typically, up to 3m wide and 12m long with dimensions normally set by simple transport restrictions. Cassettes can be fabricated using traditional lightweight floor trusses or I-beam joists and plywood, particle board or OSB flooring panels; or for longer spans, rib-slab floor cassettes utilising typically LVL floor joists (ribs) and thick floor-slab panels (45-75mm) and often thick ceiling-slab panels to form structurally efficient closed box sections.

Mass-timber floor panels. Solid floor panels of CLT, LVL, GLT or NLT typically up to 12m long with widths varying depending on products and transport.

For wall systems prefabricated elements could include:

Open panel walls. Lightweight framed wall systems, similar to those use regularly in traditional residential framing.

Partially enclosed wall systems. Lightweight framed wall systems, but with one face clad in the factory. Includes internal or external walls sheathed with bracing panels or external walls sheathed with bracing, vapour permeable membranes and in some instances with external cladding and/or windows preinstalled.

Fully enclosed wall systems. Lightweight framed wall systems, with both faces clad in the factory. Includes internal external walls lined both sides using fire-rated or non-fire-rated linings depending on application or fully finished external walls often with windows and doors preinstalled and sealed and all insulation included.

Mass-timber wall panels. Solid wall panels typically of CLT, or LVL, GLT either unclad or clad with fire-rated linings and/or external wall systems: fire rated cladding, air-gap battens, insulation, vapour permeable membrane, moisture resistant fire rated lining.

Other off-site perfricated elements could include stair panels or bathroom pods.

Floor cassette line

Wall lining installation

Fully enclosed staggered stud walls

External walls with windows installed

9. Onsite Assembly

With building designs largely resolved and structural elements fabricated to a high level of accuracy prior to their delivery to site, on-site construction processes are reduced to an assembly process.

Directly aided by plans indicating the order of element installation and 4D scheduling models, the assembly process of mid-rise timber structures is not only highly ordered and efficient, but also very quiet and safe. Indeed, with timber elements connected with screws, nails, and/or dowels, the number of power tools required on site is limited to battery powered screw drivers, staple guns, and on some projects, compressed air nail guns. Unlike traditional construction systems there is no need for concrete pumping trucks, welding, or large cranes to move heavy formwork or steel reinforcing bars around the site.

Prefabricated elements are delivered to site in a predetermined order for assembly. Once on site, prefabricated timber elements generally require the assistance of a small crane for their lifting and installation. This means that site productivity is limited to the productivity of the crane, and therefore there is only a need for enough labour to service and follow the crane – typically 5-8 people. While a reinforced concrete element requires formwork, steel fixing, concrete pumping, concrete placement, and potentially other trades, these extra contracts, and extra workers on site can be completely avoided in the installation of timber.

It is widely understood and accepted that timber construction is safer than traditional construction processes. With minimal manual handling, fall protection often installed on floor panels before they are lifted, a significant reduction in the number of labour on site, and a reduced on-site program it is clear that the risk exposure on timber projects is significantly reduced. Indeed, this gold class safety standard has been demonstrated on a wide variety of timber projects in Australia and around the world, with one of the largest timber builders, Lendlease, yet to record a 'Lost Time Injury' (LTI) on a timber site at the time of writing.

With correct pre-planning, a consideration of timber's potential and a bit of experience it is easy to see how a timber structure will benefit your next project. If you are looking for a fast, safe, renewable and responsible construction system, make sure to contact WoodSolutions today!

Lightweight cassette floor panels

Lightweight cassette floor panels

Lightweight cassette floor panels

Lightweight cassette floor panels

Lightweight cassette floor panels

Lightweight cassette floor panels

10. Environmental & Sustainability Benefits

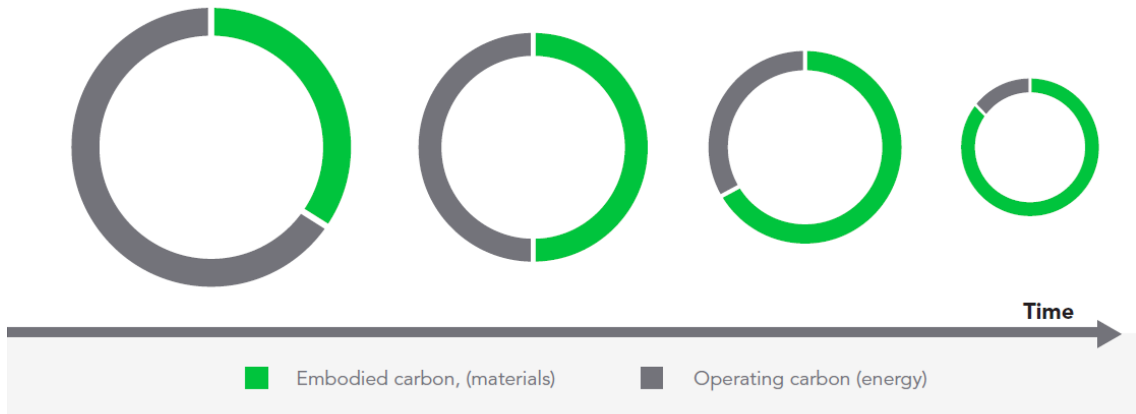
Our buildings are becoming increasingly operationally efficient from our improving electricity grids, cost reductions in renewable energy and the improved construction code standards for building performance. As operationally energy impacts reduce, the proportion of environmental impacts that come from embodied energy is increasing. Therefore the spotlight is shifting towards materials with a growing understanding that there is a need for renewable sources, as there is for our consumption of energy.

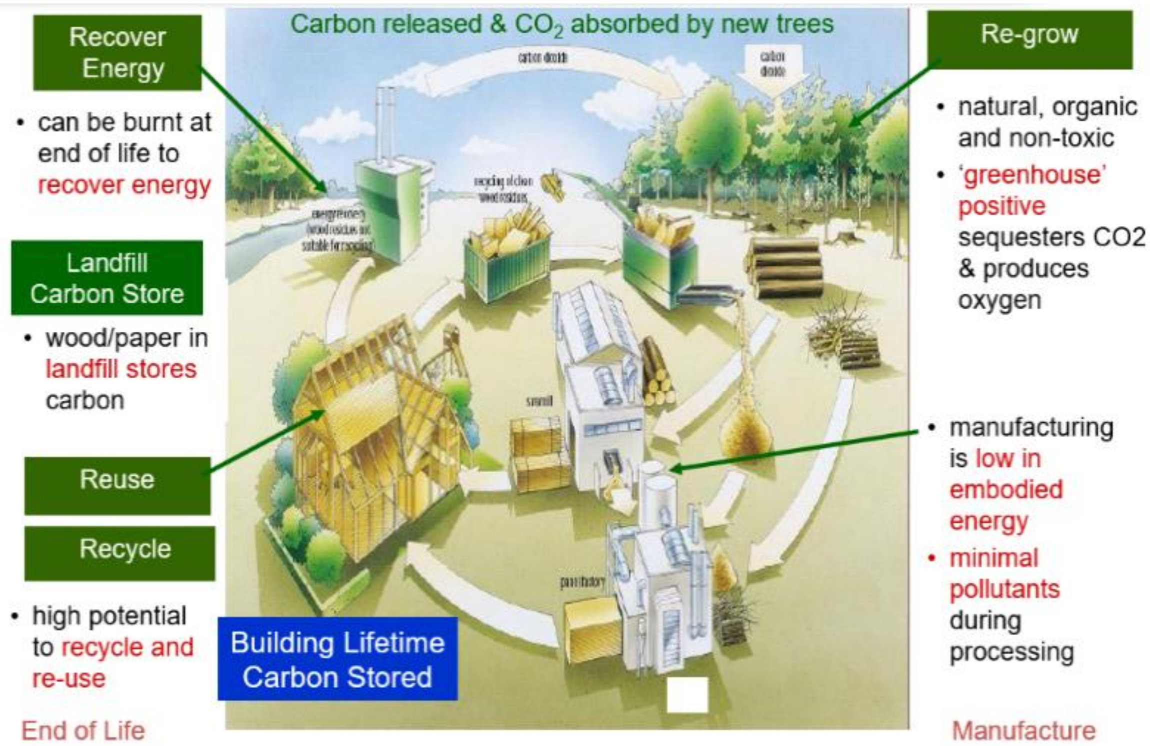
Solar and wind are the cost competitive and renewable solution for energy, sustainably managed wood is a cost competitive and renewable solution for materials.

A product obtained from a natural resource which through the process of photosynthesis and using the solar energy of the sun converts CO_2 to the oxygen that we breathe and to carbon which is stored in the woody mass of the trees.

Around half the dry weight of wood is carbon – so a hardwood product of a density of 1,000kg/m^3 stores around 500kg/m^3 of carbon, multiply this by 3.66 and that is how much CO_2 is stored in the wood. The carbon sequestered will remain stored for the life of the wood product.

At the end of the products first-life, timber products have a great opportunity to be directly reused (doors, windows, floors, etc) or and recycled/reprocessed into other wood-based products. When a wood product can no longer be reused or recycled it can be utilised as a co-generation fuel in biomass energy plants, reducing the reliance on non-renewable fossil fuels such as coal, - the CO_2 released from the burning of the timber goes back to the atmosphere where ultimately it may be absorbed by other growing trees. It provides a very positive cradle-to-cradle lifecycle or carbon cycle story for wood products.





10. Environmental & Sustainability Benefits

From a CO2 sequestration and carbon storage perspective what is important to note is that the trees need to be harvested. Forests when they are young grow vigorously adding to the stored carbon pool. At some point in a forest's life the carbon being stored equals the carbon being lost through forest litter decomposition and then the mature forest moves into a senescent phase, where after the trees start to die and decompose. A forest left naturally to grow and die (or lost through fire) is effectively carbon neutral with any carbon being sequestered later being released to the atmosphere where new growing trees reabsorb the carbon and the cycle continues. If the forest is a 'sustainably managed production forest' and trees are harvested and regrown, then this provides a different equation. When trees are harvested for wood products then this is not a carbon emission, rather a carbon transfer from one carbon pool – the forest, to another – the products.

Continually replacing the harvested trees with actively growing trees ensures that the net sequestration of carbon dioxide continues. Australian softwood plantations grow at around 19-23m^3/min and the engineered timber products used in our mid-rise buildings that come from this resource effectively regrow at a rate of 11-14m^3/min. This means that the timber products used in some of our iconic Australian mid-rise projects (see below) will grow back literally in hours.

Wood products really are the Ultimate Renewable.

Forests & Wood The Ultimate Renewable™

Timber volume: 970m^3

Time to regrow: 1-1.5 hours

Project: Forte Living
Architect: Lendlease
Engineer: Lendlease
Builder: Lendlease
Location: Docklands, Vic

Timber volume: 2,700m^3

Time to regrow: 3-4 hours

Project: Aveo Norwest
Architect: Billard Leece
Engineer: TTW
Builder: Strongbuild
Location: Sydney, NSW

Timber volume: 1,700m^3

Time to regrow: 2-2.5 hours

Project: Gillies Hall
Architect: Jackson Clement Burrows
Engineer: Aecom
Builder: Multiplex
Location: Frankston, Vic

Timber volume: 970m^3

Time to regrow: 1-1.5 hours

Project: 55 Southbank Boulevard
Architect: Bates Smart
Engineer: Vistek
Builder: Atelier Projects
Location: Southbank, Vic

11. Conclusion

Mid-rise timber framed construction continues to grow in interest both here in Australia and internationally as building professionals continue to recognise the economic and environmental benefits of mid-rise timber construction compared to traditional materials such as concrete and steel; as we move into a carbon constrained future it is simply the logical option.

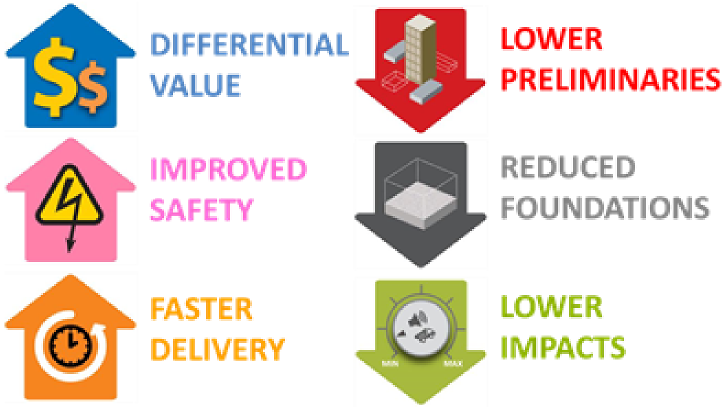
The major benefits have been proven:

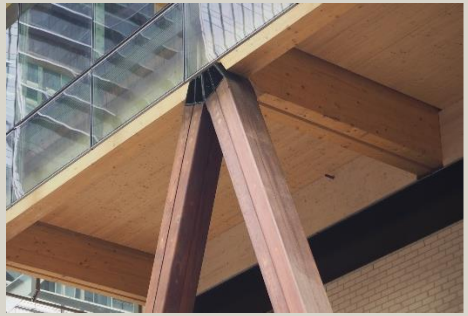
- Higher differential value compared to alternative materials
- Improved safety for on-site workers
- Faster delivery in both structure and follow on trades
- Lower preliminary costs due to shorter on-site program times
- Reduced foundations required due to lighter weight structure
- Lower site impacts on neighbouring properties and far lower environmental impacts than alternative materials in fact a CO_2 sequestering – carbon storage solution using the Ultimate Renewable resource.

Whilst the current NCC Deemed-to-Satisfy provisions limit mid-rise timber construction to an effective height of 25m, using the NCC's performance approach much taller structures are achievable. This opens up amazing prospects for forward thinking and innovative design and building professionals.

From mid-suburban, mid-rise apartment projects, built by mid-size builders and developers using the simplified DtS provisions to flagship commercial and institutional structures built by Tier 1 companies using the NCC performance provisions and exposed timber element to capture the full aesthetic and biophilic benefits of the materials the options and opportunities are endless and exciting.

The options and opportunities for mid-rise timber buildings are endless and exciting





Project: The Green
Architect: SJB
Engineer: Irwin Consult
Builder: Australand
Location: Parkville, Vic

Project: International House
Architect: Tzannes
Engineer: Lendlease Designmake
Builder: Lendlease
Location: Barangaroo, Vic

WoodSolutions Mid-rise Advisory Program

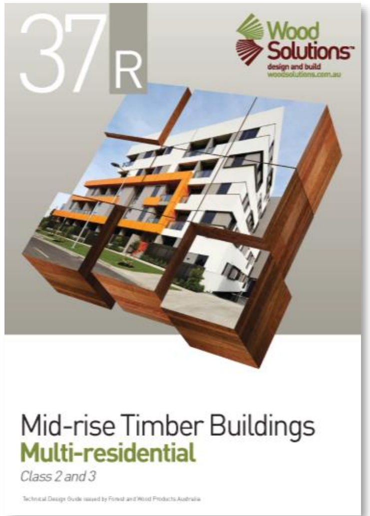
Expert advice from WoodSolutions Mid-rise Advisers
Accessible through woodsolutions.com.au

Contact our Program Development team about your next project

With extensive experience in property development, construction, structural engineering, codes and regulations, fire engineering, and architecture, the WoodSolutions team of Program Development Managers are ideally placed to liaise with development, design and construction professionals, providing generic information and advice on making the most of the cost, time, environmental and other advice.

Download free WoodSolutions Technical Design Guides

A wide range of technical design guides with detailed, state-of-the-art technical information on designing and building timber mid-rise timber buildings are available to download in PDF format from woodsolutions.com.au



Access a Full-scale Mid-rise Timber Construction Demonstration Model

As visiting active construction sites can often be difficult and restricted a full-scale mid-rise demonstration model has been constructed. This three-storey structure represents a seven-storey timber apartment building and allows building professionals to see first-hand the different structural, fire, and acoustic systems available for mid-rise timber construction. Contact the mid-rise advisors to visit the structure at Holmesglen Institute or take an e-tour on the woodsolutions.com.au website.

Partners of the Mid-rise Advisory Program include:

The WoodSolutions full scale, Mid-rise Demonstration at Holmesglen Institute, Melbourne. The structure is available for guided tours by appointment.