NZ WOOD
For a better world

NZ Wood Design Guides

COSTING
TIMBER BUILDINGS

Chapter 4.1 | March 2020

Wood Processors & Manufacturers
Association of New Zealand

NZ Wood Design Guides

A growing suite of information, technical and training resources, the Design Guides have been created to support the use of wood in the design and construction of the built environment.

Each title has been written by experts in the field and is the accumulated result of years of experience in working with wood and wood products.

Some of the popular topics covered by the Design Guides include:

- Timber, Carbon and the Environment
- Seismic Design of Timber Buildings
- Holes, Notches and Cutouts
- Post and Beam Buildings
- Working Safely with Prefabricated Timber
- Structural Forms and Exemplars

To discover more, please visit http://nzwooddesignguides.wpma.org.nz

NZ Wood Design Guides is a Wood Processors and Manufacturers Association (WPMA) initiative designed to provide independent, non-proprietary information about timber and wood products to professionals and companies involved in building design and construction.

ACKNOWLEDGEMENTS

The NZ Wood Design Guide Project is grateful for the valuable contributions made by the following people and companies who have provided technical input, peer review comment and support in kind on the draft of this guide:

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COMPANY SUPPORT

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Nick Newson — XLAM Australia/NZ
Gary Caulfield — Steeltech NTU ABS
Tony Joseph — Joseph & Associates
Fiona Gavriel — Prendos New Zealand Ltd
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Funding for the NZ Wood Design Guides is provided by our partners:

1. INTRODUCTION

This Guide provides an introduction and overview based on typical engineered timber buildings while considering the relevant factors to take on board in order to provide appropriate estimates.

The value proposition of Engineered Timber goes beyond lowest price mentality and more about when is it appropriate to use and seeking to quantify the Sustainability benefits, Health Safety and programme efficiency which should be part of the assessments to highlight the true benefits of Engineered Timber Solutions.

The WPMA, in conjunction with NZ Wood Design Guides, has recognised this need and set about implementing a suite of new and revised Timber Guides. Engineered timber products available in New Zealand, for use in construction, has technically evolved to be able to offer superior products that compete with traditional steel and reinforced concrete options. Encouraging the construction industry to adopt innovative approaches, needs information and evidence. In order to show the value proposition of timber construction requires some guidance.

In the words of the inspirational leader Nelson Mandela "Education is the most powerful weapon which you can use to change the World".

The first Quantity Surveying Guide for Engineered Timber Buildings is directed at cost consultants, who typically are the first to set construction budgets and analyse options in feasibility exercises, even before the details have been developed by the full design team. It will no doubt be the first of many editions that seeks to improve knowledge in our timber industry in New Zealand. The purpose of this guide is to provide a standardized approach for Quantity Surveyors, develop understanding generally of the key drivers of when an Engineered Timber solution is most appropriate and if so, what factors to consider.

Current measuring guides that Quantity Surveyors (QS) use in New Zealand are the Elemental Analysis of Costs of Building Projects, issued in January 2017 by NZIQS and the new joint Australian and New Zealand Standard Method of Measurement of Building Works 2018 Edition (ANZSMM 2018) suitable for detailed Schedule of Quantities.

We plan to build on the principles of current NZ guides and expand to provide a standard basis for "structural engineered timber products" (such as LVL, Glulam, CLT, etc). This guide will provide a brief overview of prefabricated panels, as well as, reference to "Volumetric" options although this will be limited in information with suggested links or alternative reference sources indicated.

Early project budget or cost plans are compiled on Concept Design information which by the very nature can be limited or sketchy information. At such early stages reliance is made on cost data from previous similar projects and other available benchmarking information with necessary adjustments for current proposals. QS's produce estimates at each deliverable Design stage being Concept, Preliminary, Developed and Detailed Design Stages. Accordingly, as the design information develops the level of accuracy of the estimates increases in relation to the level of available design information at each stage.

For a Quantity Surveyor (QS), the challenge lies where the current available "actual cost" data is not readily available in house or on published data sites. The lack of "historical" benchmark data, as a basis for early estimates, means that to evaluate such solutions requires first principle approaches, when often design detail is not yet developed. In time the "pooled" greater local QS cost knowledge will be more readily available, however for now the best approach is a "collaborative" early input from supplier and design engineer, as the best approach to apply to Engineered Timber Structures for any Quantity Surveyor to take. Failing which, QS's may build in for "perceived" risk of such products at early design stages, which can result in projects not being feasible, or result in the project not even being considered further as an option. The task of the QS is to establish a robust budget for the client to be able to deliver the project. A key tool to ensuring this is achieved, is by assessing the "risks" in the project and making appropriate "allowances" until such time as details and market testing of the cost plan is possible. We will expand on the appropriate use of Project Contingency and Design Development Contingency and comment on how it is adjusted through the "Design Stages".

The case studies referred to relate to typical construction in New Zealand, such as medium rise apartment buildings over 4 and 6 storeys. The case study cost plans are based on a city location with easy port access and the site areas assumed with no significant cost implications concerning site access or ground conditions.

We will discuss comparisons with other framed options, where it has been possible to obtain actual data, in order to provide informative findings for future reference. We have not delved into a comparison with a reinforced concrete frame, as following the Christchurch Earthquakes, the trend is away from reinforced concrete frames to primarily steel or timber frame options in New Zealand.

The aim of this Guide is to provide a standardized approach that takes on board the factors that impact on costs in a pragmatic approach. Understanding what aspects drive the structural design decision will improve the assumption basis of estimates.

2. PRICING TIMBER BUILDINGS COST BASIS

To provide a basis for Quantity Surveyors to assess the costs of timber buildings, requires insight into product manufacturing, supply and installation together with appreciation of the cost drivers. Most manufacturers and suppliers produce technical guides which should be consulted in the first instance, along with WPMA reference sources and NZ Wood Design Guides Series. What is meaningful is to provide context of when “Engineered mass timber” is appropriate to use, based on identified benefits. A selection of NZ projects are listed as reference, based on key drivers:

A: POOR SOIL CONDITIONS resulted in a timber solution being more cost effective with far less foundation requirements than traditional build with extensive piling or foundation requirements substantially reduced:

- Otago Polytechnic Student Residence
- Bealy Avenue, All Stars backpackers, Christchurch
- Arvida Retirement Apartments, Christchurch
- Mt Pleasant Community Centre, Christchurch
- St Albans Community Centre, Christchurch

B: BUILDING ON EXISTING STRUCTURES to increase building area with additional floors:

- Merchants Quarter Apartments, Auckland- 3 new storeys on existing high rise
- Old Fonterra Head Office, Auckland-addition of filling in octagon footprint at corners and increasing overall building area with additional levels
- Beatrice Tinsley Building (ex Von Haast), University of Canterbury, new 4 storeys built on existing basement

C: QUIET CONSTRUCTION required to reduce noise level:

- Mary Potter Apartments, Wellington

D: SPEED OF CONSTRUCTION – reduced on site time:

- Housing New Zealand Auckland social housing programme (HNZ stated at the 3rd Timber conference reduced programme time from 14 months to 6 months)

E: SEISMIC RESILIENCE – ability to perform during an earthquake with minimal damage:

- Trimble Offices - Christchurch
- Merrit Building - Retail and Offices, Victoria Street, Christchurch
- Kaikoura District Council offices, archives and library
- Hutt Valley Health Hub - Medical centre to IL4

F: EXEMPLAR BUILDINGS – Innovation and landmark buildings:

- Nelson Airport - new Terminal building
- Waitoma Caves Visitor Centre
- NMIT Nelson - Arts and Media academic building

Otago Polytechnic Student Residence.

Mt Pleasant Community Centre, Christchurch.

Waitomo Caves Visitor Centre.

Nelson Airport. New Terminal building.

OVERVIEW INTERNATIONAL FINDINGS

As part of the global village, we are able to consult international experience where Europe (with over 20 years of CLT and Glulam use) and Canada (with more than 50 years of timber use) are the leaders. In the Southern Hemisphere, Australia is fast gaining a track record with over 7 years of growth in Engineered structures such as example of Forte Apartments (10 storeys high:`as highest CLT structure in Southern Hemisphere) erected in 2012 by Lend Lease and as supplied by KLH Austria. To develop cost comparisons, in the absence of historical benchmarking data, invariably means that the QS's view it as a unique project, applying first principles of cost build ups and consulting the market early with the absence of design detail.

UK EXAMPLE: ALINEA CONSULTING COST PLAN

We consider some key aspects from a UK example by Alinea Consulting, which is the most recent European published Cost Model by "Alinea consulting" in London in Building Magazine on 9 June 2017 refers;

294 residential Apartment comprising CLT frame, upper floors, roof, core, stairs, external walls (all first floor and above) with reinforced concrete ground and transfer slab. (pricing Q2 2017). The summary of the findings of cost comparison between CLT structure and traditional concrete is as follows:

- Substructure was 12.7% a reduction in Foundations and is a key factor to reduce risk and cost in Foundations
- Above ground works was a 2% increase
- Main Contractor P&G's reduced by 2.2%
- **The Overall analysis showed a cost increase for CLT frame solution of 1.1%**
- Reduced overall programme of **10% to 15% shorter than concrete**
- Approximately 3 months of earlier income on apartments occupied sooner than anticipated in comparison to traditional build

AUSTRALIA EXAMPLE: MACARTHUR GARDENS AFFORDABLE HOUSING, AUSTRALIA

During negotiations the Structural Engineer, Nick Newson of Xlam Australia with QS support by Linda Lodetti, reached a cost neutral proposal with the Australian Contractors, Strongbuild. The Contractors initially assessed the cost difference between a CLT structure and conventional concrete structure to be 2% more. The Contractors scheduled a reduced overall programme that resulted in a 15% reduction in time and reduced related Preliminaries (P&G). The effect of the reduced programme on their original conventional P&G was a 3% reduction in P&G costs, a reduction in value of $620,000 on the circa $27mil project. Further savings were realised due to consideration of methodology, reduction of labour on site (considering use of previous 30 versus 5 skilled labour staff now, at key times), reduced scaffolding requirements with rationalised optimized CLT design that yielded, at contract signing agreement that at minimum **the CLT proposal was "Cost Neutral"**. Subsequent feedback from the contractor has revealed that the Contractor eventually achieved an increased profit of 4%. As the construction programme proved so much faster than anticipated, it resulted in subsequent trades now offering reduced costs for their services in future projects.

Further acknowledgements of Research & Development (R&D) investment by companies, such as Lend Lease in Timber Innovation in Australia, is encouraging. Refer to projects such as Forte Apartments in Melbourne, Library on the Dock and International House, Sydney, to name but a few. This demonstrates that for the Southern Hemisphere, the process and the learning curve has substantially increased, and that the benefits have materialised which creates the confidence to offer the benefits in the future projects.

NZ EXAMPLE: NMIT ARTS AND MEDIA BUILDING IS A LEADING EXEMPLAR PROJECT

In Nelson, the Academic NMIT building has long been the example of what is possible in engineered timber structures and over the past few years further notable examples have been designed and constructed in NZ. A report was produced by the University of Canterbury for the Ministry of Agriculture and Forestry (MAF) in 2011. Irving Smith Architects and Aurecon re-designed the building in Concrete and Steel for the cost comparison.

Refer to the listed buildings at the beginning of Section 2 for more recent examples.

The trend of designing and erecting Engineered Timber buildings is increasing in NZ and it is important to consider what factors impacts on costs in order to budget appropriately. Due to our geographical location and lack of economies of scale, we need to understand what is required, as a minimum, to be able to offer a Cost Neutral solution or an Alternative option that represents the most appropriate solution for the challenges of the specific site.

Typically the disadvantages that impact on costs in NZ are:

- Relatively remote island location on the globe
- Local supply chain capacity
- Lead in times critical to construction programme
- Fragmentation of design, supply and installation
- Weathertightness issues and design details
- NZ Design Codes and Building Regulations
- Interpretation of the regulation for fire safety
- Construction Industry skill set and experience
- Limitations of company sizes affecting economies of scale
- High local log prices
- Limited local demand to obtain the benefit of competitive overseas supply
- Acoustic and Fire Compliance requirements
- Perceived risk when using new technology
- No subsidy when using sustainable and renewable building materials

Advantages on the other hand are:

- Sawn timber and SG plants of scale for export capacity
- Abundance of Radiata Pine supply
- Advanced engineering particularly seismic design
- Willingness to innovate
- Relatively low population requiring low rise infrastructure
- Local Communities support regional development using local resources

At this stage it means that we have a few cost anomalies that are not the same as evidenced elsewhere internationally. New Zealand's conventional construction would be steel framed with concrete floors and timber infill walls.

TABLE A: SUMMARY OF TRADITIONAL ESTIMATE VERSUS TIMBER OPTIONS

	A	B	C
TYPES OF STRUCTURAL FRAME	**TRADITIONAL STEEL FRAME**	**LIGHTWEIGHT TIMBER FRAME (LTF) AND LVL JOISTS**	**LIGHT WEIGHT TIMBER FRAME AND LOCAL NZ CLT SOLID TIMBER FLOORS**
FOUNDATION (PROVISIONAL)	$463,382.00	$468,009.00	$468,009.00
ELEMENTS COMPARED IN STRUCTURAL FRAME: Frame, Structural walls, Upper floors, Roof, Exterior walls, Interior walls, Wall Finishes, Ceiling Finishes & Fire Services	$3,131,264.00	$3,140,014.00	$3,762,335.00
ELEMENTS CONSTANT IN COMPARISON: Windows & Doors, Stairs, Interior Doors, Fiitings & Fixtures, Sanitary Plumbing, HVAC services, Electrical, Lifts, Appliances, Drainage and Balustrading. (Minor adjustments in Balustrading)	$2,687,362.00	$2,717,883.00	$2,717,883.00
EXTERNAL WORKS	$122,807.00	$80,807.00	$80,807.00
PRELIMINARIES	$768,640.00	$768,806.00	$686,893.00
MARGIN	$322,829.00	$322,898.00	$377,791.00
Total	**$7,496,284.00**	**$7,498,417.00**	**$8,093,718.00**
OVERALL COST PER M²	$4,074.07	**$4,075.23**	**$4,398.76**
$ Variance to A		$2,133.00	$597,434.00
% Variance to A		0.028	7.970
Comment		Cost neutral	8% Premium

Note:
i) The case study comparison excludes contingencies.
ii) The costs are a guideline only to demonstrate overall construction costs of the case study.
iii) The focus is on elements being compared in the structural frame analysis of the case study.

Refer to section 6 for breakdown of elements.

For the similar cost comparison project we have found the following:

- A. The costs per m² for conventional steel frame is $2,294/m²
- B. Lightweight Timber frame and walls with LVL joists and timber floor, overall costs are $2,300/m²; equating to a **COST NEUTRAL** option.
- C. Lightweight timber frame with CLT floor panels solution overall costs are $2,623/m²; equating to approximately a 14% increase in costs. Note: this is based on traditional GIB plastered wall linings in terms of acoustic and fire requirements and batten and cradle floating floor system.

TABLE B: STEEL CONSTRUCTION NEW ZEALAND – EXTRACT OF FINDINGS

SCNZ June 2018 Model project four storey office building approximately 1,300m² compared three different framework options. Note: All 3 options supported by 10-12m long screw piles.

OPTION	FLOOR SYSTEM	FRAMING	LATERAL LOAD-BEARING	TOTAL ESTIMATED STRUCTURAL COSTS	
				Auckland	Christchurch
1. Steel framing and metal deck slab flooring	130mm-thick slab, 60mm trapeziodal metal deck profile	Hot-rolled steel sections	Eccentrically braced frames in cross direction. Moment resisting frame in longitudinal direction	$3.23m	$2.65m
2. Timber-framed floor, in situ concrete topping, plywood shear walls	Poius panels and 65mm situ concrete topping	LVL sections	Plywood shear walls in both directions	$3.29m	$2.84m
3. Precast concrete flooring, concrete framing and shear walls	Double-tee flooring and in situ concrete topping	Concrete beams and columns	Moment frames in longitudinal direction. Concrete shear walls in transverse direction	$3.44m	$2.71m

From the findings we can assume that at present it is possible to demonstrate that timber LVL joists and timber flooring solutions are comparable in costs to Steel frame and concrete floor options and equate to COST NEUTRAL option.

EXPLORING COST CONSIDERATIONS:

There are two defined aspects or phases to consider:

- *1. During Manufacture and Supply*
- *2. On site and during Construction*

1. MANUFACTURE AND SUPPLY

SPECIES AND TYPE OF TIMBER PROCESS

The various timber species have particular properties which can impact on costs.

NZ local producers use Radiata Pine, however there are other species available such as Douglas Firs, Spruce or Larch. Various species have different performing properties and present different levels of finish. As wood is a natural material it is varied and characteristics can change during conversion and seasoning process. Grading is based on whether it will be exposed, and if requiring a visual grade quality, or purely structural, to be finished by cladding with plasterboard linings.

Note that the interpretation or categories of the grades, varies between suppliers and so does expectation. It is recommended that samples are requested and technical information consulted. Generally local NZ supply is referred to as follows:

- Non-visual grade (has irregularities in joints and knots and meant to be over-clad typically with plasterboard lining)
- Visual grade (finished off with surface designed to be exposed) – allow $20/m^2

ENGINEERED TIMBER COMMODITY VS COMPONENT PRODUCTS

By definition Components are made to order, project specific from the outset and not viewed as a stock item held by Merchants.

SG TIMBER – Stress Graded Timber

- Various sizes and lengths available as stock items. (Refer Suppliers and Merchants)
- Various levels of treatment available
- Prefabricated structural members e.g. roof trusses
- Largest supply capacity and availability

The bespoke components are generally supplied direct from suppliers (not through merchant stockists), are often CNC machined off site and rely on full CAD model for design and machining.

CLT – Cross Laminated Timber

- Layers of timber (various species) in kiln dried process and under pressured gluing of lamellas
- Layers of wood laid orthogonally into panels
- The layers fixed perpendicularly to each other, provide the bi-axial strength
- Lengths possible up to 15.4m and widths up to 3.45m however transport restrictions often reduce typical panels to 13m x 3m
- Thickness possible from 60mm to 380mm thick (Current code covers thickness up to 340mm)
- Finger Jointed
- Suitable for walls, floors and roofs (similar to the strength of precast concrete panels). Available in UT, H1.2 & H3 treated timber.
- For commercial and residential construction
- Material sourced from Sustainably Managed Forests with FSC accreditation and status declared
- CAM /CAD design process
- CNC machining and cutting

LVL – Laminated veneer Lumber

- Made from thin veneers of Radiata Pine in “ply” like layers glued together under high pressure and heat
- Uniformity of structural properties
- Dimensionally stable
- Grain orientated
- Good workability
- Lightweight and easy handling
- Joists, Framing, Lintels, Posts, Beams and Portal frames
- Stress skin panels/ cassettes. Sanded finishes for exposed sides. Veneered options for facing sides
- CAM /CAD design process
- CNC machining and cutting

Glulam – Glue Laminated Timber

- Series of thicker lamella glued together as stronger component than sawn timber but not as strong as LVL
- Straight or curved
- Long lengths up to 30m possible
- Higher cost than LVL in NZ due to scale of plants
- Beams, posts/ columns, and lintels
- Manual manufacture in NZ
- CAM /CAD design process
- CNC machining and cutting, if required

LEAD-IN TIME AND EARLY DESIGN CONSIDERATIONS

In terms of procurement and programme planning consideration is to be given to what is required. Raw untreated timber requires a 12 week period for manufacture whereas 16 weeks are required for treated timber, both types would require between 6 to 8 weeks minimum for shop drawings and for machining. This is one of the factors that leads to Early Contractor Involvement (ECI) which we will expand on, as it represents the approach to be taken which varies from traditional design & procurement routes.

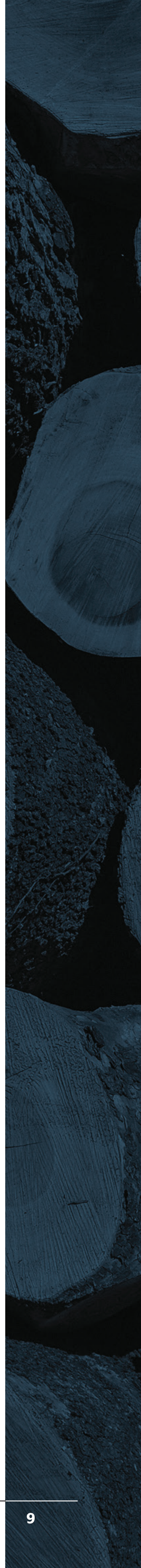
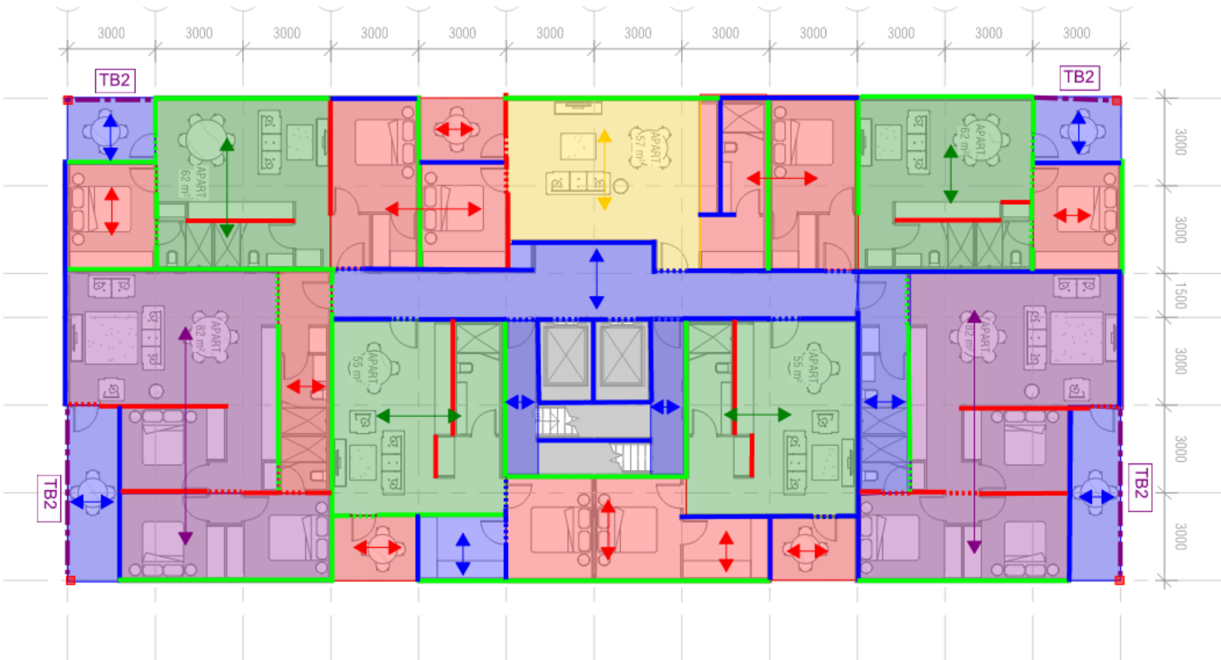
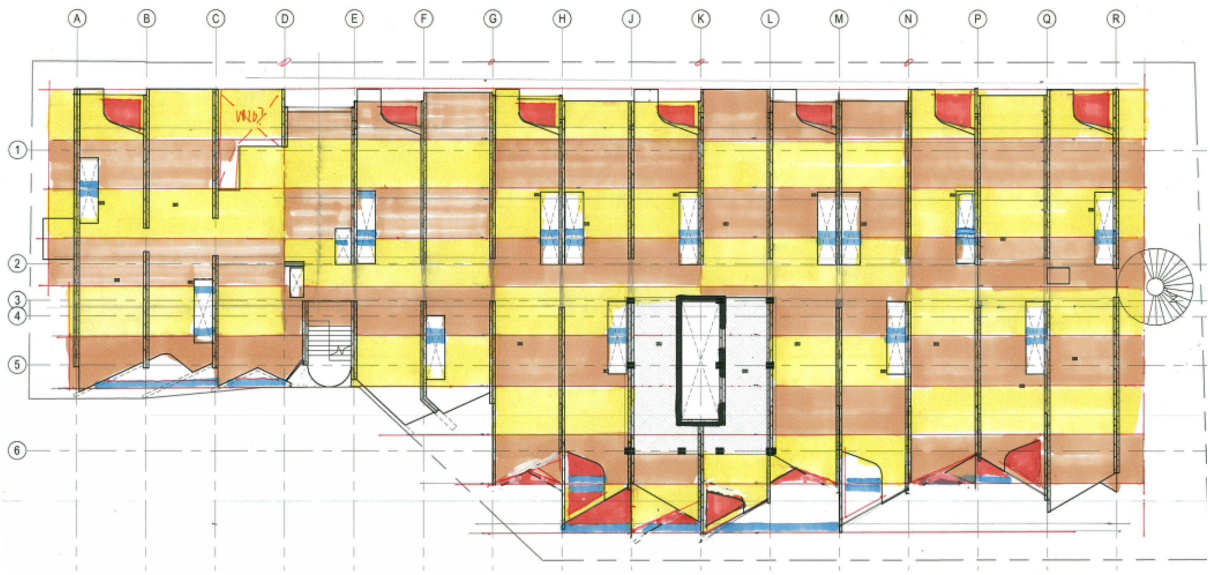


TABLE C: PANEL OPTIMISATION AND DESIGN

POOR VS GOOD LAYOUT



Poor Example



Good Example

PANEL COMPLEXITY

Increasing complexity + COST

VERY LOW

- 1 x Perimeter cut (Router)

LOW

- 1 x Perimeter cut (Router)
- 2 x Halflaps

MODERATE

- 1 x Perimeter cut (Router)
- 2 x Halflaps
- 2 x Drillings
- 1 x Window cut-out

HIGH

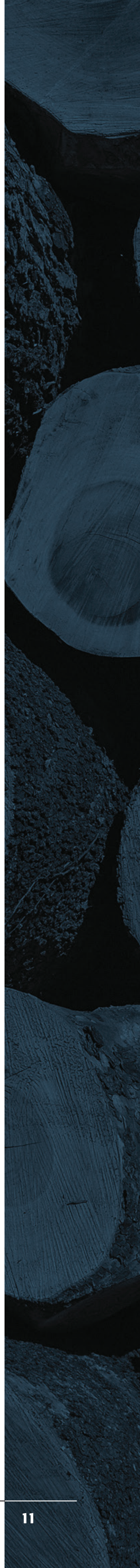
- 1 x Perimeter cut (Router)
- 2 x Halflaps
- 2 x Drillings
- 1 x Window cut-out
- 1 x Door cut-out
- 2 x Circular penetrations
- 1 x Channel
- 1 x Recess

VERY HIGH

- Multiple Panels
- 1 x Perimeter cut (Router)
- 2 x Halflaps on all panels
- 1 x Window cut-out
- 1 x Door cut-out with supports
- 1 x Channel
- 1 x Recess

SUMMARY

- Designing creatively can still be done simply
- Design with manufacturing and logistics in mind
- A design sent to the factory is the same as the building being completed
- If a panel looks complicated, it probably is, therefore
  - ✓ Find alternative connection solutions
  - ✓ Find alternative engineering solutions
- Avoid recesses on both sides of both sides of a panel to avoid flipping
- Make it transportable



SIZE OPTIMISATION AND WASTAGE

This is where we consider what panel sizes manufacturers produce and how we should take this into account in the design.

Refer to Panel Optimisation and Design Considerations.

TIMBER TREATMENT:

To meet building regulations in the NZBC, timber may need to be treated as per NZS 3602. This may be a factor to be worked through in due course in NZ with improved attention to weathertightness issues, such as drained cavities and moisture control in buildings. Treated timber can potentially create an environmental issue at the end of the life of the treated timber, depending on how it is treated.

TRANSPORT:

Fabricated timber panels and components need to be transported from the factory by road and depending on the distance, it can range between $1,000 to $3,000 of 35m^3 to 40m^3 load. If logistics is possible by road, height and width restrictions need to be taken into account.

- Maximum CLT panel sizes that can be manufactured are typically 2.9m wide x 12m long however check supplier guides
- Transporting panels would generally be limited to not exceeding 13m long x 3m wide and not stacked more than 2.4m high
- Maximum weight permitted on roads is 25 tonnes and reduces the permissible volume of timber able to be transported
- Coastal transport by ship can be considered, however consideration of extra handling, size restrictions of containers and additional fixings due to increased number of panels should be investigated
- The maximum panel size typical shipping containers can house is 12m x 2.2m which means that additional fixing would need to be allowed due to more panels being cut to be able to fit into the containers
- Alternative shipping, on covered flat beds requires further considerations of the logistics and risks associated

TIMBER QUOTE BASIS:

- Quotations are based on Schedule of Quantities
- Marked up on drawings (Architect or Engineer drawings)
- Materials, labour and connections costed. Often Provisional Sum offer by supplier with co-ordination and markup charges nominated
- Constraints considered such as section sizes and lengths that manufacturers can produce and fabricate
- CAD model complexity
- CNC complexity and time considered
- Lead in times to be noted
- Deposits required

2. ON SITE AND DURING CONSTRUCTION

CRANAGE & INSTALLATION:

Cranage logistics and costs are to be considered and may depend on what the main contractor supplies. As timber is one fifth the weight of concrete it can generally be hoisted up with a smaller size crane than required by precast concrete panels or structural steelwork, subject to reach requirements and site logistics. The average density of timber is approximately 500kg/m^3 for Glulam, CLT, and SG timber, however LVL is 600kg/m^3 due to densification in the manufacturing process.

Labour is typically reduced on site for panelised or mass timber solutions. In comparison concrete construction would have staff compliments of between 20 to 30 personnel depending on which trades are involved, whereas Timber may require only 4 during key erection phase. This is due to the kitset nature of timber construction. Treating mass timber construction as a logistics and assembly process can assist with speed of construction and results in a reduction of site storage requirements.

Materials are to be protected on site from adverse weather and stored in waterproof manner to avoid water damage. Depending on the size of components, the site logistics and sequence of installation, due consideration of adequate temporary propping needs to be undertaken.

CONNECTIONS (DESIGN & SUPPLY):

In the early concept design stages, connections are not yet designed so become part of the detailed design stage or even, further down the design process including in the procurement phase. Specialist suppliers suggest we allow between 8% to 12% of the timber supply price. Noting that for more complex connections this can range between 15% and 35% of timber volumetric costs.

- Nails $0.05/ each
- Screws $0.50/ each
- Bolts $1.60 per set
- Fabricated steel brackets cost between $10K to $15K per ton in NZ
- Engineered wood screws $2 to $15 each

There are numerous "off the shelf" fixings, nails, bolts, screws along with specialist fasteners and steel brackets. Imported fasteners are available from suppliers such as Rothoblaas, Spax, Wurth, Simpson Strong Tie and others. Substitution of specified products, by the contractor, impacts on design and programme. The shipping costs from Italy, Australia and the USA are reasonable, however, if the lead time is compromised and fixings are required urgently, then airfreight costs from Europe, for example, can be costly to NZ.

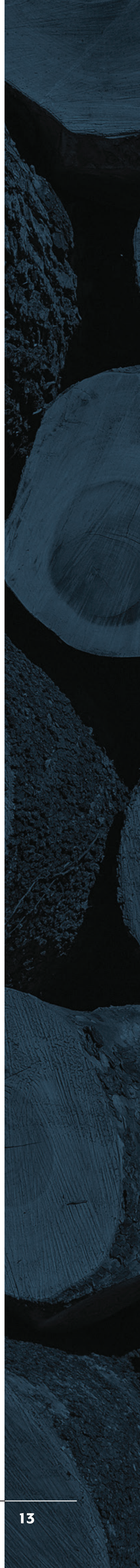
FIRE REQUIREMENTS:

In principle, the thickness of mass timber for structural purposes can provide an inherent char layer with the remaining section, supporting post fire stability loads. Additional fire requirements place further demands, requiring either, additional plasterboard linings or additional lamina timber added on to act as sacrificial charring layer for fire. Unprotected surfaces are classified as group class 3 for surface spread of flame. Spread of flame applications to reduce the group number can be applied at costs ranging between $\$45/m^2$ to $\$65/m^2$ to exposed timber.

ACOUSTIC REQUIREMENTS:

Acoustic requirements impact on costs and the various internal wall cladding composite buildups needs to be considered for all intertenancy floors and walls.

- Lightweight concrete screeds can be used, however, there is a drive to move away from all wet trades to ensure we are reducing the overall programme with use of dry trades, as well as, in high seismic areas to reduce mass. Budget costs are approximately $\$40/m^2$ to $\$60/m^2$.
- At present "floating timber floors" are the most common solution to meet acoustic requirements. The batten and cradle floating floor solution adds, approximately, $125/m2 to $135/m2 to supply and install. This provides a layer to place thermal insulation in.
- Flanking strips of up to $15/m at strandfloor perimeters of all rooms and floor void sound batts.
- A wide range of acoustic ceiling options exist and, depending on the products, range in costs from $\$60/m^2$ to $\$200/m^2$.
- Plasterboard Noiseline walls and ceilings can be used for extra value over standard plasterboard at $\$10/m^2$.



3. PRICING FLOW CHART

From the Quantity Surveying perspective, the traditional design route follows typical stages and with each successive stage comprising further detailed design information. It is relevant to consider a brief overview of each stage to better understand what pricing tools Quantity Surveyors generally use at each stage.

CONCEPT DESIGN STAGE

- Client outlines basic Gross Internal Floor area (GIA) function requirements with the Architect
- Architect considers bulk, form and broad floor layout approach that could provide such functional floor areas
- Quantity Surveyor considers historical cost data of similar buildings worked on in the past. Estimates are based on per m^2 rates of Gross Floor Area (GFA) with adjusting factors, such as inflation allowances, undertaking checks against published cost data and addressing anticipated site specific costs, such as, Foundations, Services and Siteworks. The QS provides a “High level” cost estimate or “Elemental Concept” estimate subject to sufficient data being available.

At this early stage structural options have not generally been considered in much detail but rather assumptions made of what would typically be expected, based on structural design intent. Structural Engineers set parameters for the Architects and have proven invaluable to the QS from early cost perspective. Seeking early structural input is strongly advised. The client uses budgetary advice at the Concept stage to make decisions on the project viability, to commence funding applications and obtain resource consent approvals.

TABLE D: EXTRACT FROM QV COST BUILDER ON 3 BUILDING TYPES AS AN EXAMPLE

EDUCATION: TERTIARY INSTITUTIONS — CostBuilder powered by QV

All finishes to medium standard							
Study Buildings	Unit	Auck $	Wgtn $	Chch $	Dun $	Waik $	PNth $
Arts Block, 1 to 2 storeys. Tutorial and lecture rooms, including built-in cupboards and fittings	m2	3,200-3,500	2,700-3,000	2,650-2,950	2,650-2,950	2,750-3,050	2,700-3,000
Lecture Theatre Block. Tutorial and lecture rooms, including seating, built-in cupboards and fittings	m2	3,250-3,550	2,850-3,150	3,000-3,300	2,750-3,050	2,850-3,150	2,750-3,050
Music School Block, 1 to 2 storeys. Performance chambers and tutorial rooms, including acoustic design, built-in cupboards and fittings, service lift	m2	3,500-3,800	3,200-3,500	3,450-3,750	3,000-3,300	3,250-3,550	3,150-3,450
Science/Laboratory Block, 1 to 2 storeys. Laboratories and tutorial rooms, including built-in cupboards, benches and fittings, fume extractors	m2	3,300-3,600	3,100-3,400	3,300-3,600	3,000-3,300	3,100-3,400	3,000-3,300
Administration Buildings	Unit	Auck $	Wgtn $	Chch $	Dun $	Waik $	PNth $
Administration, 1 to 2 storeys. Subdivisional partitions to offices, common areas, toilets and amenities	m2	2,800-3,100	2,400-2,700	2,450-2,750	2,350-2,650	2,400-2,700	2,350-2,650
Library, 1 to 2 storeys. Storage room, small office, amenities. Partial ventilation, sprinklers, service lift. Excludes heating, air conditioning and passenger lifts	m2	2,350-2,650	2,200-2,500	2,350-2,650	2,150-2,450	2,200-2,500	2,150-2,450
Halls of Residence, 1 to 2 storeys. Separate bedrooms, average 10m2, with bed, wardrobe and desk. Communal showers, toilets, kitchen and lounge facilities. Smoke detection and security system	m2	2,600-2,900	2,500-2,800	2,700-3,000	2,350-2,650	2,500-2,800	2,450-2,750

OFFICES — CostBuilder powered by QV

Base Building Costs are for a “Lettable Shell” building. Costs exclude subdivisional partitions, parking areas, and owners or tenants special requirements							
Add for fit out costs to standard required							
Base Building Cost	Unit	Auck $	Wgtn $	Chch $	Dun $	Waik $	PNth $
Low Rise Offices, Basic Services. Excludes HVAC, sprinklers, FF&E. basic standard finishes.							
Up to 2 storeys, no lifts	m2	1,450-1,650	1,350-1,550	1,475-1,675	1,300-1,500	1,375-1,575	1,325-1,525
3 to 5 storeys, with lifts	m2	1,750-1,950	1,650-1,850	1,800-2,000	1,575-1,775	1,650-1,850	1,600-1,800
Low Rise Offices, Partial Services. HVAC. Excludes sprinklers and FF&E. Basic standard finishes.							
Up to 2 storeys, no lifts	m2	1,775-1,975	1,625-1,825	1,775-1,975	1,600-1,800	1,650-1,850	1,600-1,800
3 to 5 storeys, with lifts	m2	2,100-2,400	1,925-2,125	2,100-2,400	1,875-2,075	1,950-2,150	1,875-2,075
High Rise Offices, Full Services. 6 to 15 storeys. HVAC, lifts and sprinklers. Medium standard finishes	m2	3,000-3,300	2,750-3,050	3,050-3,350	2,650-2,950	2,800-3,100	2,700-3,000
Fit Out to Offices	Unit	Auck $	Wgtn $	Chch $	Dun $	Waik $	PNth $
Subdivisional Partitions, kitchen and additional amenities, reception and boardroom							
Basic standard finishes	m2	550-650	520-620	580-680	510-610	520-620	500-600
Medium standard finishes	m2	660-860	620-820	690-890	610-810	630-830	610-810
High standard finishes	m2	900-1,200	860-1,160	960-1,260	850-1,150	870-1,170	840-1,140

RESIDENTIAL

Multiple Units, Low Rise	Unit	Auck $	Wgtn $	Chch $	Dun $	Waik $	PNth $
2 or 3 Storey Townhouse, 100-200m2. Concrete floor slab. Kitchen, bathroom, 2 WCs, ensuite. Double garage. Excludes balconies and decks							
Cedar or pine weatherboards, Colorsteel® roof. Medium quality fittings	m2	2,150-2,450	2,050-2,350	2,000-2,300	1,900-2,100	2,050-2,350	2,000-2,300
Polystyrene or fibre cement cladding with textured plaster or acrylic coating. Colorsteel® roof. Medium quality fittings	m2	2,350-2,650	2,200-2,500	2,200-2,500	2,050-2,350	2,250-2,550	2,200-2,500
Brick veneer to ground floor, polystyrene or fibre cement cladding with textured plaster acrylic coating to upper storeys. Concrete tile roof. High quality fittings	m2	2,350-2,650	2,250-2,550	2,250-2,550	2,100-2,400	2,250-2,550	2,200-2,500
Brick veneer, cedar or pine weatherboards to upper storey. Concrete tile roof. High quality fittings	m2	2,350-2,650	2,200-2,500	2,200-2,500	2,050-2,350	2,250-2,550	2,200-2,500
Small Apartment, 50-100m2. Concrete floor slab. Kitchen, bathroom, WC, ensuite. Garaging. Small balcony							
Cedar or pine weatherboards, Colorsteel® roof. Medium quality fittings	m2	1,960-2,160	1,890-2,090	2,030-2,330	1,880-2,080	1,910-2,110	1,850-2,050

Multiple Units, High Rise	Unit	Auck $	Wgtn $	Chch $	Dun $	Waik $	PNth $
Multi-Storey Apartments. Kitchen, bathroom, WC, laundry. Lift to each floor. Excludes balconies and loose fittings	m2	2,950-3,250	2,600-2,900	2,750-3,050	2,450-2,750	2,650-2,950	2,600-2,900
2 or 3 bedrooms. Medium quality fittings	m2	2,950-3,250	2,700-3,000	2,900-3,200	2,700-3,000	2,750-3,050	2,700-3,000
2 or 3 bedrooms. Ensuite. High quality fittings	m2	3,400-3,700	3,100-3,400	3,350-3,650	3,100-3,400	3,150-3,450	3,050-3,350
Add extra for balconies, reinforced concrete, to							
Medium standard units	m2	790-890	730-830	800-900	730-830	740-840	730-830
High standard units	m2	810-910	750-850	830-930	750-850	770-870	740-840

PRELIMINARY DESIGN STAGE

- Design team members are appointed in terms of needs at early design stages
- The Architect develops the 2 dimensions floor layouts and elevations
- Specification and finishes options are explored
- Structural concept design is commenced with appropriate "grid" layouts
- Quantity Surveyors assists with exploring options
- Preliminary Elemental Estimate is developed by rough order measuring of the key elements using "composite rates" largely based on historical cost data or built up from first principles
- Some market testing of key products is undertaken

At this stage the design takes shape and the QS estimate sets up "Cost Plans" for the various elements to be developed within and which the client will sign off on.

TABLE E: EXTRACT FROM QV COST BUILDER ON FRAME ELEMENTS

FRAME

CostBuilder powered by QV

Portal Frames Glulam	Hrs	Unit	Auck $	Wgtn $	Chch $	Dun $	Waik $	PNth $
Add for purlins and girts								
Glulam Portal Frame, laminated rafters and legs, metal base shoes, plywood fixings. Frames at 5m centres. Knee height 4m.								
12m span		m2	110.00	104.00	110.00	103.00	105.00	102.00
15m span	0.54	m2	169.00	161.00	169.00	160.00	162.00	159.00

Portal Frames LVL	Hrs	Unit	Auck $	Wgtn $	Chch $	Dun $	Waik $	PNth $
Frames at 4.8m centres								
Add for purlins and girts								
LVL Portal Frame, Hyspan® 600 x 63 columns, Hyspan® 450 x 63 rafters. 15 bays								
12m span, 4.5m to portal knee	0.27	m2	92.00	88.00	92.00	88.00	89.00	87.00
12m span, 6m to portal knee	0.28	m2	106.00	102.00	106.00	102.00	103.00	101.00
14m span, 4.5m to portal knee	0.24	m2	84.00	81.00	84.00	80.00	81.00	80.00
14m span, 6m to portal knee	0.25	m2	92.00	89.00	92.00	88.00	89.00	88.00
LVL Portal Frame, Hyspan® 600 x 63 columns, Hyspan® 450 x 63 rafters. 7 bays								
12m span, 4.5m to portal knee	0.29	m2	98.00	94.00	98.00	94.00	95.00	93.00
12m span, 6m to portal knee	0.3	m2	114.00	110.00	114.00	109.00	110.00	108.00
14m span, 4.5m to portal knee	0.25	m2	90.00	86.00	90.00	86.00	87.00	85.00
14m span, 6m to portal knee	0.27	m2	99.00	95.00	99.00	94.00	96.00	94.00
LVL Portal Frame, Hyspan® 600 x 63 columns, Hyspan® 450 x 63 rafters. 4 bays								
12m span, 4.5m to portal knee	0.31	m2	108.00	104.00	108.00	103.00	104.00	102.00
12m span, 6m to portal knee	0.33	m2	125.00	120.00	125.00	119.00	121.00	119.00
14m span, 4.5m to portal knee	0.28	m2	98.00	95.00	98.00	94.00	95.00	93.00
14m span, 6m to portal knee	0.29	m2	108.00	104.00	108.00	103.00	105.00	103.00
LVL Portal Frame, Hyspan® 600 x 63 columns, Hyspan® 600 x 63 rafters. 10 bays								
16m span, 4.5m to portal knee	0.23	m2	91.00	87.00	91.00	87.00	88.00	87.00
16m span, 6m to portal knee	0.24	m2	98.00	95.00	98.00	94.00	95.00	94.00
18m span, 4.5m to portal knee	0.21	m2	83.00	80.00	83.00	80.00	81.00	79.00
18m span, 6m to portal knee	0.22	m2	90.00	87.00	90.00	86.00	87.00	86.00
20m span, 4.5m to portal knee	0.19	m2	79.00	77.00	79.00	76.00	77.00	76.00
20m span, 6m to portal knee	0.2	m2	85.00	83.00	85.00	82.00	83.00	82.00

CARPENTRY

CostBuilder powered by QV

Framing, General Notes	Hrs	Unit	Auck $	Wgtn $	Chch $	Dun $	Waik $	PNth $
References in subheadings, eg, T6.3 or C6.8.3, are to Tables and Clauses in NZS3604:2011. Sizes given are generally those nominated in NZS 3604.								
'100mm x 50mm/ *90mm x 45mm* indicates usual naming convention/ *new naming convention* '								
All framing timber is Radiata Pine, Planer Gauged, KD SG8, unless stated otherwise.								
Framing items following are based on retail supply rates less 35% discount. Adjust as required for varying trade discounts.								

Framing Floor, H1.2, KD, SG8	Hrs	Unit	Auck $	Wgtn $	Chch $	Dun $	Waik $	PNth $
Ground Floor Joists, T7.1								
150mm x 40mm/ *140mm x 35mm*	0.13	m	15.10	14.40	14.50	13.00	14.40	14.10
100mm x 50mm/ *90mm x 45mm*	0.13	m	13.30	12.90	13.70	11.90	12.60	12.40
150mm x 50mm/ *140mm x 45mm*	0.15	m	18.30	18.10	17.70	16.00	17.30	17.50
200mm x 50mm/ *190mm x 45mm*	0.16	m	22.00	22.40	21.30	19.60	22.60	21.80
250mm x 50mm/ *240mm x 45mm*	0.16	m	25.50	26.60	27.40	27.10	26.90	26.00
300mm x 50mm/ *290mm x 45mm*	0.16	m	29.90	30.10	30.80	31.90	30.60	29.70
Mid Floor Joists, T7.1								
100mm x 40mm/ *90mm x 35mm*	0.15	m	14.20	11.90	13.90	11.80	12.40	12.40
150mm x 40mm/ *140mm x 35mm*	0.15	m	16.40	15.40	15.80	13.90	15.40	15.00
100mm x 50mm/ *90mm x 45mm*	0.15	m	14.60	13.90	15.00	12.90	13.60	13.30
150mm x 50mm/ *140mm x 45mm*	0.17	m	19.60	19.10	19.00	16.90	18.30	18.40
200mm x 50mm/ *190mm x 45mm*	0.17	m	22.70	22.90	21.90	20.00	23.20	22.20
250mm x 50mm/ *240mm x 45mm*	0.17	m	26.10	27.10	28.00	27.60	27.40	26.40
300mm x 50mm/ *290mm x 45mm*	0.18	m	31.20	31.10	32.10	32.80	31.60	30.60
Solid Nogging, C7.1.2								
150mm x 50mm/ *140mm x 45mm*	0.22	m	22.70	21.50	22.10	19.30	20.90	20.70
200mm x 50mm/ *190mm x 45mm*	0.23	m	26.50	25.80	25.70	22.90	26.30	25.00
250mm x 50mm/ *240mm x 45mm*	0.23	m	29.90	30.10	31.80	30.40	30.50	29.20
300mm x 50mm/ *290mm x 45mm*	0.29	m	38.10	36.50	39.00	38.00	37.30	35.60
Herring Bone Strutting, C7.1.2.4								
75mm x 50mm/70mm x 45mm	0.24	m	19.70	16.40	20.20	15.70	16.70	15.40

DEVELOPED DESIGN STAGE

- Co-ordinated design development by the design team
- Elevations, cross sections and key details are developed
- Structural design developed so that specific sizes are calculated
- Value engineering exercises focus on those elements that are impacting on the cost and decisions made on final form, layout and specification
- Developed design estimates will comprise measurement of Architectural and Structural elements with possibly services being considered on /m^2 cost basis
- Other specialist consultants input into the design
- With Mass Engineered timber specialist suppliers need to be engaged and the client needs to consider "Nominating" such suppliers to secure production line placement.
- QS can manage a procurement process of such

At this stage the cost estimate is worked up on detailed rates that comprise material, labour and plant costs. Any gaps in cost data can be verified by market testing with suppliers such as specialist facade, ceiling and flooring specialists etc.

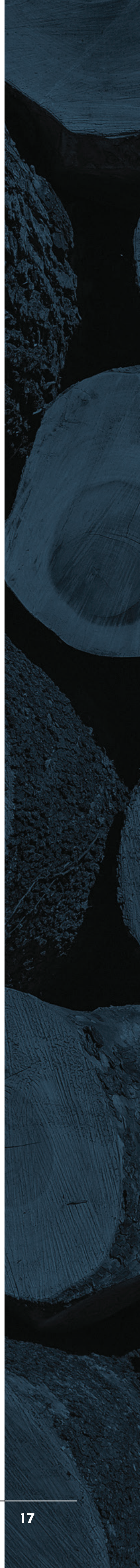
TABLE F: EXTRACT FROM QV COST BUILDER ON SERVICES

MECHANICAL SERVICES

Air Conditioning	Hrs	Unit	Auck $	Wgtn $	Chch $	Dun $	Waik $	PNth $
Rates given hereafter indicate the range of average costs for typical buildings, excluding any significant site conditions.								
Costs are *per m2 of air conditioned area,* ie, not necessarily entire building								
For detailed rates,See Mechanical Services								
Offices and Administration								
Packaged plant, ducted								
1-5 storey		m2	258	254	261	254	254	254
All air system, medium standard								
1-5 storey		m2	284	279	288	279	280	280
6-10 storey		m2	350	345	355	345	346	346
11-20 storey		m2	414	408	420	408	409	409
All air system, high standard								
1-5 storey		m2	414	408	420	408	409	409
6-10 storey		m2	567	559	575	559	560	560
11-20 storey		m2	503	496	511	496	497	497
Residential								
Ducted, medium standard								
House		m2	179	177	182	177	177	177
Multi-storey		m2	179	177	182	177	177	177

ELECTRICAL SERVICES

Costs per Square Metre	Hrs	Unit	Auck $	Wgtn $	Chch $	Dun $	Waik $	PNth $
Rates given hereafter indicate the average cost for power and lighting to a medium level.								
For detailed rates,See Electrical Services								
Education								
Primary Schools		m2	169	167	172	167	167	167
Secondary Schools		m2	226	223	230	223	224	224
Technical Institutes		m2	249	246	253	246	246	246
University Arts		m2	370	364	375	364	365	365
University Lecture Theatre		m2	370	364	375	364	365	365
Hospitals								
District, Private		m2	415	409	422	409	410	410
General		m2	467	460	474	460	461	461
Hotels and Motels								
City, three star		m2	235	231	238	231	232	232
City, five star		m2	246	243	250	243	243	243
Motel, standard		m2	160	158	163	158	158	158
Industrial								
Warehouse with small office		m2	82	80	83	80	81	81
Factory with small office		m2	82	80	83	80	81	81
Laboratory, workshop		m2	218	215	221	215	215	215



DETAILED DESIGN STAGE

- The architectural detail develops including expanding on specifications for all products and finishes
- Structural engineers develop connection details
- Mechanical and Electrical Consultants develop their designs. Noting some services comprise "Design & Build" services
- The traditional procurement route in New Zealand is based on a Lump Sum Contract tendered on detailed drawings and specifications
- Alternatively, the QS can provide a Schedule of Quantities as a Procurement basis which details all trade items required to be priced by the contractor based on a Standard System of Measuring. Refer to latest ANZSMM 2018
- Building Consent is lodged

The design process typically takes between 6 and 9 months and could be longer depending on project size and complexity before construction on site commences.

TABLE G: EXTRACT FROM QV COST BUILDER ON STRUCTURAL TIMBER

CARPENTRY CostBuilder powered by QV

Beams LVL	Hrs	Unit	Auck $	Wgtn $	Chch $	Dun $	Waik $	PNth $
For LVL Portal Frames,See Portal Frames LVL								
Hyspan® LVL Beams, H1.2, laminated veneer lumber								
45mm thick								
150mm	0.13	m	34.60	32.80	34.50	32.50	33.00	32.30
170mm	0.14	m	38.80	36.80	38.70	36.50	37.10	36.30
200mm	0.15	m	44.60	42.60	44.60	42.20	42.80	42.00
240mm	0.15	m	52.00	50.00	52.00	49.00	50.00	49.00
300mm	0.17	m	63.00	61.00	63.00	61.00	61.00	60.00
360mm	0.17	m	75.00	72.00	74.00	72.00	73.00	72.00
400mm	0.17	m	82.00	79.00	82.00	79.00	80.00	79.00
63mm thick								
150mm	0.15	m	46.40	44.30	46.30	43.90	44.60	43.70
200mm	0.15	m	59.00	57.00	59.00	56.00	57.00	56.00
240mm	0.17	m	70.00	67.00	70.00	67.00	68.00	67.00
300mm	0.17	m	84.00	82.00	84.00	82.00	82.00	81.00
360mm	0.18	m	101.00	98.00	101.00	98.00	99.00	97.00
400mm	0.19	m	111.00	109.00	111.00	108.00	109.00	108.00
450mm	0.2	m	127.00	124.00	127.00	124.00	124.00	123.00
600mm	0.22	m	165.00	162.00	165.00	162.00	163.00	161.00
Available in H3 by special order only, with a minimum of 10m ^{3}								

CARPENTRY CostBuilder powered by QV

Beams LVL, Floor Joists and Lintels	Hrs	Unit	Auck $	Wgtn $	Chch $	Dun $	Waik $	PNth $
hyJOIST® Floor Joists, with LVL flanges and 9mm plywood web								
63mm thick, H1.2								
240mm x 63mm x 36mm	0.15	m	20.10	18.00	20.00	17.60	18.30	17.40
300mm x 63mm x 36mm	0.15	m	21.40	19.30	21.40	19.00	19.60	18.70
360mm x 63mm x 36mm	0.15	m	22.80	20.80	22.80	20.40	21.00	20.20
90mm thick, H1.2								
240mm x 90mm x 36mm	0.16	m	21.90	19.60	21.80	19.30	19.90	19.00
300mm x 90mm x 36mm	0.16	m	23.40	21.20	23.30	20.80	21.50	20.60
360mm x 90mm x 36mm	0.16	m	25.00	22.70	24.90	22.40	23.00	22.10
400mm x 90mm x 36mm	0.17	m	32.90	30.60	32.90	30.20	30.90	29.90
63mm & 90mm thick available in H3 by special order only, with a minimum of 10m ^{3}								
63mm thick, UT								
240mm x 63mm x 36mm	0.15	m	30.90	28.80	30.80	28.50	29.10	28.20
300mm x 63mm x 36mm	0.15	m	33.20	31.20	33.20	30.80	31.40	30.60
360mm x 63mm x 36mm	0.15	m	36.60	34.50	36.50	34.20	34.80	33.90
90mm thick, UT								
240mm x 90mm x 36mm	0.16	m	33.90	31.70	33.90	31.40	32.00	31.10
300mm x 90mm x 36mm	0.16	m	37.10	34.80	37.00	34.50	35.20	34.20
360mm x 90mm x 36mm	0.16	m	40.20	38.00	40.20	37.70	38.30	37.40
400mm x 90mm x 36mm	0.17	m	56.00	53.00	56.00	53.00	54.00	53.00
Hy90® 90mm LVL Lintel, H1.2								
150mm x 90mm	0.33	m	55.00	50.00	55.00	49.00	51.00	49.00
200mm x 90mm	0.35	m	68.00	64.00	68.00	63.00	64.00	62.00
240mm x 90mm	0.38	m	82.00	77.00	82.00	76.00	77.00	75.00
300mm x 90mm	0.45	m	112.00	106.00	112.00	105.00	107.00	104.00
360mm x 90mm	0.5	m	142.00	135.00	142.00	134.00	136.00	133.00
400mm x 90mm	0.6	m	161.00	153.00	161.00	151.00	154.00	150.00

CONSTRUCTION PHASE

The proposed tenderers bid on the issued tender documents, seeking quotes from their supply chain of sub-contractors. To understand how this relates to the timber supply chain, we need to consider the manufacturing route and consider how this overlaps with the "Building Design Process".

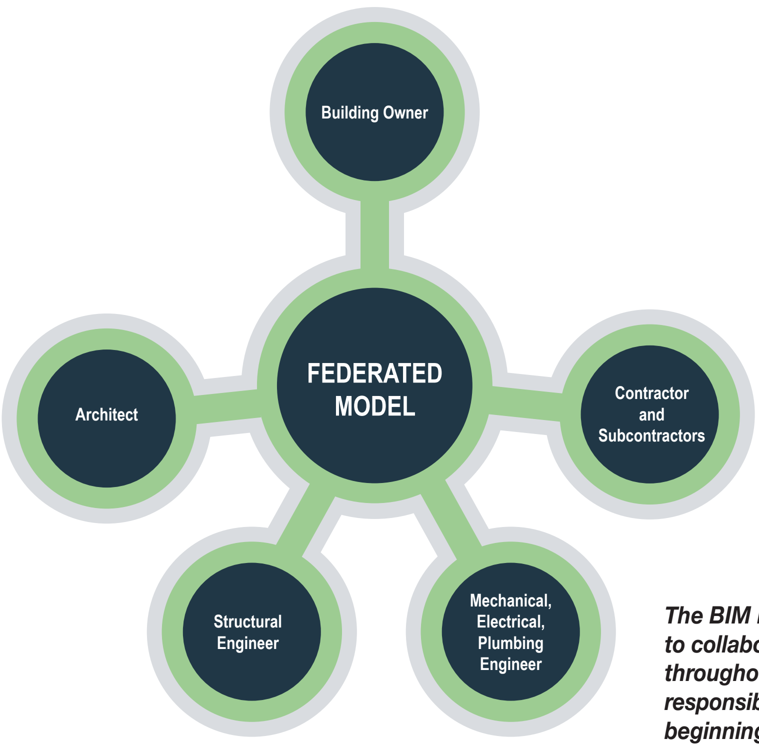
Design and Build impact on Traditional routes

With structural timber solutions, we need to start with "what does a timber solution look like", in order to maximise the end result benefits. What is commonly derailing projects is that it is traditionally designed in steel and concrete and there after timber solutions are sought, to match or fit in with steel grids or concrete frame solutions. Structural timber or prefabricated options should be considered from the very beginning. In terms of impact on the time-line, this does increase the "The Design Process" time and requires greater earlier co-ordination. The build process off site, overlaps with the commencement on site, as the Main Contractor's programme for the scheduled enabling works and foundation works are on the critical path.

This alternative approach is based on Design & Build principles and Nominated Suppliers basis, with best project outcomes achieved by Early Contractor Involvement (ECI).

TABLE H: EXTRACT FROM NZ BIM HANDBOOK 2016 EDITION

MODEL FEDERATION DIAGRAM



The BIM Process allows for project stakeholders to collaborate on a federated information model throughout the lifecycle of building. Execution and responsibilities need to be specified carefully at the beginning of every BIM project.

Note: Building Information Modeling (BIM) is a process supported by various tools, technologies and contracts. BIM files can be exchanged or networked to support development of built assets and aid facility management. BIM software is used to plan, design, construct, operate and maintain diverse physical built assets and infrastructure. Using a Federated Model approach for BIM projects achieves best outcomes. Refer to NZ BIM Handbook, latest edition for further benefits of adopting the BIM process.

4. MATERIALS

In New Zealand, the timber industry are members of WPMA (Wood Processing and Manufacturing Association) who promote the industry, provide support and reference materials, such as the current Timber Guides series. Individual companies produce their own technical publications, which contain detailed information on their products and systems that should be consulted in the first instance. A brief generic product overview is provided here with indicative cost ranges:

STRESS GRADED TIMBER

Comprises the largest share of the NZ timber industry with numerous suppliers providing capacity and diversity.

- General SG timbers for stick framing - $\$800/m^3$ to $\$1,200/m^3$
- SG Frame and Truss (F&T) - $\$2,000/m^3$

CLT PANELS

Budget costs for Supply and Fabrication can be anticipated between **$\$2,000/m^3$ to $\$3,000/m^3$**, which includes CNC costs of approximately $\$500/m^3$. New resources coming to market will be providing CLT billets with CNC to be undertaken by others.

Costs can be considered in various forms from raw billets, machined panels, complex machined panels and visual quality, thus users are urged to contact suppliers for detailed costs. Note for components delivered to site that they are quoted in m^2 depending on thickness, number of lamellas, treatment and including installation (if to be quoted on) as a guide as follows:

- 105mm thick panel supply only approx $\$260/m^2$
- 135mm thick panel supply only approx $\$280/m^2$
- 175mm thick panel supply only approx $\$400/m^2$

Refer to the additional items to be taken into account in the budget, as detailed under BUDGET ITEMS below.

LVL BEAMS AND COLUMNS

Budget costs for Supply and Fabrication can be anticipated between **$\$2,500/m^3$ to $\$3,800/m^3$** subject to complexity, sizes, machining, connections details, location delivery and site logistics.

GLULAM BEAMS AND COLUMNS

Budget costs for Supply and Fabrication can be anticipated between **$\$3,000/m^3$ to $\$6,000/m^3$** subject to complexity, sizes, connections details, location delivery and site logistics.
As a broad overview the following can be anticipated:

- Straight timber without machining $\$3,000/m^3$
- Simple machining $\$4,000/m^3$
- Complex machining $\$5,000/m^3$
- Curved members and complex machining $\$6,000/m^3$

CASSETTE/STRESSED SKIN FLOORING

Budget costs for supply and install can be anticipated at **$\$150/m^2$ to $\$230/m^2$** subject to design, sizes, connections details, location delivery and site logistics.

ENERGY DISSIPATION DEVICES

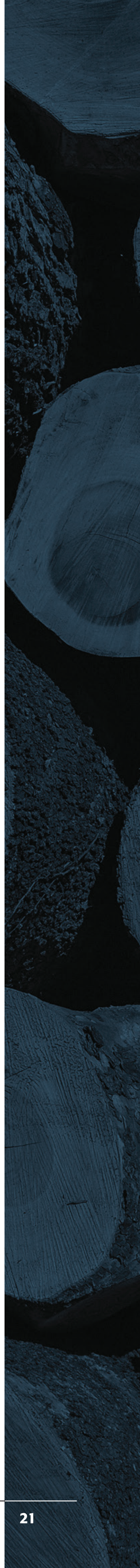
Energy dissipation devices and designs are a specialised field that provides solutions for future proofing buildings to minimise structural damage typically from earthquakes. Refer to specialists such as:

- For products such as Tectonus RSFJ and RingFeder for post tensioned springs. As an indicative budget, allow 20% of superstructure frame cost
- Buckling Restrained Brace (BRB), designed to withstand cyclical earthquake induced loading. Refer to suppliers such as Corebrace
- Pres-lam system. Refer to PTL Structural Consultants for patent design solution

BUDGET ITEMS

Additional items to take into account in the budget are:

- Treatments, if required
- Visual grade additional costs approx. $20/m^2$
- Delivery transport costs between $2k and $4K per load depending on site and noting load constraints
- Transport in containers limits panel sizes and increases fixing connections
- Cranage for erection - Refer to Main Contractor to confirm if supplied in P&G
- Engineering design fee - $10K to $45K depending on project
- Fixings - between 10% and 35% timber value
- Suppliers require deposits, generally 35%, to secure production line placement.
- Erection and labour - between 10% and 15% of timber value excluding crane costs (Refer to Main Contractors P&G)
- Possible offsite storage costs
- Prefabricated LVL joints
- Castellated CLT (additional CNC and wastage)
- Rothoblaas strips and tie rods
- Grouting at base of CLT walls (Main Contractor work)
- DPC’s (Damp proof course)
- Batten & Cradle floating floor system
- Acoustic flanking strips
- Sub-floor noise batts
- Fire shield
- Additional CNC for rebates and service penetrations
- Secondary framing to balconies to form falls for drainage
- Secondary roof timbers
- Allow for “mock ups” as best practice to address issues



5. BUILDING FORMS

OVERVIEW

Understanding construction methodology and details becomes a key factor to unlocking what underpins the associated costs. Construction methodology is part of numerous factors that start with history, location, local available resources in terms of materials and labour and then become a function of what technology has been able to provide, including the logistics of manufacturing and transporting to construction sites. Building, has through the centuries, taken place at, and on, the construction site, transporting raw materials and forming elements to the drawings and vision of the Architects and Engineers. This process has meant that work on site is generally exposed to the elements and the programme time at risk of being delayed by adverse weather.

Over time, craftsmen worked from protected environments, exercising better control of the quality of their output in workshops and "transporting" completed components to sites. What this means, is that the time actually spent on site becomes part of a construction programme where segments can be run in parallel and the critical path adjusted to reduced overall programme. In theory, this means that reduced "on site" time, reduces the overall site operating costs that main contractors carry. Any products and processes that assists with reducing overall time on site, provides the Main Contractors with opportunity to offer **reduced Preliminaries and General costs**. In order to offer this saving, Main Contractor's need to be up skilled and labour needs to be trained, to fully take up any opportunities where time savings can be unlocked. Often when new products and systems appear on our very diverse markets, it does not immediately translate to the speedy programme times as there is a "learning curve" time that often only improves with experience.

As part of a pricing strategy, contractors may not pass on the full extent of any initial savings unless competitors are doing so, and thus will tender close to previous costing levels until such time as market conditions drive changes. We are all strongly influenced by what we have done before, as we are comfortable and competent and any new products or systems means exposing ourselves to risks of mistakes and we tend to build in "risks" for the unknown that any new products and systems represents. The need to reduce the overall programme time is also driven by clients needing to use the building for its intended function, as soon as practical. From a commercial aspect this becomes key, as every day that the premises are not operational translates into loss of potential income being generated. The bigger picture is not just about driving down construction costs, but unlocking the building as soon as possible, for its potential to generate income for the owners. Considering that temporary or alternative accommodation as well as relocation costs are often part of the client's costs that are stacking up daily while construction occurs is a driving factor for prefabrication.

TIMBER AND PREFABRICATION:

With this guide, our focus is on timber construction and how timber is incorporated into construction in a modern context. Fast forwarding history brings us to that segment of the construction industry where we are still seeking to achieve similar outcomes along the lines of Cost, Time and Quality. By prefabricating off site, manufacture and preparation is possible in a controlled environment which then increases quality and control with no delays to productivity, such as experienced from working unprotected in any adverse weather conditions.

A very good overview of the variations of prefabrication that is available in our New Zealand industry is as set up by Prefab NZ in their "The Material Matrix" www.prefabnz.com.

TABLE I: THE MATERIAL MATRIX BY PREFABNZ

ABOUT

The Material Matrix is a guide to the different variations of prefabrication that are available in our industry. Acting as a beginning point for designers and interested parties to understand the different options available to them.

THE MATERIAL MATRIX

TO START

Addressing the number one question of

COST

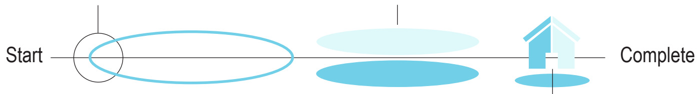
"Is it cheaper?"

1. Time Savings

Simplified Design + Build Timeline

When you should begin considering how to incorporate prefab.

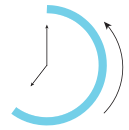
The build process is able to overlapped on-site and offset. Meaning twice as much work done in the same period of time.



Design process is longer when prefabrication is included.

Off-site and on-site elements come together on on-site.

2. Save Time = Save Money



60% → 15%

Saving

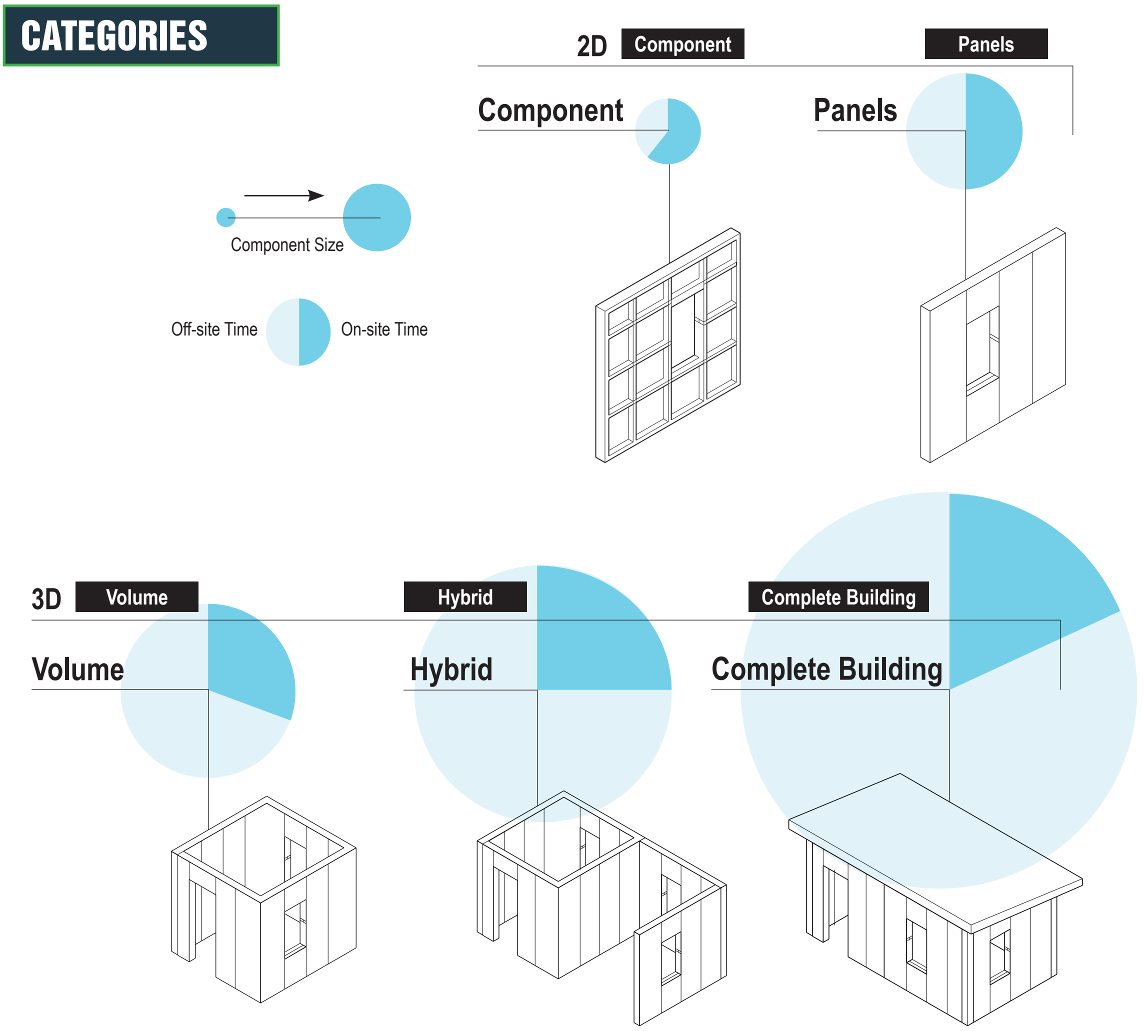
= $32,000

60% of construction time can be reduced through off-site construction *(PrefabNZ Value Case 2014)*

3. Cost Savings

Prefab delivery can mean a saving of about 15% in total construction cost - $32,000 for a 157m² house. *(PrefabNZ Value Case 2014)*

CATEGORIES



RELEVANT BUILDING CODE CLAUSES

	B1	B2	C1-6	E1	E2	E3	F2	F4	F7	G1	G2	G3	G4	G7	G9	G12	G13	H1
Component	●	●																
Panels	●	●	●		●	●									●	●	●	●
Volumes	●	●	●		●	●	●		●				●	●	●	●	●	●
Hybrid	●	●	●		●	●	●	●	●				●	●	●	●	●	●
Complete Building	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Key

- **A** General Provisions
- **B** Stability
- **C** Protection from Fire
- **D** Access
- **E** Moisture
- **F** Safety of Users
- **G** Services and Facilities
- **H** Energy Efficiency

B1 | Structure
B2 | Durability

E1 | Surface Water
E2 | External Moisture
E3 | Internal Moisture

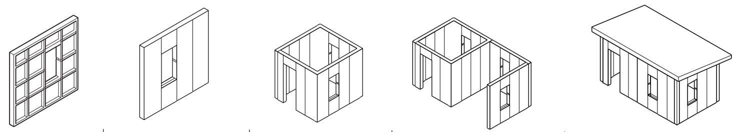
F2 | Hazardous Building Materials
F4 | Safety from Falling
F7 | Warning Systems

G1 | Personal Hygiene
G2 | Laundering
G3 | Food Preparation
G4 | Ventilation
G7 | Natural Light
G9 | Electricity
G12 | Water Supplies
G13 | Foul Water

H1 | Energy Efficiency

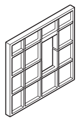
CONSIDERATIONS

An overview of some of the key considerations when designing for off-site construction.



	Component	Panels	Volume	Hybrid	Complete Building
Structural connection to adjacent components	●	●	●	●	●
Durability of particular component	●	●	●	●	●
Bracing integrity of each panel		●	●	●	●
Lining selection		●	●	●	●
External weatherproofing / internal waterproofing		●	●	●	●
Pre-installation of services pipework & electrical cabling		●	●	●	●
Method of termination / reconnection		●	●	●	●
Transportation / lifting		●	●	●	●
Fire safety design / active and passive fire protection			●	●	●
Safety from falling			●	●	●
Finish level / specification @ internal junctions			●	●	●
Tolerances in design and with other components			●	●	●
Timing of joinery installation				●	●
Protection of other properties					●
Modification during construction					●

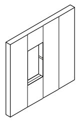
KEYWORDS



CARTRIDGE
A cartridge is a closed panel containing services, ducts, electrical conduits etc.

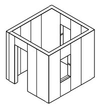
FLAT-PACK
This is a collection of panels transported in one package to site. Refer to panelised prefabrication.

OPEN PANEL
An open panel is a panelised element that consists of framing without cladding or lining. See also closed panel.



CLOSED PANEL
A closed panel is a panelised element that consists of framing with cladding or lining, or both. It may also include integrated services such as plumbing ducts and electrical conduits.

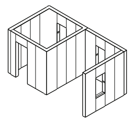
SIPS OR STRUCTURALLY INSULATED PANELS
SIPs are used as building panels for floors, walls and roofs in residential and commercial buildings. (Sylvester). SIPs are one type of panelised prefabrication.



SEMI-VOLUMETRIC PREFABRICATION
This is an interchangeable term with hybrid prefabrication. Refer to hybrid prefabrication.

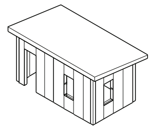
BLOCK
A block is another term for a module, pod or unit.

CHUNK
A chunk is a grouping of pre-formed materials into a complex component or module, prior to assembly at the construction site.



HYBRID-BASED OR HYBRIDISED PREFABRICATION
Hybrid-based prefabrication is also referred to as semi-volumetric prefabrication. It consists of a mixture of volumetric or modular units and non-volumetric or panelised units (module plus panel). It may also include component and site-built elements.

KIT, KIT-OF-PARTS, KITSET
This is the set of components prepared away from the construction site which are then assembled on site.



MODULAR HOME
This is a house designed using pre-existing modular products or systems and built at the site using a combination of modular and standard materials (Sylvester). A modular home meets building codes and is permanently fixed to a foundation on site.

PANELISED HOME
A building designed using pre-existing panelised products/systems and built on-site using panelised prefab components and "standard" materials (Sylvester).

WHO

Industry snapshot

A brief selection of prefabricated elements developers available throughout New Zealand.

Areas of Measurement

Type of Project:

Transport Size

Component

CHH WoodProducts
Prefabricated timber framing
Glulam / LVL components

Pryda
Pre-nailed truss and frame assembly
Floor cassettes

W+R Jack
Cross Laminated timber
CLT and CNC Machinery

Placemakers
Prefabricated timber framing

NZ Steel
Prefabricated Steel framing

Panels

Plywood (Panels)

XLam
Cross laminated timber
Can be used for floors, walls, ceilings, volumes, and complete buildings

Spanbild
Closed panel production at Concision factory - walls, floors and roof elements

Altus
Fast easy window systems installation

Apex
Apex wiring solutions
And Ke Kelit NZ for plumbing

Volume

Stanley
Cross laminated / mass timber framed construction, custom panels and volumes

NZ SIPS
Timber structural insulated panels

UNIpod
Open source bathroom pod design

Hybrid

Working with Tall Wood

James Hardie
Facade systems

Metra Panel
Reconstituted timber panels, walls, ceiling and floors. Also used for bathroom pods.

PLB Construction
Transportable homes using Metra panels Also make bathroom pods

Complete Building

Laing Homes
Transportable homes using Metra panels

Haven Transportables
Transportable homes

Keith Hay Homes
Transportable homes

Genius Homes
Transportable prefabricated and kitset homes

Matrix Homes
Volumetric and transportable homes

The number one question invariably "is it cheaper?" is far more complex to answer than looking at the specific prefabricated component in isolation and trying to compare costs.

For more information see PrefabNZ.com/resources

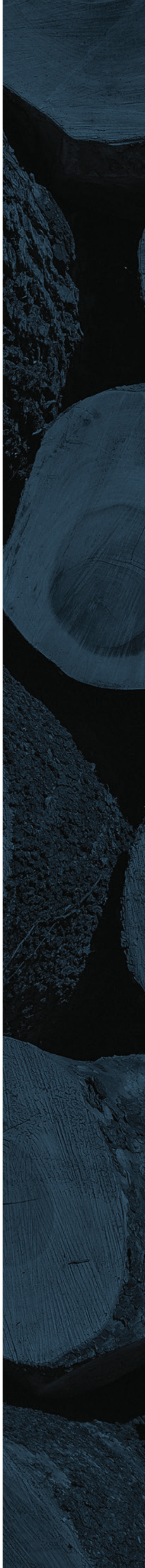
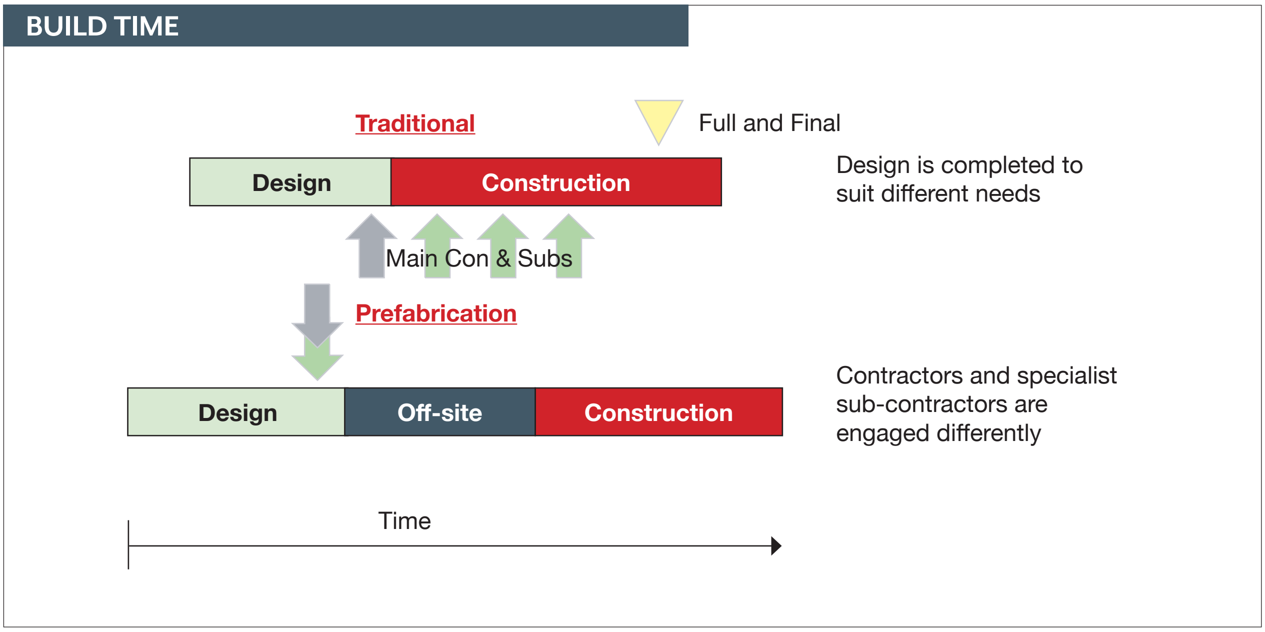


TABLE J: BUILDTIME, TRADITIONAL VS PREFABRICATION



If it is possible to extract the individual components to what it is to be compared to against traditional construction, the answer would most likely be, yes "prefabrication" is more expensive than traditional construction. What is produced is a value added product, being manufactured in a controlled environment with all the necessary Health and Safety operations in place, with equipment and machinery investment to assemble the prefabricated components. The real outcome of prefabrication is time savings, as the build process is able to be overlapped on site and activities running in parallel, equates to twice as much work being possible in the same period of time.

PrefabNZ states that from a Value Case in 2014 that 60% of construction time can be reduced through offsite construction which led to a 15% saving in this project of $32,000 for a 157m^2 house.

However as the prefabricated product assembly costs are more than the individual parts when constructed on site, it is then in the hands of the Main Contractor's estimator and programme scheduler to unlock the time savings and their associated overhead costs. If Main Contractor's have traditionally based their on site programme on historical actual times, they would not without good reason reduce expectations of reduced programmes until such time as they have evidence from their own experience.

The other catch 22 situation, as mentioned is that why would Contractors provide a 15% saving on contract costs compared to what their competitors are offering until such time as the market forces competitors to show their hand on any advantages from alternative or specialist systems. Contractors may offer marginal savings on prefabricated systems or alternative options, to pricing levels just below competitors pricing, when tendering for work unless all tenderers are tendering on exactly the same systems (apples for apples).

In order to get the contractor market to "give up" cost savings requires more contractors to get experienced with any new or alternative systems, training in new installation methods on site and sharing of knowledge. Quantity Surveyors have the skill set to analyse options beyond Capital costs even extending into Life Cycle Costs and Financial Viability Rates of Return on Investments.

Now, any sharing of knowledge starts to encroach on what contractors may perceive as their commercially sensitive information or market edge and likely that there would be reluctance to share or publish commercially sensitive case studies.

In theory, if we applied a 15% saving on construction costs, as suggested by PrefabNZ, we could expect the following based on a typical sizable NZ project (such as a community library project with meeting rooms, display areas and café facility) of say 2,000m^2 built for $10mil and constructed in 18 months in traditional construction:

> Typically, we could expect $1,080,000 to form part of the Main Contractors site overheads as outlined in the Preliminaries costs for say an 18 months construction period. Without defining which prefabrication system could be applied, but working on the premise that we can achieve a 15% saving then that could potentially result in an anticipated saving of $162,000 in Preliminaries alone which is a substantial value.
>
> Would this be possible to achieve and if so under what circumstances?
>
> Just considering the Preliminaries for every month we reduce the programme by, in this example, we can save in the order of $60,000 per month for staffing and overheads. The rest of the saving is to be unlocked in the trades, such as the carpentry where traditional Main Contractors would be flooding a site with resources and where, in contrast prefabricated systems labour resources could be drastically reduced by as much as 80%.
>
> This principle gets extended to all the subsequent trades who either have already had first fix stages of their work incorporated into the prefabrication or are able to work in more accessible areas, much faster than before, creating a knock on effect and with increased productivity. Again, it will take a few cycles on tendering before sub-contractors give up any financial advantages gained in new systems unless the market forces them to.

BUILDING TIMBER FORMS:

The Categories as outlined by PrefabNZ refers and sets the general context of correct terminology to apply. See also Glossary under PrefabNZ.com/resources. We have spoken about time being the real “cost saving” and the diagrams of the categories shows the impact that reduced “on site time” that each could potentially unlock.

2D COMPONENT

The most commonly used “prefabricated” component is timber wall framing comprising the studs, intermediate and cavity battens prefixed to required wall lengths and heights.

Overall size constraints will be dictated by the factory equipment handling ability and transporting logistics. Transported as panels and with potential to reduce “on site” time by 37.5%.

PANELS

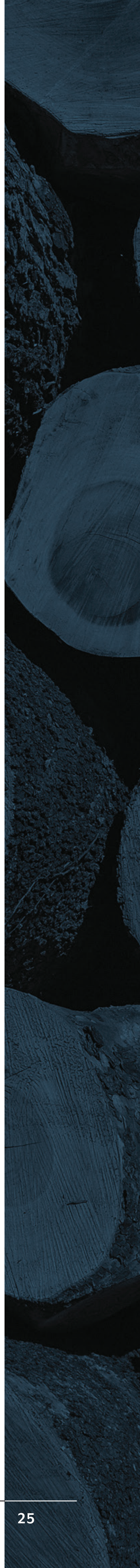
Panels could be a “cassette” or “cartridge” which is a closed panel containing services, ducts, electrical conduits, etc “Closed” panel is a panelised element that consists of framing with cladding or lining. It may contain integrated services such as plumbing ducts and electrical conduits.

“CLT” panels are structurally engineered timber panels for use as structural elements for floor, walls and roofs. These panels form the structural frame design and are mostly covered in traditional external cladding materials and internal plaster board linings with the possibility of the CLT panels being exposed internally after due design consideration of acoustics and fire requirements.

Transported as panels and potential to reduce “on site” time by 50% for the structural frame elements.

3D VOLUME

Volumetric or semi-volumetric looks at parts that lend themselves to preconstruction in pods, modules or units such as “bathroom” pods where there is a concentration of elements and services. It is more practical to compile these on a production line, send out as completed section and slotted into place on a traditional site. Transported as 3D pods, units or modules have potential to reduce “on site” time by as much as 67%.



HYBRID

Consists of a mixture of volumetric or modular prefabrication and non-volumetric or panelised units and may include component and site built elements. Transported as 3D pods, units or modules and panels with potential to reduce "on site" time by 75%.

COMPLETE BUILDING

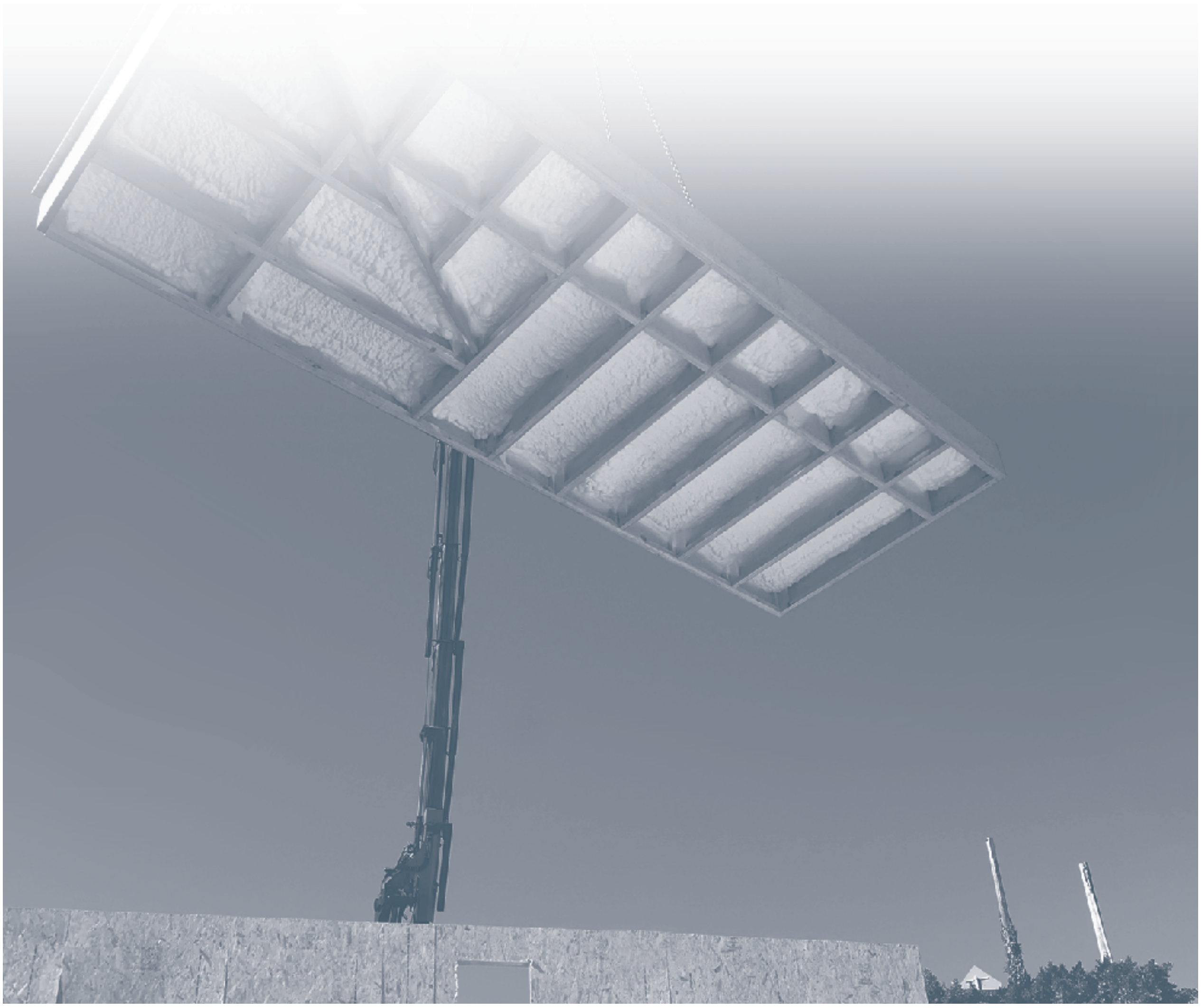
This is generally houses designed to be fixed to an on-site foundation system where trade mark companies have bespoke designs which are limited only by how they are able to be taken apart and transported either in sections or as a complete house.

Transported as part or whole 3D house with potential to reduce "on site" time by 83%.

CONSIDERATIONS

Prefabrication forms part of a highly specialised sector with a handful of specialist suppliers/manufacturers that need to be engaged at very early stages to obtain the real benefits of prefabrication.

Readers are recommended to consult directly with industry specialists.



6. CONSTRUCTION COSTS

Expanding on the "big picture", where to get timber to the table for project consideration, we need to be able to say "definitely" what the anticipated costs are, to bring a particular timber solution to the design selection table.

Whilst we would like to set out that a structural timber frame is at minimum **"cost neutral overall"** it can only be reached at this stage in NZ under very specific conditions and design components. Consider the three solutions below, compared against a structural steel frame solution.

STRUCTURAL FRAME ANALYSIS

TABLE K: CASE STUDY ELEMENTAL SUMMARY STRUCTURAL FRAME COMPARISON

COST PLAN COMPARISON

	A	B	C
TYPES OF STRUCTURAL FRAME	**TRADITIONAL STEEL FRAME**	**LIGHT WEIGHT TIMBER FRAME AND LVL JOISTS**	**LIGHT WEIGHT TIMBER FRAME AND LOCAL NZ CLT SOLID TIMBER FLOORS**
FRAME	$947,940.00	$213,168.00	$149,530.00
STRUCTURAL WALLS	$143,320.00	$943,233.00	$912,313.00
UPPER FLOORS	$387,072.00	$616,127.00	$1,128,328.00
ROOF	$248,063.00	$240,290.00	$492,236.00
EXTERNAL WALLS &	$373,874.00	$265,319.00	$270,202.00
EXTERNAL FINISH			
INTERNAL WALLS	$214,431.00	$90,920.00	$129,174.00
WALL FINISHES	$453,280.00	$394,690.00	$413,065.00
CEILING FINISHES	$174,111.00	$187,094.00	$78,314.00
FIRE SERVICES	$189,173.00	$189,173.00	$189,173.00
PRELIMINARIES	$768,640.00	$768,806.00	$686,893.00
MARGIN	$322,829.00	$322,898.00	$377,791.00
TOTAL	**$4,222,733.00**	**$4,231,718.00**	**$4,827,019.00**

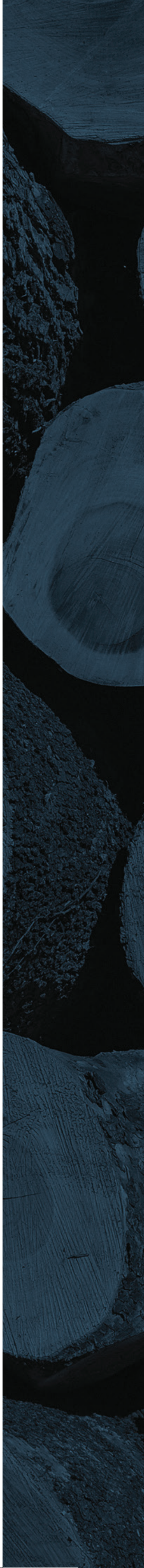
$ Variance to A		$8,985.00	$604,286.00
% Variance to A		0.213	14.310
Comment		Cost neutral	14% Premium

Note: The above Elements exclude Elements not affected in the comparison.
Note: The costs cannot be considered as being the total construction cost of the Building

This example demonstrates that compared to a traditional Structural Steel frame that a Lightweight Timber frame and LVL joist floors is comparable in costs.

Considering this further, based on using Lightweight Timber Frame and local NZ supply treated CLT floor panels, that project costs overall are approximately 14% more than traditional Structural Steel frame options.

The capacity of the New Zealand supply chain needs to be taken into account when considering the scale of a project in timber and for the associated economies of scale. Note that financiers place high risk on products and systems where there is reliance on a single dominant supplier. This leads us to where would such an option be best suited i.e. under what conditions would a timber solution be the best approach.



We need to explore this in much more detail and consider the aspects that can be targeted to unravel cost savings such as:

- **Foundations** – The catch 22 is that when QS's are doing initial estimates of projects on early concept layouts that Foundations are yet to be designed and thus costs are based on previous typical projects. The basis of the assumptions are stated in the estimates, however, these are likely to be on the cautious side of any allowance. To unlock the benefits of any timber structure, we need to consider that timber weighs one fifth the weight of concrete, so against any precast or reinforced concrete solution the foundation loading is drastically reduced and the **foundation design should respond accordingly**. This benefit needs Structural Engineering input to unlock and, traditionally, only gets developed later in the design process when initial feasibility has been provided.

  Following the Earthquakes in Christchurch, Engineers are required to design to the ground conditions from TC1, TC2 and TC3. Actual projects costs have shown that where ground conditions are the poorest, that timber becomes the preferred cost effective solution.

  Bealy Avenue, All Stars Backpackers, Christchurch a project designed by RM Designs and Engco was initially not financially viable and lighter structures or prefabricated options were investigated . The solution was finally much shallower timber piles, CLT floor and wall panels, all within acceptable budget costs of $2,200/m^2 in 2013/2014 excluding site specific foundations.

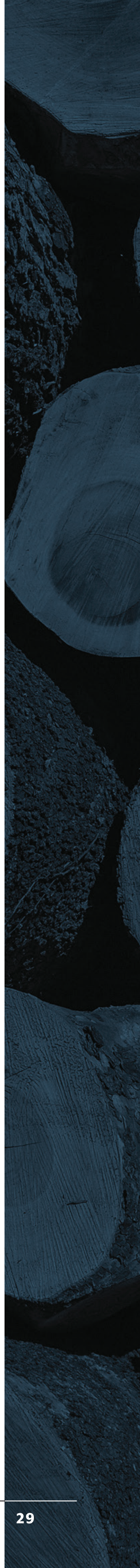
  The Arvida Retirement village in Christchurch used a preloading technique of gravel, piled 3 m to 4m high, until acceptable ground settlement was reached. After removal, retaining a lessor depth of gravel upon which a thick 300mm reinforced concrete ground floor was cast without requiring the use of concrete piling to great depths.

Both projects are very good indicators that where poor soils exist that structural timber should be the most appropriate solution to consider. To flush out what that means in terms of the foundation design and not just base it on previous historical cost data, is the challenge QS's have at early cost advice stage.

Bealey Avenue, All Stars Backpackers, Christchurch.

The Arivda Retirement village, Christchurch.

Where the foundation design is unaltered i.e. designed to accommodate maximum top load structure, then there is a strong possibility that the full extent of potential cost savings is not being unlocked or realised for a timber structure design.

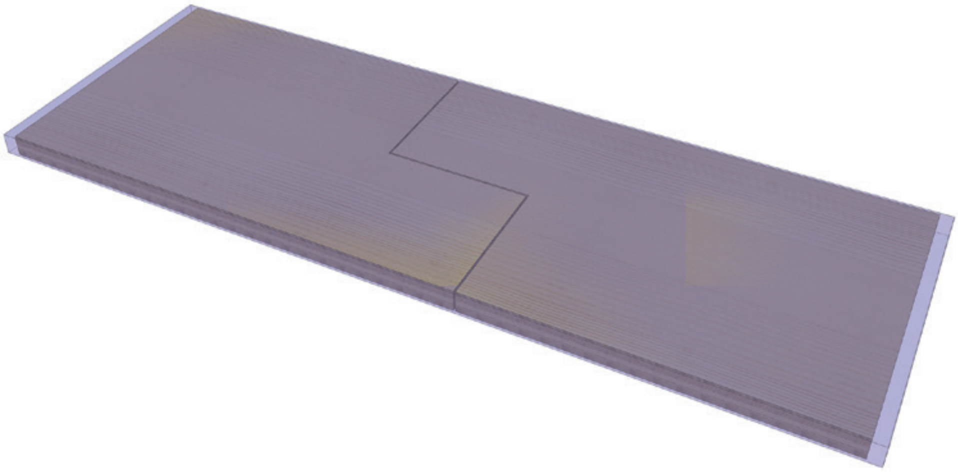


- **Fire ratings** – requirements apply to all projects. Sprinklers, additional timber laminas, spread of flame products, Fyreline plasterboard linings, etc are available to achieve specified fire ratings. In terms of the basic understanding of CLT panels, the cross laminas provide the structural properties and, as default property, the thickness of the **panel has inherent fire rating** based on test results. Whilst a nominal thickness is required for structural properties, additional layers can provide the required fire rating performance time. It is thus not uncommon, for timber designs to be evaluated in an equitable way, that quotes are based on structural performance only. As with other solutions being compared, fire requirements are considered under a separate identifiable section. Where CLT is clad in plasterboard linings, this normally meets the fire ratings required without the need to increase the thickness of the CLT timber panels. In most countries, building regulations are calling for Fire Sprinkler Protection, which, if installed could avoid the need to increase the timber panel thickness.
- **External scaffolding** – To unlock savings, consideration of where external scaffolding is required in Traditional construction vs "panelised" frame is necessary. Traditional external scaffolding is used for the majority of the contract period (by various tradesmen). In any panelised solution **the methodology used can result in significant savings** as the scaffolding costs are time related for the hire duration. With CLT panels or other panelised approaches, it may be possible to reduce the scaffolding time as edge protection could be installed on the ground to the edge of floor panels and lifted up. This means that the particular floor is immediately available for use by the tradesmen. Compared to concrete floors that require time to cure and for temporary propping to remain in place. Subsequent trades can use the internal stairs without requiring external scaffolding for a good few weeks. The use of CLT floors and roofs eliminate the need for fall netting. This results in costs savings up to 20% or more of the overall scaffolding costs.
- Where CLT panels are of visual grade and designed to be exposed, there is **potential for savings to consider in the omission of plaster board linings and paint**, compared to extra value of visual grade timber with spread of flame finish as Fireshield however at best can be considered cost neutral depending on a few factors.
- Reduced labour on site as less Carpenters and Joiners are required with panelised systems, which results in **significant savings in labour resources**.
- Shorter Mechanical and Electrical scheduled programme time as the trades are able to **fix directly to substrate and move in immediately**.
- It is possible to order windows and doors from drawings due to accurate CNC cutting that **reduces lead in time to order windows**, which traditionally can only be commenced following site measurements. This has huge programming advantages, which should not be undervalued.
- All the factors that have potential to reduce programme time, in turn, have potential savings in **reduced P&G costs compared to traditional construction**.
- Generally **smaller crane capacity** is required due to the timber weight being far less than Precast panels and less than steel.
- Less wastage is experienced with prefabricated products and with less skips required, it reduces wastage on site and **reduces wastage removal costs**.
- Prefabricated items become more an **exercise in site logistics** and assembly and the impact of correct sequencing is essential to avoid "doubling handling" on site. Careful planning is key to successful delivery, as is, how the timber is stored, protected and handled on site.

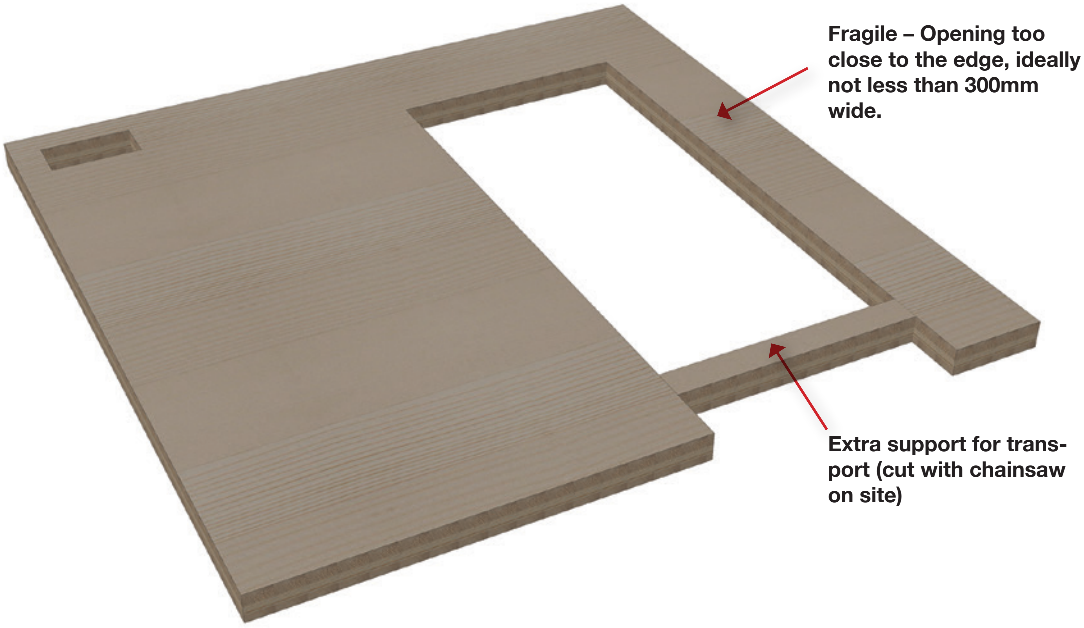
Note that **panel size optimization can result in significant savings**, which may be achieved in the fine tuning of the design. Architects may be keen to cut elaborate features, however, the implication on cutting time and factory logistics can result in increased costs.

TABLE L: PANEL SIZE OPTIMISATION

SIMPLE NESTING



MAKE IT TRANSPORTABLE



7. SAFETY COSTS

A key factor to consider, is that timber is one fifth the weight of concrete which represents a more acceptable solution when compared to the risks that the weight of precast concrete panels represents. This is even more evident when we explore what that means in terms of "safety in design" risk assessments. Generally it is difficult to justify the use of precast concrete panels when considering transport and temporary propping design requirements from a "safety in design" risk assessment.

With CLT panels or similar timber floor solutions, there is the **possibility to fix safety barriers to the edge of floor panels**, crane the panels up and have the floor panel area immediately accessible and safe to work on. In comparison, any wet trade flooring options requires time to cure and propping that needs to remain in place for the required curing to occur. As a minimum requirement, in terms of H&S, note that "safety harnesses" should be used by all key installers working at height.

Temporary propping needs to be taken into account and designed where required for Timber installations.

Cranage logistics is important and in terms of **safe days for lifting** may affect productivity (i.e. in windy days it would not be possible to lift up panels). This may result in the cranage being on site longer than initially scheduled.

Lifting straps and hook points are required as well as skilled lift operators and banksman.

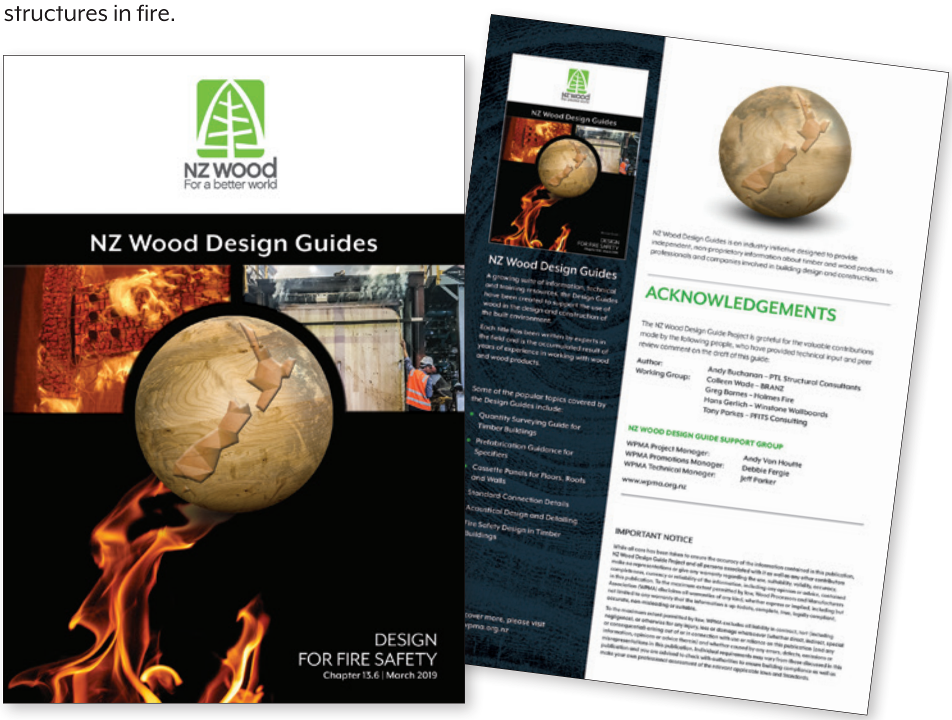
Site access, sequencing and logistics needs to be reviewed well before arriving on site with the materials.

Fixing directly and cutting timber is by far safer and easier than steel or concrete.

Tooling for timber is typically smaller with **less risk of serious injury**.

Timber is by far the safer product to work with compared to steel and concrete and is evident in terms of the **reduced risk in transportation and installation on site**.

In terms of performance of engineered timber during a fire, we recommend readers refer to the *"Design For Fire Safety"* guide in this series by Andy Buchanan. The properties of timber means that due to the "charring" ability" timber buildings will not simply fail or collapse, due to the additional laminas increasing the fire rating and the performance of timber structures in fire.



8. CONTINGENCIES

Making appropriate allowances for Contingencies is a skill that is improved upon after gaining related experience. QS's allow Contingencies based on percentages that varies through the design stages into the construction stage to accommodate the risks of likely budget blow outs.

DESIGN DEVELOPMENT CONTINGENCIES:

For elemental estimates, allowance is made for the detailing that needs to occur following any proposed Concept. This allowance is related to the complexity of the proposed project and hence it could be as high as 7.5% at Concept and progressively reduced at each design stage typically 5 % at Preliminary and 2.5% at Developed Design and finally 0% at Detailed Design. This often causes confusion, however, it is to be considered as part of the normal process of moving an estimate from Concept to Detailed Design and forms part of what the design team requires from a budgetary perspective for the project detail development.

CONSTRUCTION CONTINGENCIES:

This category of Contingency is typically what we see applied to budget estimates and which vary depending on the risks identified in relation to the specific project. As with all risks there are options to eliminate, manage or transfer ownership of it. Where there are risks that we cannot expect the Contractor to take ownership of, the risk ownership generally sits with the client/employer. For example site specific ground conditions, dealing with contaminated sites, asbestos materials and existing services.

Depending on the type of construction contract, some of the risks can be transferred to the Contractor ranging from where inadequate site investigations have occurred, incomplete designs, adverse weather, industrial action, H&S related issues and impact of "lead in times" from suppliers.

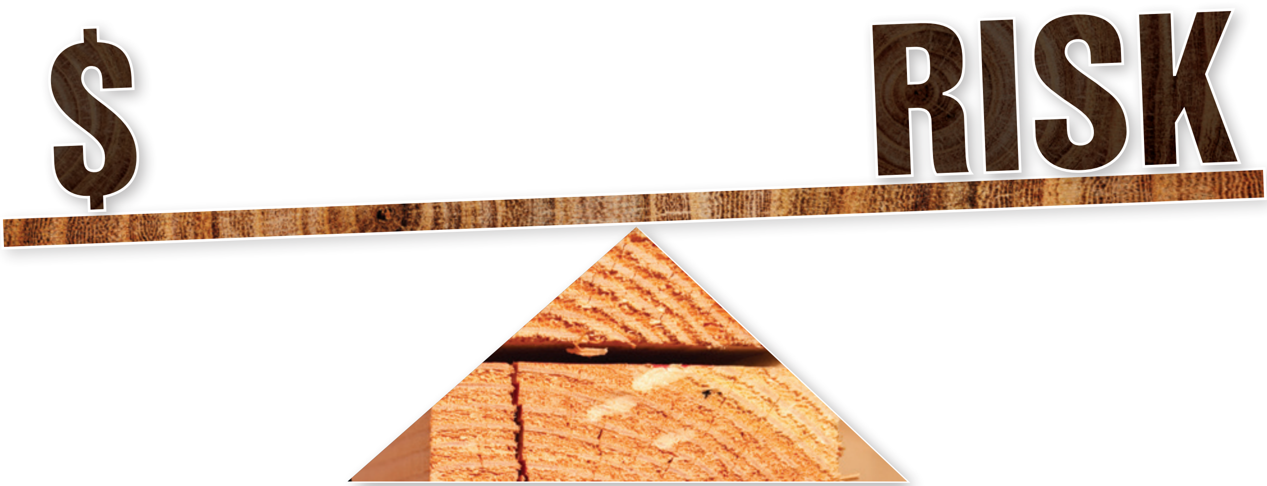
We would generally expect to see a **budgetary allowance of 10% for the full duration of the construction period**.

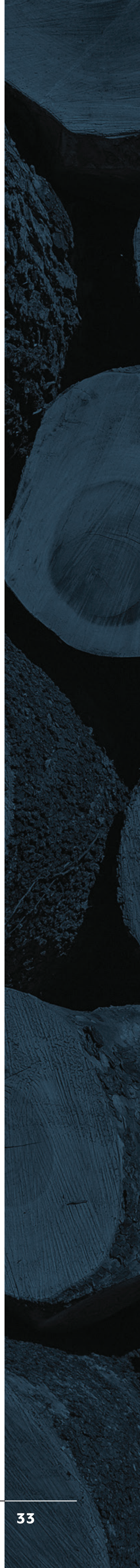
This Contingency can however be as high as 20% if the impact of risks has been assessed as greater or as low as 5% where the risks have been minimised and the project risks identified as low impact and low value. Whilst the risk is highest in the relatively unpredictable foundation stages, it is common to hold back on any design changes or variations until such time as the project is "out of the ground" and proceeding to superstructure. Often, clients will hold a higher Contingency until such time as the foundations are complete and then issue instructions to reduce the available Project Contingency in line with risks normally associated with superstructure constructions and Finishes. Clients/employers generally retain the risks around end user requirements, time scale related issues, legal issues, financial impact of funds, interest rates and exchange rate terms.

Where Quantity Surveyors find it difficult to assess costs at early stages, they will work up an appropriate Contingency in order to avoid exposing the client to any anticipated cost overruns or risks. The following aspects need due consideration by QS's when evaluating structural timber systems:

- Lead in time for design, manufacture and install
- Deposits required and impact on ownership of materials
- Cost of local timber competing against export value pricing
- Transport logistics
- Main Contractors knowledge of new systems and his tendering basis
- Productivity and corresponding labour allowances
- Transport requirements
- Cranage requirements
- Overall critical path programme and impact of delivery delays
- Dealing with remediation of new products and systems
- Varying fixings options
- Exchange rates of international supply goods
- Treatment of timber
- Varying Local Council Building Standards and requirements
- Impact of Fire requirements
- Impact Acoustic requirements

These are examples of the type of issues that could be evaluated without undue increases in Contingency levels. The timber solutions are providing real savings that QS's need to identify and unlock in costs assessments.





9. PROFESSIONAL FEES

In considering the overall project budget for the client, there is based on past projects an "expected % range" that the overall professional fees budget should allow for. As expected this varies from project to project and depends on the project size, number of consultants required and level of involvement, contract duration and extends to factors like procurement routes used. Although the professional fees are often quoted as fixed fees, they are based on the anticipated hours that will be required for the particular project by each service provider.

The quantity surveyor will set up the project budget based on an acceptable % in relation to the project construction estimate costs. In terms of regular financial reporting to the client, the professional fees budgets will be adjusted following the appointed design team's actual offer of services fees for each individual consultant and the scope of works that they have signed up for and as per the stages of design and construction.

The full typical design team comprises the following:

- Project Manager/ Engineer to the Contract - approx 2%
- Architect/ Lead Designer - 5% to 7%
- Geotechnical Engineer - 0.5%
- Urban Planner - 0.5%
- Quantity Surveyor - 1% to 1.5%
- Structural Engineer - 2%
- Civil Engineer - 0.5%
- Electrical Engineer - 1.5%
- Mechanical Engineer - 1.5%
- Acoustic Consultant - 0.5%
- Fire Consultant - 0.5%
- Other Specialist service providers- e.g. Facade Engineer, BIM Modeller,Peer Review consultant, Heritage Consultant, IT specialist, Interior Fitout Designer, etc.

Thus, the typical budget allows between 10% to 20% for professional fees and the exact percentage of which varies depending on a range of factors as mentioned above. Noting there is a sliding scale relationship between overall fees and actual % allowances where we can expect a smaller project value to have a disproportionately large fees % allowance. Conversely, with major projects of significant value, we can expect a reduced % allowance of the overall fee values. This is attributed to the economies of scale from the actual professional fees being based on time, rather than the value of the project, although noting that architectural fees can be related to contract value and adjusted following approved variations.

Traditionally the client engages the consultants directly and with any special projects would need to consider how services are to be engaged.

In a design & build contract, the client would instruct for services up to concept and possibly preliminary stage and then by contractual agreement "Novate" the professional design team over to the contractor. This process passes the risk over to the contractor as part of their responsibility for delivery of the full design and build service.

Design for Manufacturing and Assembly (DfMA), which requires early BIM or fabrication modelling to avoid delays, is being used more often in the construction industry. Structural timber solutions requires a similar approach for best outcomes.

Depending on when and how the timber system sits in the consultant appointment process, there is a need for the client to consider early engagement with specialised suppliers in order to commence the "lead" time for the specialised products required. Subject to agreement, the option exists for nominated services to the builder as a "nominated supplier". A "timber engineering" design fee replaces traditional structural design fee allowances and a "connection/ fixing" design is required. The timber engineering design fees can be provided by professional structural engineers depending on their in-house resources and capabilities. In addition to the sets of design drawings already provided by the design team, there will be requirements for shop drawings that relate to the timber design for the manufacturing process, in the same way as required for steel and prefabricated concrete shop drawings. The timber design, fixing design and the shop drawings fees are all part of the costs that does need to be considered for inclusion at the relevant stages.

10. DETAILED COST PLAN

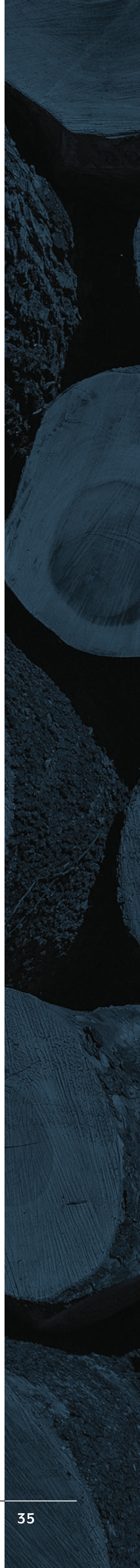
The attached case study is an example of a Lightweight Timber Frame (LTF) solution designed in LVL members for a 5 storey construction. This represents a "cost neutral example" when compared to a traditional steel frame option in NZ. The overall GFA of the project is 1,866m² and comprises two tower block sections abutting each other over a split level (one 5 storey and the other 4 storey). The ground floor area of 500 m² comprises reinforced concrete slabs, and the 5 storey block has a Comfloor 60 system overcroft floor to the parking area of 255m². The LTF walls comprise 90x45 LVL8 at 600 centres to the engineers design, upper floors are 300x45 LVL13 joists with 19 plywood floor including a floating floor timber system with 60 Autex ASB4 insulation. Shearwall ties allowed use a Strongrod system. All internal walls are lined in GIB plasterboard linings with 75mm Pink Batts silencer and including an extra layer of Fyreline to all intertenancy walls.

Note: for simplicity the costs have been analysed on a "per m² floor area" for a wider range of readers in mind, however, it is noted that standard elemental analysis is undertaken on an "elemental" area basis by QS's as per the relevant measuring guidelines.

TABLE M: DETAILED COST PLAN – LTF WALLS AND LVL JOISTS, (1st Quarter 2019) CASE STUDY

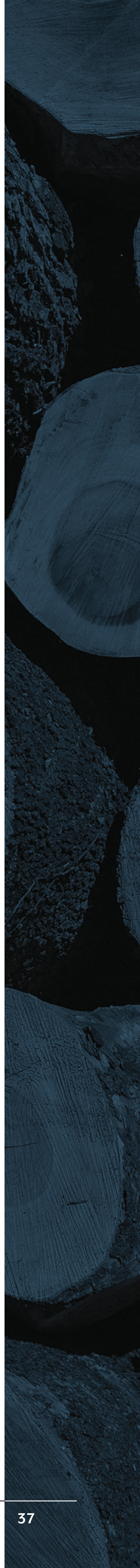
REVISED ESTIMATE - LTF & LVL JOISTS

Code	Description	Quantity	UOM	Rate	SubTotal	Factor	Total	Total	Total
1	MAIN BLOCK & EXTERIOR WORKS								
1.1	SITE PREPARATION								
1	Site clearance	677	m²	15.75	10,663		10,663		
2	Protection to existing tree	1	No	200.00	200		200		
	TOTAL SITE PREPARATION	1,866	m²	5.82	10,863			10,863	
1.2	SUBSTRUCTURE								
1	Bulk Excavation (with some fill remaining on site)	1,674	m³	78.75	131,828		131,828		
2	Excavation to foundation footings	89	m³	78.75	7,009		7,009		
3	Use bulk cut excavation and fill below slab to first and second floor	229	m³	15.75	3,607		3,607		
4	Disposal of excess soil off site	1,500	m³	10.50	15,750		15,750		
5	Backfill	395	m³	57.75	22,811		22,811		
6	Nova flow drain	103	m	26.25	2,704		2,704		
7	100 Thick reinforced concrete slab	269	m²	147.00	39,543		39,543		
8	150 Thick reinforced concrete slab	231	m²	155.00	35,805		35,805		
9	2,400 x 300 Deep reinforced concrete footing	20	m	820.00	16,400		16,400		
10	1,000 x 500 Deep reinforced concrete beam	27	m	640.00	17,280		17,280		
11	3,300 x 500 Deep reinforced concrete beam	32	m	1,660.00	53,120		53,120		
12	3,400 x 500 Deep reinforced concrete beam	15	m	1,710.00	25,650		25,650		
13	1,000 x 600 Deep reinforced concrete beam	26	m	770.00	20,020		20,020		
14	1,000 x 800 Deep reinforced concrete beam	7	m	1,030.00	7,210		7,210		
15	1,000 x 1,500 Deep reinforced concrete beam	33	m	1,770.00	58,410		58,410		
	TOTAL SUBSTRUCTURE	1,866	m²	244.99	457,146			457,146	



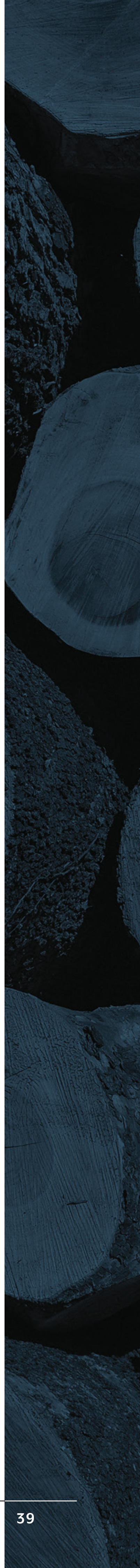
Code	Description	Quantity	UOM	Rate	SubTotal	Factor	Total	Total	Total
1.3	**FRAME**								
1	Lift steel	1	Sum	15,750.00	15,750		15,750		
2	Fixtures, plates, bolts and the like PROVISIONAL	1	Sum	15,000.00	15,000		15,000		
3	3/90 x 45 LVL8 column	30	m	55.00	1,650		1,650		
4	135 x 140 LVL8 column	21	m	120.00	2,520		2,520		
5	360 x 135 LVL13 beam	29	m	230.00	6,670		6,670		
6	400 x 270 LVL16 beam	6	m	560.00	3,360		3,360		
7	600 x 270 LVL16 beam	16	m	830.00	13,280		13,280		
8	20Dia Reidbrace	5	m	20.00	100		100		
9	250 UC 130 Column	2,730	kg	8.00	21,840		21,840		
10	360 UB 44 Beam (TBC)	418	kg	8.00	3,344		3,344		
11	350 UB 44 Beam	724	kg	8.00	5,792		5,792		
12	610 UB 125 Beam	6,407	kg	8.00	51,256		51,256		
13	360 x 135 LVL13 beam	29	m	370.00	10,730		10,730		
14	400 x 270 LVL16 beam	6	m	560.00	3,360		3,360		
15	600 x 270 LVL16 beam	16	m	830.00	13,280		13,280		
16	Additional steel beam	62	m	250.00	15,500		15,500		
17	3/90 x 45 LVL8 column	36	m	68.00	2,448		2,448		
18	135 x 140 LVL11 column	48	m	80.00	3,840		3,840		
19	150 UC 30 Column	720	kg	8.00	5,760		5,760		
20	250 UC 89 Column	2,136	kg	8.00	17,088		17,088		
21	32Dia Reidbrace	20	m	30.00	600		600		
	TOTAL FRAME	**1,866**	**m^2**	**114.24**	**213,168**			**213,168**	
1.4	**STRUCTURAL WALLS**								
1	Reinforced blockwork	15	m^2	252.00	3,780		3,780		
2	Tanking and protection to masonry	271	m^2	115.50	31,301		31,301		
3	Strapping to wall at units below ground	358	m^2	26.25	9,398		9,398		
4	Sealant to blockwork	129	m^2	31.50	4,064		4,064		
5	White render finish to blockwork	63	m^2	115.50	7,277		7,277		
6	100 Thick reinforced concrete wall (TBC)	59	m^2	410.00	24,190		24,190		
7	300 Thick reinforced concrete retaining wall	50	m^2	550.00	27,500		27,500		
8	400 Thick reinforced concrete retaining wall	225	m^2	620.00	139,500		139,500		
9	500 Thick reinforced concrete retaining wall	47	m^2	690.00	32,430		32,430		
10	500 Thick reinforced concrete stairwell and lift shaft	85	m^2	690.00	58,650		58,650		
11	LTF 2/90 x 45 LVL8 at 600crs, 3,000 high	267	m^2	271.00	72,357		72,357		
12	LTF 90 x 45 LVL8 at 600crs, 3,000 high	1,164	m^2	239.00	278,196		278,196		
13	LTF 140 x 45 LVL8 at 600crs, 3,000 high	413	m^2	260.00	107,380		107,380		
14	Extra value for exterior timber treatment	645	m^2	38.87	25,071		25,071		
15	Extra value for visual finish	787	m^2	27.04	21,280		21,280		
16	Waterproofing membrane	645	m^2	45.00	29,025		29,025		
17	Shearwall ties as Strongrod	1	item	71,835.35	71,835		71,835		
	TOTAL STRUCTURAL WALLS	**1,866**	**m^2**	**505.48**	**943,233**			**943,233**	
1.5	**UPPER FLOOR**								
1	Comfloor 60 system with 160 reinforced concrete topping slab	255	m^2	210.00	53,550		53,550		
2	300 x 45 LVL13 joists	3,547	m	61.00	216,367		216,367		
3	300 x 45 LVL13 blocking	510	m	64.00	32,640		32,640		
4	Joist hanger	626	no	30.00	18,780		18,780		
5	19 Thick plywood	1,438	m^2	70.00	100,660		100,660		

Code	Description	Quantity	UOM	Rate	SubTotal	Factor	Total	Total	Total
6	85 Thick floating floor comprising 20 ply on 45 x 45 battens on rubber mountings fixed to floor structure including 60 thick Autex ASB4 insulation	1,438	m^2	135.00	194,130		194,130		
	TOTAL UPPER FLOOR	**1,866**	**m^2**	**330.19**	**616,127**			**616,127**	
1.6	**ROOF**								
1	Membrane roofing over concrete ceiling including appropriate fall to gutters	126	m^2	305.00	38,430		38,430		
2	Timber parapet including cladding installed to manufacturers instructions to either side	127	m^2	535.50	68,009		68,009		
3	Parapet cap flashing	127	m	63.00	8,001		8,001		
4	Extra value for membrane upstand to parapet and wall	154	m	63.00	9,702		9,702		
5	Internal gutter	76	m	157.50	11,970		11,970		
6	Glazed balustrade including fixings to roof	45	m^2	430.50	19,373		19,373		
7	Downpipes	154	m	52.50	8,085		8,085		
8	Connections to stormwater system to last	1	Sum	2,100.00	2,100		2,100		
9	Roof penetrations	1	Sum	3,675.00	3,675		3,675		
10	Membrane roof over substrate and timber framing to dumbwaiter including associated flashings	2	m^2	372.75	746		746		
11	Kingspan Warmroof KS1000 RW 60 on DHS 200/15 purlins at 1,000crs	351	m^2	200.00	70,200		70,200		
	TOTAL ROOF	**1,866**	**m^2**	**128.77**	**240,290**			**240,290**	
1.7	**EXTERIOR WALLS AND EXTERIOR FINISH**								
1	Timber framing between LTF and windows	417	m^2	73.50	30,650		30,650		
2	RAB board	417	m^2	47.25	19,703		19,703		
3	Timber cavity battens	417	m^2	26.25	10,946		10,946		
4	Insulation	417	m^2	15.75	6,568		6,568		
5	Clay tile facade cladding system	211	m^2	315.00	66,465		66,465		
6	White render plaster system	174	m^2	115.50	20,097		20,097		
7	Light vertical plank rain screen cladding	699	m^2	136.50	95,414		95,414		
8	Timber framing including RAB board, cavity battens, building paper and insulation with light vertical plank rain screen cladding to surround of dumbwaiter	44	m^2	351.75	15,477		15,477		
	TOTAL EXTERIOR WALLS AND EXTERIOR FINISH	**1,866**	**m^2**	**142.19**	**265,319**			**265,319**	
1.8	**WINDOWS AND EXTERIOR DOORS**								
1	Double glazing aluminium window joinery, architraves including all flashings and the like	294	m^2	787.50	231,525		231,525		
2	Extra value for hardware to automated slider	1	no	4,200.00	4,200		4,200		
3	Extra value for hardware to single door	6	no	210.00	1,260		1,260		
4	Extra value for hardware to single slider	41	no	262.50	10,763		10,763		
5	Extra value for hardware to double slider	2	no	420.00	840		840		
	TOTAL WINDOWS AND EXTERIOR DOORS	**1,866**	**m^2**	**133.22**	**248,588**			**248,588**	
1.9	**STAIRS & BALUSTRADES**								
1	Concrete stair to corridor	4	No	2,625.00	10,500		10,500		
2	Concrete precast stair including landing	5	No	7,875.00	39,375		39,375		
3	Balustrade	28	m	189.00	5,292		5,292		
4	Handrail to stair including brackets	68	m	126.00	8,568		8,568		
	TOTAL STAIRS & BALUSTRADES	**1,866**	**m^2**	**34.16**	**63,735**			**63,735**	



Code	Description	Quantity	UOM	Rate	SubTotal	Factor	Total	Total	Total
1.10	**INTERIOR WALLS**								
1	Internal timber framed walls to units	1,237	m^2	73.50	90,920		90,920		
	TOTAL INTERIOR WALLS	**1,866**	**m^2**	**48.72**	**90,920**			**90,920**	
1.11	**INTERIOR DOORS**								
1	Single doors to corridor including frame, architraves and hardware	9	No	997.50	8,978		8,978		
2	Single entry doors to units including frame, architraves and hardware	39	No	997.50	38,903		38,903		
3	Single doors to units including frame, architraves and hardware	21	No	682.50	14,333		14,333		
4	Single cavity slider including frame, architraves and hardware	31	No	735.00	22,785		22,785		
5	Double folding door to wardrobes including frame, architraves and hardware	3	No	997.50	2,993		2,993		
6	Double sliding wardrobe door including frame, architraves and hardware	13	No	1,155.00	15,015		15,015		
	TOTAL INTERIOR DOORS	**1,866**	**m^2**	**55.20**	**103,005**			**103,005**	
1.12	**FLOOR FINISHES**								
1	Carpet	1,109	m^2	68.25	75,689		75,689		
2	Corridor flooring	153	m^2	68.25	10,442		10,442		
3	Cafe and store flooring	86	m^2	115.50	9,933		9,933		
4	Floor finish to staircase	75	m^2	26.25	1,969		1,969		
5	Tiles	373	m^2	220.50	82,247		82,247		
6	Entry lobby floor finish	23	m^2	231.00	5,313		5,313		
	TOTAL FLOOR FINISHES	**1,866**	**m^2**	**99.46**	**185,593**			**185,593**	
1.13	**WALL FINISHES**								
1	Gib standard lining	4,991	m^2	47.25	235,825		235,825		
2	Extra value for aqualine	1,005	m^2	10.50	10,553		10,553		
3	Extra value for sheet of fyreline to corridor and intertenancy walls	1,489	m^2	57.75	85,990		85,990		
4	Plaster and paint finish to lift walls	126	m^2	115.50	14,553		14,553		
5	75mm Pink batts silencer to walls	243	m^2	15.75	3,827		3,827		
6	Skirting including paint finish to walls	1,479	m	26.25	38,824		38,824		
7	Tile skirting to bathroom walls	325	m	15.75	5,119		5,119		
	TOTAL WALL FINISHES	**1,866**	**m^2**	**211.52**	**394,690**			**394,690**	
1.14	**CEILING FINISHES**								
1	Plasterboard ceiling linings including stopping, fixings and paint finish to units, cafe and halls	1,840	m^2	57.75	106,260		106,260		
2	Rondo suspended ceiling grid to last	1,840	m^2	42.00	77,280		77,280		
3	Extra value for wet wall plasterboard	160	m^2	10.50	1,680		1,680		
4	Square stopping	357	m	5.25	1,874		1,874		
	TOTAL CEILING FINISHES	**1,866**	**m^2**	**100.26**	**187,094**			**187,094**	

Code	Description	Quantity	UOM	Rate	SubTotal	Factor	Total	Total	Total
1.15	FITTINGS AND FIXTURES								
1	Wardrobe shelving/rail	15	No	157.50	2,363		2,363		
2	Bathroom vanity	39	No	630.00	24,570		24,570		
3	Mirror	39	No	315.00	12,285		12,285		
4	Kitchen complete	39	No	7,350.00	286,650		286,650		
5	Allow for sundry hooks, toilet roll holders and rails	1	Sum	15,750.00	15,750		15,750		
6	Allow to fit out commercial kitchen to cafe	1	Sum	136,500.00	136,500		136,500		
	TOTAL FITTINGS AND FIXTURES	**1,866**	**m²**	**256.23**	**478,118**			**478,118**	
1.16	SANITARY PLUMBING								
1	Allowance for incoming water supply including meters, valves and connections as required	1	Sum	10,500.00	10,500		10,500		
2	Cold water pipe work to fittings	273	No	157.50	42,998		42,998		
3	Hot water pipe work to fittings	234	No	157.50	36,855		36,855		
4	HWC including associated valves	39	No	1,260.00	49,140		49,140		
5	WC	39	No	1,890.00	73,710		73,710		
6	Vanity basin	39	No	525.00	20,475		20,475		
7	Kitchen sink	39	No	945.00	36,855		36,855		
8	Tub	39	No	630.00	24,570		24,570		
9	Shower complete	39	No	2,887.50	112,613		112,613		
10	Builders work for this trade	1	Sum	10,500.00	10,500		10,500		
11	Soil waste and vents	1	Sum	4,725.00	4,725		4,725		
	TOTAL SANITARY PLUMBING	**1,866**	**m²**	**226.66**	**422,940**			**422,940**	
1.17	HEATING AND VENTILATION SERVICES								
1	Heat pump	39	No	3,150.00	122,850		122,850		
2	Extract fan to bathrooms	39	No	630.00	24,570		24,570		
3	Extract fan to kitchens	39	No	630.00	24,570		24,570		
4	Allowance for fresh air to units and cafe	1,840	m²	73.50	135,240		135,240		
5	Builders work for this trade	1	Sum	7,875.00	7,875		7,875		
	TOTAL HEATING AND VENTILATION SERVICES	**1,866**	**m²**	**168.87**	**315,105**			**315,105**	
1.18	FIRE SERVICES								
1	Street Connection and valve set complete	1	Sum	63,000.00	63,000		63,000		
2	Incoming sprinkler main including meters, valves and connections	20	m	210.00	4,200		4,200		
3	Fully automated sprinkler system including carpark covered area	2,003	m²	57.75	115,673		115,673		
4	Builders work for this trade	1	Sum	6,300.00	6,300		6,300		
	TOTAL FIRE SERVICES	**1,866**	**m²**	**101.38**	**189,173**			**189,173**	
1.19	ELECTRICAL SERVICES								
1	Incoming power supply	1	Sum	31,500.00	31,500		31,500		
2	Electrical power and lighting	1,866	m²	120.00	223,920		223,920		
	TOTAL ELECTRICAL SERVICES	**1,866**	**m²**	**136.88**	**255,420**			**255,420**	
1.20	VERTICAL AND HORIZONTAL TRANSPORTATION								
1	Lift to service 6 floors	1	Sum	126,000.00	126,000		126,000		
2	Dumbwaiter	1	Sum	25,200.00	25,200		25,200		
	TOTAL VERTICAL AND HORIZONTAL TRANSPORTATION	**1,866**	**m²**	**81.03**	**151,200**			**151,200**	



Code	Description	Quantity	UOM	Rate	SubTotal	Factor	Total	Total	Total
1.21	SPECIAL SERVICES								
1	Oven and hob	39	No	945.00	36,855		36,855		
2	Rangehood to kitchen	39	No	735.00	28,665		28,665		
3	Dishwasher	39	No	630.00	24,570		24,570		
4	Fridge	39	No	840.00	32,760		32,760		
5	Washing machine	39	No	840.00	32,760		32,760		
6	Heated Towel Rail	39	No	472.50	18,428		18,428		
7	Security system	1	Sum	21,000.00	21,000		21,000		
8	Builders work for this trade	1	Sum	6,300.00	6,300		6,300		
	TOTAL SPECIAL SERVICES	**1,866**	**m²**	**107.90**	**201,338**			**201,338**	
1.22	DRAINAGE								
1	Sewer drain PROVISIONAL	100	m	157.50	15,750		15,750		
2	Stormwater drain PROVISIONAL	100	m	189.00	18,900		18,900		
3	Waste pipes PROVISIONAL	250	m	68.25	17,063		17,063		
4	Street connections	1	Sum	26,250.00	26,250		26,250		
	TOTAL DRAINAGE	**1,866**	**m²**	**41.78**	**77,963**			**77,963**	
1.23	EXTERNAL WORKS								
1	External steps	51	No	31.50	1,607		1,607		
2	Pavers to entry	75	m²	147.00	11,025		11,025		
3	Carpark paving	325	m²	73.50	23,888		23,888		
4	Painting to carpark	1	Sum	5,250.00	5,250		5,250		
5	Judder bars	2	No	450.00	900		900		
6	Bin store complete	1	Sum	5,000.00	5,000		5,000		
7	Landscaping	263	m²	126.00	33,138		33,138		
	TOTAL EXTERNAL WORKS	**1,866**	**m²**	**43.30**	**80,807**			**80,807**	
1.24	SUNDRIES								
1	Galvanised steel frame cantilevered balconies								
	including timber framing and substrate	34	No	3,150.00	107,100		107,100		
2	Glazed Balustrades	68	m	430.50	29,274		29,274		
3	Angled timber slat balustrade	56	m	136.50	7,644		7,644		
4	Metal balustrade	52	m	346.50	18,018		18,018		
5	Timber balcony screen	33	m	336.00	11,088		11,088		
6	Mail boxes on ground floor	1	Sum	10,237.50	10,238		10,238		
7	PROVISIONAL SUM for integration of balconies								
	with structure	1	Sum	30,000.00	30,000		30,000		
	TOTAL SUNDRIES	**1,866**	**m²**	**114.34**	**213,362**			**213,362**	
1.25	SUB-TOTAL:							6,406,713	
1.26	Preliminary & General	12.0	%					768,806	
1.27	Sub-Total:							7,175,519	
1.28	Contractor's Overheads & Margin	4.5	%					322,898	
1.29	Sub-Total:							7,498,417	
1.30	Contingency Allowance	7.5	%					562,381	
	TOTAL MAIN BLOCK & EXTERIOR WORKS	**1,866**	**m²**	**4,319.83**	**8,059,279**			**8,059,279**	
	TOTAL FOR BUILDING								**8,059,279**

11. SUMMARY

Cost are provided for guidance purposes only and are not to be relied upon without seeking professional Quantity Surveying advice.

In conclusion, the best approach to designing and delivery of a cost effective Engineered Timber solution, is to design it in timber from the word go. This translates into early collaboration with the Structural engineer, talking to the key Suppliers, Manufacturers and Main Contractors. Early Contractor Involvement is highly beneficial and becomes key to the successful delivery of the project.

Changing the approach from traditional procurement on key structural frame items to an ECI approach with the Main Contractor and "nominated specialist supplier" is essential. Focus and inclusion of the critical path programme and considering the lead in time of 12 to 16 weeks is key to successful project delivery.

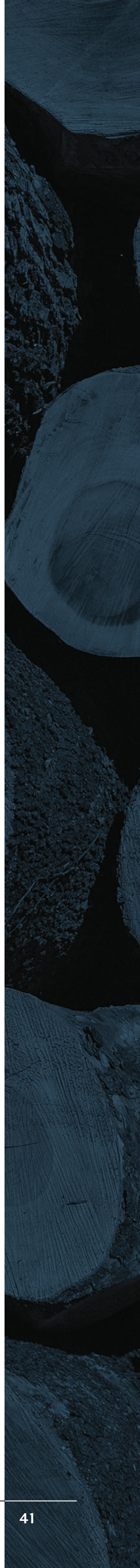
The long term benefits of a reduced programme time on site, less labour requirements and any foundation savings should all be considered in conjunction with other factors that impact on costs.

Consulting with professionally recognised and experienced Quantity Surveyors will result in robust budgets and add the value required to make the project delivery successful.

In conclusion, we reiterate that the value proposition of Engineered Timber goes beyond lowest price mentality and more about when it is appropriate to use. Seeking to quantify the sustainability benefits, aesthetics and free form into tangible benefits, should be part of the assessments to highlight the true benefits of Engineered Timber solutions.

KEY POINTS

- **Early Contractor and Supplier involvement**
- **Design considering the Manufacturing and Installation**
- **Choose the product for the right application**
- **Consider programme assessments and implications of reduced time**
- **Timber suits prefabrication**
- **Potential savings in foundations**
- **Reduced preliminaries**
- **Reduced labour on site**
- **Improved H&S on site**
- **Knock on benefits for subsequent trades**
- **Reduced lead in time for windows due to CNC precision cutting**
- **Availability of suppliers growing**



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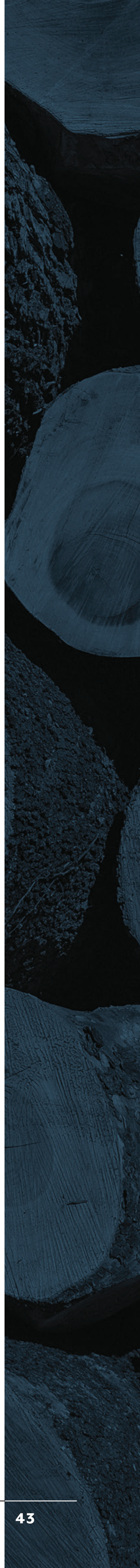
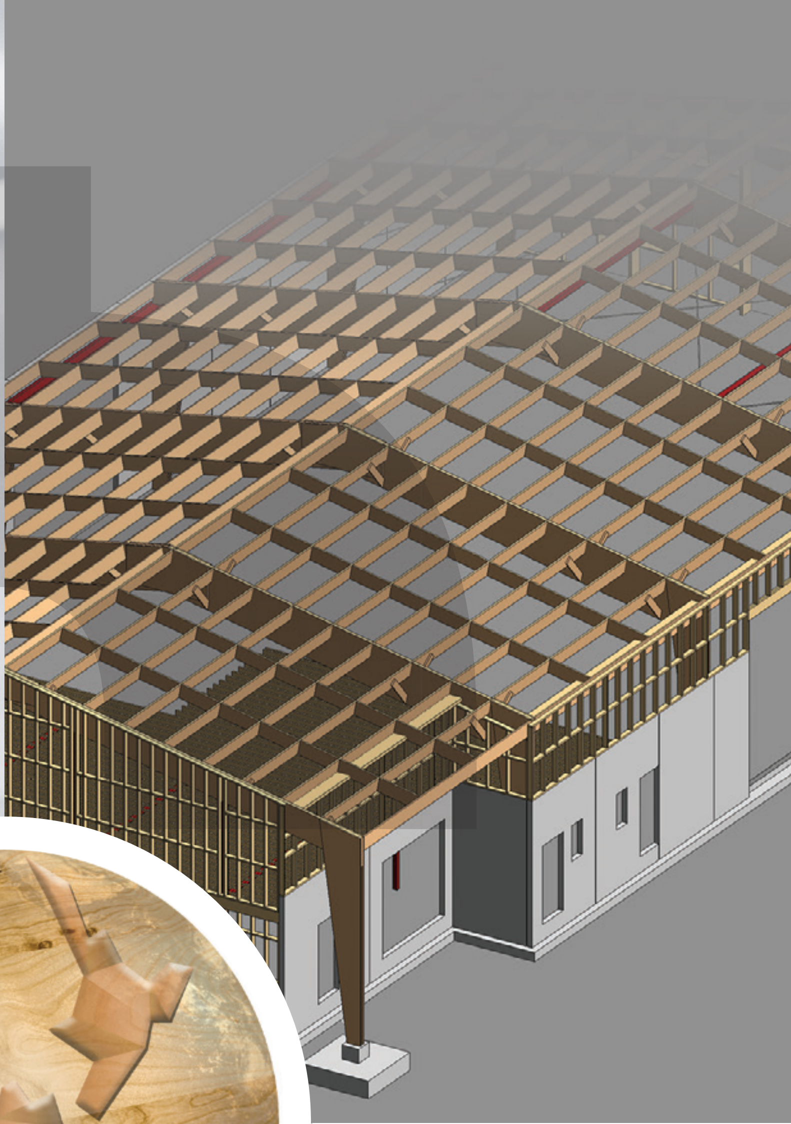
ABOUT THE AUTHOR

Trained in South Africa, **Linda Lodetti** holds a BSc QS Honours and is a member of the Royal Institute of Chartered Surveyors and the New Zealand Institute of Quantity Surveyors. Linda has 35 years' experience in a variety of construction projects across all traditional Quantity Surveying services, her skills ranging from elemental cost estimating and tender reporting to financial reporting and technical advisory.
A vast experience in earthquake insurance claims and subsequent strengthening assessments has resulted in involvement with considerable legal claims. Linda has acted as an independent witness for leading insurance companies, loss adjustors and individual private clients providing balance unbiased reports. She has significant experience in sustainable solutions and is one of New Zealand's leading voices in the role, benefits and use of engineered timber.





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