Mid-Rise Mass Timber in the Contemporary Workplace

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Abstract: Mass timber construction, although an alternative construction method currently, is in the beginnings of a resurgence. Quick to erect, prefabrication friendly, light weight and sustainable – timber is an attractive material for urban construction. Presently, the body of knowledge on timber design is highly focused on technology, leaving absent from the discussion the spatial, functional or architectural implications of timber structures. While timber products are used extensively for low rise housing in New Zealand, little success has been found in the mid-rise market and even less so in the commercial sector. This research seeks to develop the interaction between timber structure and workplace planning at a mid-rise scale, suggesting ways mass timber, as a unique architectural language, can change future workplace design. Drawing on existing literature and the graphic analysis of a series of conceptual and new build precedent studies, it critiques and extracts key concepts of both workplace and mass timber design. Reflecting on current workplace models, we suggest that future mass timber construction offers potential, utilising its inherent properties, rather than as a simple substitute for steel and concrete.

Keywords: Mid-rise mass timber; commercial architecture; workplace design.

1. Introduction

Mass timber structures for medium to large scale non-residential buildings are becoming increasingly popular. Most such structures imitate their steel and concrete predecessors, using post and beam frame techniques to resist loads and form the architectural resolution of the building. These timber frames do not exploit the inherent structural and material properties of timber and to the detriment of the interior, adhere to historical notions of open floor plate spatial planning. This paper explores the proposition that buildings which utilise the inherent material properties of timber will have a radically different architectural expression, and this will likely affect the planning and construction at all scales of building; from the detailing, to the interior layout and beyond to the urban connection. This paper explores this in the context of office buildings, questioning the feasibility and potential of timber for the kinds of flexible or open planning required for commercial viability.

1.1. Scope

A preliminary literature review explains the historic relationship between innovative building structures and new forms of office planning in the modern period. The main focus of the paper is a series of precedent reviews of both international and significant Pacific mid-rise mass timber office buildings. Utilising the authors’ graphical analysis of the plan and overall structural/architectural resolution, conclusions drawn from this analysis are used to reflect on current design trends, with the expectation that inferences drawn may be directly applied to future mid-rise mass timber office buildings in the urban context of New Zealand.

2. Office Planning – Historical to Contemporary

The modern office has seen a variety of interior planning solutions since the early twentieth century, from the International Style to the more recent uptake of Activity Based Working environments. These shifts in interior solutions correlate to shifts in architectural technologies, where technological advancements have enabled fundamental change in workplace planning. We suggest that the workplace is on the brink of another significant change, one that timber as a unique architectural language can enable.

2.1 The International Style and the Open Plan Office

Skyscrapers, corporate monoliths of the past, make up our cities. The urban fabric is defined by tall glass boxes rising up from the flat landscape in which they were imposed. These structures are an example of the International Style. Developed during the early decades of the 20th century and canonised in the 1950’s, the International Style represented both architectural modernism and the globalisation of corporate culture (Flowers, 2009, p. 90-104).

It was through the advent of technology that these buildings became the international benchmark. Once steel frames eliminated the need for load bearing external walls, curtain glass skins became viable facades. The development of air-conditioning and later the fluorescent tube and suspended ceiling marked a significant turning point in the office, where the office became “fully autonomous from the exterior environment” (Mozas, 2017, p. 18). There was no longer a need to place employees close to the perimeter where they might get a glimpse of natural light and open a window for fresh air: the suspended ceiling housed all these functions and fluorescent lighting illuminated all.

Lever House (1952) by SOM and The Seagram Building (1958) by Mies van der Rohe, both in New York, proved popular not only for their sleek modernist exteriors, but also for their thoroughly designed, open-plan interiors. Both buildings were technical and architectural successes, but there was danger hidden in this success. As Lewis Mumford wrote in discussion of Lever House, “if its planning innovations prove sound, it may become one unit in a repeating pattern...” (Mumford, 1952, p. 35). This is where we find ourselves today: surrounded by an endless repetition of the pure functionalist structures of the past. The office building has become a “simple, neutral technology, endlessly reproducible” (Saval, 2014, p. 138).

2.2 Questioning the Open Plan: Activity Based Working

Whilst the International Style office building was being canonised across the world as the typology of the future, the interior of these office buildings were also being reconsidered. Modernist technologies allowed for large, open-plan floor plates but space planning was not necessarily well considered and office
interiors still tended toward historical notions of organisational hierarchies. From the 1960s, the tenets of modernism and the unquestionable International Style came under attack – modernism was critiqued as “antihuman”, ignoring human psychology to impose a single method and aesthetic of design (Saval, 2014, p. 230).

Since the 1960s, a number of design responses have been produced, born out of dissatisfaction with the open plan office, from the Office Landscape (Bürolandschaft) by the Schnelle brothers to the Action Office by Robert Propst, and more recently, ‘Activity Based Working’ (ABW). This term describes a method of working which is agile and flexible. It describes a working culture which values choice, mobility, communication, collaboration and the elimination of hierarchy (Skogland, 2016, p. 63). Generally defined as a transformative business and workplace design strategy, the ABW environment encourages employees to recognise that “different work activities can be better supported by spaces and features designed specifically for that task” (Leesman, 2017, p.6). It facilitates diverse activities ranging from confidential, enclosed individual work to highly collaborative, open group work. This concept is a reaction to the rigidity and repetition of the modernist International Style office.

![Plan diagrams with overlayed visual analysis of the proportion of individual to group work, circulation and fully enclosed space in Kirshenbaum & Partners West, Sedgwick Rd, PricewaterHouse Coopers and EMI London Headquarters. (Source: Author, 2020.)](image-url)
However, like the Office Landscape and the Action Office, ABW still operates within the same basic framework. Figure 1 analyses the floor plans of four mid-rise office buildings presented in Myerson & Ross (2006). Visual analysis of the overall planning solutions is overlayed to uncover the strategies used within the architecture to create a contemporary work environment. These case study international buildings are of a representative size and scale to be applicable to a mid-rise typology in a New Zealand urban environment. The BRANZ BEES study (2014) established that 20% of the total floor space in New Zealand comprises buildings between 3,500m² and 9000m² total floor area. A further 20% of the total floor area is made up of buildings over 9000m². These analysed buildings range from 2,000 to 12,000m² in area. The interior resolution of these buildings is resolutely tied to the large, regular, open grid of steel and concrete. Stripped of architectural quality and meaning, the interior relies exclusively on partition walls and unique furniture systems to supply the differing spaces required for a successful ABW environment. A high degree of undefined circulation space and little variation in planning arrangements creates a homogenous working environment, where the structure contributes little to the architectural image of the building. This inevitably leads to resistance in the uptake of this new mode of working, with the more commonly cited issues in open plan environments such as a “lack of privacy” and “too much visual and auditory distraction” leading to a lack of engagement with mobility and flexible work processes (van Meel, 2019; Leesman, 2017; Rolfö et al., 2018). Fully enclosed spaces are still clearly desired in the workplace to create this privacy. For the buildings in Figure 1 50% (on average) of the total workspace is enclosed. The prevalence of these walls begs the question, could they be more permanent fixtures and contribute directly to the architectural language of the office?

This disconnect between the structure and planning suggests that the architecture of commercial buildings might better facilitate a meaningful variation in spaces that is distinct from simple furniture systems and superficial aesthetics. The use of mass timber, a unique material with its own tectonic language, is one way we suggest to challenge the future of commercial architecture, in particular workplace design.

3. Mid-Rise Massive Timber Technology

Massive timber technology, in the context of mid to high rise structures, is a rapidly evolving field. “As trees are harvested from forests, humankind seeks to reformulate or re-engineer wood to fulfil a new purpose” (Mayo, 2015, p. 9), new methods of engineering, jointing and manufacturing are all developed to realise the architectural intent of a building. Popular mass timber products currently utilised in the New Zealand context include; Cross Laminated Timber (CLT), where layers of timber are glued perpendicular to one another to create panels; Laminated Veneer Lumber (LVL), where thin veneers of timber are glued in parallel to create billets; and Glue-Laminated Timber (Glulam), where layers of timber are glued again in parallel to typically create long span beams.

Timber is fundamentally a natural material, one that is grown, cut and glued. Not formed or welded like steel and concrete. As such it is a material with defects, properties that are not inherently advantageous to engineers and designers alike. And while engineered timber products have been proven to be a comparatively light weight and sustainable choice, it is difficult to view the tensile and compressive strength as exact replacements for more traditional mid to high rise materials like steel and concrete. Nevertheless, timber is an incredibly strong material when forces are applied perpendicular to the grain (Buchanan, 2007, p. 28) and “its high strength to weight ratio renders it an excellent choice for load-
bearing columns and walls” (FPInnovations, 2013, p. 121). As such, CLT shear walls and massive LVL or Glulam columns and beams are sensible and useable features of timber design. However, these members will be significantly larger than their steel and concrete counterparts; for example, timber beams of the same depth can span only 65% of the distance of steel or concrete beams (Marriage, 2020, p. 82). In terms of lateral design, an especially critical aspect of the overall design solution for seismically active New Zealand, timber products are typically utilised in a hybridised manner with steel plates and/or screws to provide ductility and shear capacity. While timber cannot typically be the sole lateral resistance system in mid to high rise buildings, the main advantage timber has over traditional materials in this capacity is its low weight, and therefore lower seismic load (FPInnovations, 2013, p. 123). This reduces the load imposed on the foundations and can make timber buildings more suitable for poorer soil conditions and generally makes foundations less laborious and expensive to construct.

So, what are the major difficulties in timber design? Or, what is preventing wider scale adoption? In one word, connections. “The whole structural system is no stronger than its weakest link” (Buchanan, 2007, p. 141), and for timber, designing and detailing the connections is inherently the most difficult part in getting any project into the real world. Mass timber elements perform well, they are strong and stiff but have little to no capacity to provide deformation, drift and ductility at their joints without complicated steel substitutes. And with this, material incompatibility becomes a significant engineering and architectural issue. Steel elements have a much lower fire capacity, while massive timber will char and retain its internal structural integrity, poorly designed and unprotected steel quickly turns plastic, deforms and fails (Mayo, 2015, p. 37). Architecturally, the intersection of elements can become an expensive and laborious detail, or conversely simple methods of fixing (such as nailed steel plates) leave much to be desired in terms of aesthetic and tectonic qualities.

4. Timber Precedents

Four mid-rise precedents were analysed as representative examples of typical solutions or approaches to mass timber design in the Pacific, from mixed structural solutions to pure timber wall design. The method of analysis was to strip the buildings back to structure and façade, the resulting axonometric diagrams analyse (Figure 2) the spatial qualities and logic of the architecture. Where, structure is “the regulating logic of the internal organisation... a material system complicit in the expression of the architectural concept” (Kuo, 2013, p. 90). Whether hidden or celebrated, structure is integral to the office typology and interrupts the interior planning. The skin is analysed in terms of the interior’s relationship to the external environment or urban context, how the building is contained on its sides and the placement of glass or solid materials in relation to this.

4.1 Post and Beam Structure

Post and beam construction solutions tend to be the accepted tectonic strategy for office buildings; they allow for open, large floor plates with free planning. Importantly, they are commercially exploitable as a ‘non architecture’ that can be endlessly adapted internally to accommodate any tenant or even change of use. The conservative, risk averse nature of the construction industry does not often encourage innovation (Fleming et al., 2014, p. 23). Buildings utilising a new material mimic their predecessors; “it is easier to promote a new and perhaps untrusted structural material or technique in reference to the status quo, showing that it can simply replace the old material” (Fleming et al., 2014, p. 23). But, this trend of
design thinking brings mass timber to the conversation about material selection rather than as a fundamental rethink of architectural design. Mass timber is utilised as a simple, but less efficient, substitute for concrete or steel.

Figure 2: Axonometric diagrams analysing the structural solution of 149 Featherston Street and International House. (Source: Author, 2020.)

Figure 2 analyses the structural resolution of two Pacific based precedents, 149 Featherston Street and International House respectively. 149 Featherston Street conceptually was intended to be one of New Zealand’s first timber high-rise structures, demonstrating the cutting edge of engineering and architectural design. It features timber post and beam gravity only structure, with a reinforced concrete core providing the lateral strength of the building. International House is a representative precedent of the popular trends in Australia in terms of commercial mass timber design. Designed for Lendlease, this building was the “first modern commercial engineered timber building of its size and type in Australia at the time of completion” (TZANNES, 2020). The structural design of the building lends itself towards a particular architectural form, an asymmetric core with a 2-way CLT floor diaphragm braced on the exterior with timber frames and sitting on a concrete ground floor podium. A similarly executed design solution can be seen in 25 King Street, Brisbane (2018).

Both of these precedents attempt to utilise timber as a material and structural solution whilst also achieving an open floor plate. The size of the timber members needed to achieve this desirable openness is very large. In International House 1200mm deep beams run in one direction from the core to the braced perimeter of the building, all connections are fully concealed and there is no implicit material or tectonic language that could be defined as unique or typological of timber design. 149 Featherston Street conversely achieves relatively slim (600mm deep) timber members, by virtue of its comparatively small allotment, but relies heavily on its concrete core to compensate for what timber alone cannot provide, notably lateral stability. The issues surrounding lateral loading design, whether this is primarily for earthquakes in New Zealand or wind loading in Australia, leads to mixed structural systems in post and beam construction and a reliance on concrete cores, podiums and inefficient timber bracing. This leads to
not only a high degree of structural complexity, but also material incompatibility. The interaction of these different materials is critical for the overall stability of the building and the reliance on highly engineered joints is a notable weakness of mixed system design. Is this an efficient, or even architecturally appropriate use of mass timber? Post and beam construction forces timber to impersonate the tectonic language of traditional material systems. This structural rationalism that dominates mass timber construction is detrimental not only to its wider adoption but also to its growth as a unique material with unique tectonic properties. After all, why build the imitation if the original is easier and better understood?

4.2 Wall Structure

Mid-rise mass timber residential buildings have seen a large uptake in the construction market. The comparatively simple, typically modular, architectural strategies lend themselves to current panelised timber technologies. Wall orientated structural solutions, we suggest, demonstrate the primary tectonic language of mass timber. “New technologies manifest themselves as typologies of use” (Kuzmanovska et al., 2018, p. 9). As such this wall technology has almost exclusively supported residential development. But, can the same methodology also be applied to commercial developments? Can mass timber can be effectively and efficiently used as both a structural system and architectural language?

Figure 3 analyses the structural resolution of the Forte Apartments and Studio Pacific Architecture’s competition proposal for the Scion Innovation Centre respectively. The Forte Apartments located in Melbourne is one of the most commonly cited mass timber buildings in the Pacific region. It was, at the time of conception, the tallest (32.2m) CLT building in the world and is a showpiece of modern mass timber construction. The structural design is tied inherently to the architecture of the building, where all walls are structural, leading to a ‘honey-comb’ or ‘house of cards’ resolution. Like International House, it features a concrete podium to support a retail ground level. The Scion Innovation Centre, although a low-rise concept design, is one of the few examples of a mass timber walled structure proposed in a commercial development. It features three-dimensionally folded walls that are the gravity, lateral and architectural resolution of the building. This precedent utilises a novel engineering solution to create the image of the building and a unique interior planning solution. This wall solution stemmed from a desire
to move away from using timber as a substitute for steel or concrete; “the design has not adopted a material technology but rather looked to adopt the inherent properties of wood” (Studio Pacific Architecture, 2018).

Commonly, walled mass timber buildings utilise a ‘house of cards’ structural solution, wherein most exterior and interior walls are the gravity and lateral structure of the building. This is a simple and effective solution as it minimises jointing difficulty. The most common jointing method is simple steel angle brackets connecting vertical walls to the horizontal floor slabs as seen in the Forte Apartments. It also simplifies the overall engineering of the building, because there is little room for incompatibility between different structural elements and materials. This method of construction also allows for a higher degree of prefabrication and modulation, structural elements or even whole rooms are manufactured off site and simply craned in place.

Does this widespread use of panelised mass timber structure suggest an inherent tectonic language? Or, a structural method that produces the architectural quality of mass timber buildings. It suggests a significantly smaller grid size and more cellular approach to the architectural planning than is typically seen in steel and concrete office buildings. Instead of the standard approach to office design, where the floor plate is largely structure-less, the use of mass timber suggests a higher degree of structural interdependence. This is not inherently a disadvantage; the structure could instead define a new interior. Instead of an overreliance on partition walls, mass timber office architecture could instead seek to utilise the likely cellular nature of the structure to suggest occupation and use, to break up the monotony and homogeneity of the generic open plan office. The deliberate and considered placing of wall elements in the plan could provide a series of unique and differing environments, with their own inherent character, to facilitate the diverse activities that take place in the office. Moving away from the superficial to the architectural, mass timber walls suggest a new interior that may alleviate issues currently facing the uptake of ABW in the office.

While walls can be utilised in a diverse manner to create interesting spaces in the plan, an interior solution that works well in the context of the office does not necessarily lend itself to good ground floor conditions. Many commercial buildings must also provide an open ground floor for retail tenancy, the use of many continuous shear wall elements is therefore typically terminated at ground floor and instead a concrete podium provides the necessary open plan for commercial viability. This is demonstrated in both International House and the Forte Apartments. This is a noticeable flaw in the wall structural solution, not only in terms of engineering complexity but also architectural resolution. Mass timber architecture needs to engage critically with both the office and the ground floor connection, perhaps seeking a middle ground between creating a varied spatial plan and still providing relative ‘openness’ required for commercial viability. What is clear is that there must be implicit architectural intent behind any wall placement, creating a meaningful relationship between the occupant and the structure.

4.3 Skin, External Expression and the Urban Context

As contemporary mass timber buildings are currently in their infancy, they must fulfil other functions not typically required of the office typology. Incorporating urban contributions, monumentality and presenting the image of sustainability through exposed elements, as seen in all aforementioned
precedents, are all methods by which mass timber buildings are seeking to prove themselves in the commercial marketplace. The skin in particular is one of the principal mediators between the architecture and its urban context.

![Figure 4: Axonometric diagrams analysing the skin solutions of 149 Featherston Street, International House, the Forte Apartments the the Scion Innovation Centre. (Source: Author, 2020.)](image)

Figure 4 analyses the selected precedents’ skins. All three commercial precedents utilise a non-structural curtain glass wall around all street facing facades, as is typical of an office building typology. Notably, the intentional expression of the timber is represented on the skin through the placement and division of the mullion and transom elements. The transparency of the skin allowing the pedestrian to glimpse the timber structure inside. The Forte Apartments conversely utilises punched windows with a metal cladding system protecting the external walls from moisture. Again, this is typical of the typology, the concealed nature of the wall not notably differing from typical approaches to concrete shear walls. There is an uneasy tension between the essential duplication of walls.

These buildings all utilise the façade language typical of steel and concrete buildings, posing the question; is there a façade language that is more expressive of timber as a material? What this means has not been fully explored as of yet. There is certainly an opportunity for more expressive facades that speak clearly to the structural solution, to create a clear link between the interior and urban context. Whether this is explored through utilising fully exposed timber elements, timber curtain wall systems or simply more expressive modulation, mass timber buildings could seek more meaningful and playful responses to the necessities of natural light and weather protection to create a connection to the urban context.

5. Conclusion

Currently in mass timber mid-rise commercial buildings, the inherent properties of timber as a material are not being fully explored. Structural timber is being used as a simple replacement, to impersonate the tectonic language of more traditional material systems to the disadvantage of its wider adoption and growth as a unique material with unique tectonic properties. This mimicking of more traditional modes of construction is apparently motivated by a desire to follow the presumption that commercial architecture must be an ‘empty’ architecture, an endless open floor plate with no inherent character or
quality, to be commercially viable. With the recent uptake of Activity Based Working concepts, concepts that require a diverse range of spaces to facilitate work activities, mass timber architecture has an opportunity not only to provide these spaces, but also to challenge how we conceive the planning, urban connection and façade expression of commercial architecture. Moving beyond the aesthetic use of timber in the workplace, structural mass timber suggests an architecture with a smaller grid spacing, a higher degree of structural interference and a more modular approach, and thus an entirely different internal planning and external expression to the typical office building. This interaction between the office as a typology and the properties of mass timber has not yet been developed. Mass timber commercial architecture needs to define itself in the marketplace as a viable solution, one that is not only structurally rational but also architecturally meaningful.

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