XLAM™

Australia & New Zealand Operation & Maintenance Guide

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Use of this Operation & Maintenance Guide

Thank you for choosing to design with mass timber. XLam manufacture Cross Laminated Timber (CLT) from one hundred percent natural and renewable radiata pine. Each lamella and panel is unique, even with great care by XLam, slight deviations in grain pattern, knot location and colour will occur. By choosing to design in mass timber you are embracing the natural beauty of a renewable building material, its perfection is in its natural imperfection.

The information in this Operation & Maintenance Guide is based on testing methodology and certification owned by XLam. The information is provided for use in the operation and maintenance of XLam manufactured Cross Laminated Timber (CLT) only. The Operation & Maintenance Guide is not intended as general information and guidance for all manufactured Cross Laminate Timber (CLT). The Operation & Maintenance Guide and information is specific to XLam CLT and no warranty is given to the suitability and application of the information to other manufacturers CLT.

Operation & Maintenance Guide Description

This guide provides suggested maintenance, repair and operational procedures for XLam CLT panels during their in-service design life. It provides suggestions of annual maintenance and component renewal regimes, operational considerations and repair methodologies.

Application

This Operation & Maintenance Guide has been prepared for the use of suitably qualified construction professionals to assist in the maintenance and repair of XLam CLT panels during the service life and provides operational considerations. Products referred to in this document other than XLam CLT panels are presented for information purposes only and due regard should be given to manufacturers literature. Advice on overall building design issues including but not limited to: stability, loading, temporary stability during construction, fixings, fire engineering and overall acoustic performance are not covered in this guide.

Whilst all care has been taken in the preparation of this Operation & Maintenance Guide, XLam CLT does not warrant that the information will be suitable in all circumstances. XLam CLT will not accept any liability for the failure of any other elements of the building which causes subsequent failure of XLam CLT panels.

Update and Version Control

This Operation & Maintenance Guide is identified with a version number and date of issue. The latest issue is always on the XLam website. It is the user's responsibility to ensure that the latest version is in use at all times. Unless otherwise stipulated, the XLam guides will be provided to the registered user in electronic format. Bound hard copies can be made available by XLam on request.

Introduction

XLam CLT panels provide durable, long lasting structural building elements with low maintenance requirements when designed, installed and maintained in accordance with XLam recommendations. This document provides guidance on long and short term maintenance regimes, suggestions of how to repair mass timber elements when rectification work is required and operational considerations.

Annual Preventative Maintenance

XLam CLT panels are expected to have a long service life with little or no significant change from their original specifications. It is however recommended that at a minimum the following maintenance and inspection tasks be performed on an annual basis:

- Where access allows inspect for visible signs of water ingress and deterioration of XLam CLT panels.
- Where access allows inspect fixings and connections for signs of rust or damage.
- Where access allows inspect vapour membranes for signs of damage.
- Inspect ventilation systems for debris build up and functionality, repair or replace as appropriate and remove any debris found.
- Inspect exterior cladding including external finishes, fixings, attachments, joints and sealants for signs of deterioration, rust, damage, wear, cracks, and repair or replace as appropriate.
- Inspect roof covering including external finishes, fixings, attachments, joints and sealants for signs of deterioration, rust, damage, wear, cracks, and repair as appropriate.
- Inspect windows for signs of deterioration, rust, damage, wear, cracks, and repair as appropriate.
- Inspect gutters, down pipes and flashings for deterioration, rust, damage, wear, cracks, and repair or replace as appropriate.
- Inspect all penetrations including electrical, plumbing, fire stopping and communication for deterioration, rust, damage, wear, cracks, and repair as appropriate.
- Check interior linings for signs of damage such as cracks, movement or swelling – if this has occurred further investigate possible causes.
- Where access allows measure the moisture content of XLam CLT panels with appropriate moisture metre.
- Wet areas – check tiling for loose or missing grout or caulking and repair/replace as appropriate.
- Wet areas – check waterproofing is intact and review time elapsed since installation against design life specified by manufacturers, replace if necessary.
- Basement check for signs of termites.

Component Renewal

Each building component will have a design life as specified by the product manufacturer, once the design life has been reached the building element should be renewed/replaced as per the manufacturers recommendations. The integrity, condition and performance of these elements should be inspected, maintained and replaced as per the manufacturers requirements – these include:

- Sealants in façade control joints; wet areas, openings/penetrations, external and internal plumbing, electrical, communication, acoustic, and fire stopping fixtures.
- Vapour and moisture control barriers.
- External finishes such as paint and coatings.
- Facade and roof components.
- Guttering, down pipes and flashings.
- Electrical penetrations and fire stopping systems.
- Fixings and connections.
- Air conditioning and ventilation systems.
- Support columns and beams.
- Termite barriers.

Operational Considerations

During the operation of the building these key points should be considered:

- Hot work: A hot work permit system should be implemented requiring any work which will be carried out on the building in which naked flames, elevated temperatures or other sources of ignition will be present to need a hot work permit to be filled out and approved by the appropriate party.
- Any additional penetrations will need to be signed off by a certified engineer to ensure that they do not compromise the structural integrity, fire safety, thermal, acoustic and water proofing performance of individual building elements and the building as a whole.
- Any alterations will need to be signed off by a certified engineer to ensure that they do not compromise the structural integrity, fire safety, thermal, acoustic and water proofing performance of individual building elements and the building as a whole.
- If a significant event such as a fire, earthquake, discharge of fire sprinklers occurs, a review of the structural, fire, thermal, acoustic and water proofing performance of XLam CLT components and all other associated structural components including fixings, connections, supporting beams, columns, walls and floors is required by a certified engineer. All repair and remediation recommendations will need to be carried out within the specified time frame with appropriate documentation.

The surface of XLam CLT panels will, like all timber materials, age with time and change colour after exposure to UV light, heat and moisture. Gaps may open up between surface lamellas and minor cracks appear in individual lamellas. These are cosmetic only and are part of the excepted appearance of timber and should not be touched or require any additional maintenance.

Where the surface has been dinted or scratched and refurbishment is desired XLam recommends repairing by filling gaps with resin, tinted wood filler or the installation of a timber patch. Sanding is not recommended as sanded areas will not match the colour of surrounding timber, this can result in costly remedial work to achieve an acceptable finish. Where coatings have been damaged they will need to be repaired/refurbished according to the coating suppliers instructions.

Where the surface has been marked or stained and refurbishment is desired, stains and dirty marks (including tannin spots) may be removed using a proprietary oxalic acid based wood cleaner, used in accordance with the manufacturer's Technical Data Sheet – cleaning rather than sanding is the preferred option.

In the event of a fire within the building there are several potential remediation measures to repair the structure, depending on the severity of the fire event. In all cases, a timber engineer should be appointed to review the extent of the damage and assess the future performance of the structure. Smaller fires will largely be confined to minor smoke damage and limited local charring (<3mm) of the timber. In this case depending on the timber engineer's findings, the repair may consist of sanding the timber and re-coating (if required) to bring the visual appearance back to that of the rest of the building.

Remediation measures for larger fires could involve the introduction of additional supporting beams to reduce floor spans, additional timber or steel strengthening plates for beams or columns. In extreme cases sections of the floor would be cut out and replaced, either with timber structure or steelwork as appropriate. It should be noted that the sorts of damage associated with high severity fires requiring replacement of elements of the structure would largely be similar for steel and concrete buildings after a similar fire event. The advantage of timber is that it is far simpler and less disruptive to remove the damaged members.

	Fire Severity		
Timber Element	**Low** (smoke damage, charring 1-2mm locally)	**Medium** (charring 5-15mm, relatively localised)	**High** (charring 15mm+, extensive damage)
CLT Slab	Sand back affected areas. Recoating of timber finishes to match existing areas	Routing out of charred areas. Reinstatement of damaged timber lamellas with new boards to match	Replacement of slab. Damaged areas cut out and replaced. Could be timber frames to match or steel framed and clad if simpler to install. Refer to Appendix 7 for case study
Connections	Review damage but unlikely to cause serious concerns	Review damage. Aluminium fixings replaced. Steel connections could be retained	Replace connection to match existing

In the case of replacement of parts of the structure consideration would need to be given to how replacement elements are brought onto the floor. Mass timber elements like glulam beams, columns and CLT slabs are likely to be large and heavy and difficult to manoeuvre on the floor. To deliver full length sections of beam or floor it is likely that sections of the façade would need to be removed in order to deliver the material onto the floor. Timber is also a material which is difficult to bring together on site in smaller sections and splice together, while steel would be more forgiving in these situations. There are potential benefits from bringing in smaller sections in other materials (like steel) and splicing them together as access would be simpler through a goods lift or an internal void. Any replacement would need to match the fire, acoustic and structural performance of the original structure.

Moisture represents the most likely cause of damage to the mass timber elements in this building. When moisture levels in timber remain above 18% moisture content (MC) for an extended period, there starts to be a risk of timber decay through mould or fungus. The most common sources of moisture are:

- Leaking plumbing.
- Significant water spillage.
- High humidity environment.
- Sprinkler accidental discharge.
- Failure in the façade.
- Failure in roof waterproofing.

Timber treatment can provide varying levels of protection against decay through mould, fungus or insects. Modern timber treatments are both effective and have low odours/VOC emissions and can provide a low-cost insurance policy for the timber structure should a problem arise and allow more time to identify and fix the root cause. XLam would recommend that all CLT panels are treated in the following areas:

- Floor panels below bathrooms, kitchens, laundries.
- Floor panels under balconies or roof terraces.
- Floor panels where inspection is difficult or impossible.
- Wall or floor panels in close proximity to the ground.
- Areas with elevated levels of humidity.

Due care and attention should be given to the design, installation and maintenance of the building envelope to ensure that the timber elements remain dry and warm throughout the design life of the building. However, if a moisture issue does eventuate in the timber this would likely be evidenced by dark or white staining to the timber. This will be relatively easy to observe in visual inspections where the timber is exposed internally but significantly more difficult if suspended ceilings, floor coverings or internal linings are present.

If the CLT panels become wet, it is important to determine the root cause and seek to reduce the timber moisture content to levels below 18% in a controlled manner. Moisture content levels can be measured with two-pin moisture meters and a suitably qualified timber engineer should inspect the timber and ensure that the structural performance of the timber or glue bond has not been affected. This would only be the case for a prolonged period of high moisture content for 3 months or more.

Typical remediation measures are to use forced ventilation of cold, dried air through the affected areas to allow the timber to dry out slowly. This would need to be done in a controlled manner as the use of heaters or high airflow to dry out the timber could result in cracks developing in the timber if the moisture content changes too rapidly. While not a structural concern this could impair the visual look of the timber in the long term.

Building Modifications

The CLT elements within the building typically provide a structural function as well as providing a bounding element to a fire compartment so any modifications to the floors will need to be carefully considered. Typically, new penetrations for services would not be difficult to accommodate up to around 150mm in diameter however all openings would need to be assessed by a timber engineer. In all cases, new penetrations in fire rated CLT elements would need to maintain the same level of fire rating using fire collars or insulating materials with the appropriate certification in the CLT panels. The impact on thermal, acoustic and water performance would also need to be reviewed.

Redundant openings in the panels should be filled with material to provide the same fire rating. XLam have a set of tested and certified details for the repair of smaller holes within the CLT floor and wall panels including the use of timber dowels, plugs and fire-rated sealants. The repaired areas of panels will be for visual and fire-rating purposes only and will not be expected to resist structural loads.

These repair methods are suggestions only, are general in nature and are not warranted by XLam. Each situation will require individual assessment and judgement by qualified, experienced tradespersons and/or certified engineers.

Where repair is desired of a small dint or scratch this may be achieved by filling with a timber patch, resin or tinted wood filler following these steps. Where a wall which has a fire rating is affected refer to XLam before attempting repairs:

Timber Patch

- Ensure the timber is in a dry workable condition before starting work. Cold air blowers and dehumidifiers may be used to dry timber, do not use hot air blowers to rapidly dry timber; this can result in pronounced shrinkage cracks in the timber.
- Obtain approval to conduct repair from appropriate party.
- Appoint qualified carpenter to carry out repairs.
- Assess the area that requires fixing.
- Determine what PPE and other equipment will be required, if required fill out SWMS.
- Measure and photograph the area that is to be repaired.
- Order timber patches and high quality exterior PVA adhesive.
- Create template for routing out timber using timber patch.
- Rout out timber.
- Apply adhesive.
- Place timber patch into the hole.
- Clamp into place.
- Remove clamp.

Resin Filling

- Ensure the timber is in a dry workable condition before starting work. Cold air blowers and dehumidifiers may be used to dry timber, do not use hot air blowers to rapidly dry timber; this can result in pronounced shrinkage cracks in the timber.
- Obtain approval to conduct repair from appropriate party.
- Appoint qualified carpenter to carry out repairs.
- Assess the area that requires fixing.
- Determine what PPE and other equipment will be required, if required fill out SWMS.
- Measure and photograph the area that is to be repaired.
- Order resin.
- Apply resin in gap as per manufacturers instructions.

Tinted Wood Filler

- Ensure the timber is in a dry workable condition before starting work. Cold air blowers and dehumidifiers may be used to dry timber, do not use hot air blowers to rapidly dry timber; this can result in pronounced shrinkage cracks in the timber.
- Obtain approval to conduct repair from appropriate party.
- Appoint qualified carpenter to carry out repairs.
- Assess the area that requires fixing.
- Determine what PPE and other equipment will be required, if required fill out SWMS.
- Order wood filler and black oxide tint.
- Mix black tint with wood filler.
- Apply tinted wood filler into the gap.
- Lightly sand if required.
- Reseal if required.

These repair methods are suggestions only, are general in nature and are not warranted by XLam. Each situation will require individual assessment and judgement by qualified, experienced tradespersons and/or certified engineers.

If mould is found on the surface of XLam CLT panels it needs to be removed. The following are suggestions of how this may be achieved, note there are specialist firms who could be engaged to conduct mould removal.

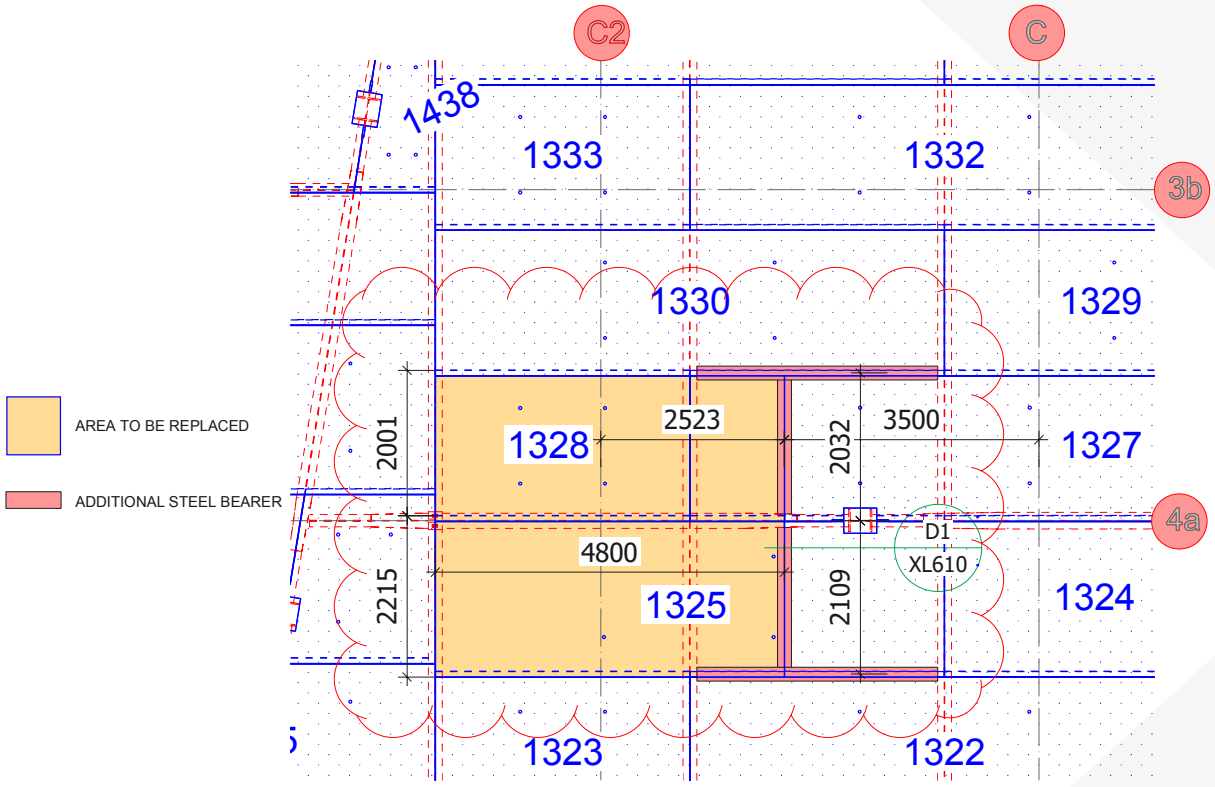
- Obtain approval to conduct repair from appropriate party.
- Appoint qualified tradesperson to carry out repairs.
- Determine the source of high moisture levels within timber and ameliorate immediately.
- Assess the area that requires fixing.
- Measure and photograph the area that is to be repaired.
- Select mould removal treatment type and order.
- Determine what PPE and other equipment will be required, if required fill out SWMS.
- Remove linings to expose CLT and allow timber to dry. Cold air blowers and dehumidifiers may be used to dry timber, do not use hot air blowers to rapidly dry timber; this can result in pronounced shrinkage cracks in the timber.
- Apply mould killing treatment to CLT panels as per manufacturers instructions.
- Sand if required.
- Do NOT cover over or enclose until moisture levels have stabilised to 12%±2% and the source of high moisture levels leading to growth of mould has been identified and eliminated.
- Replace linings as per product manufacturers instructions.

Building Type 2 story office building
Building Element CLT Floor
Event A fire occurred during the construction phase leading to damage as per these photos.

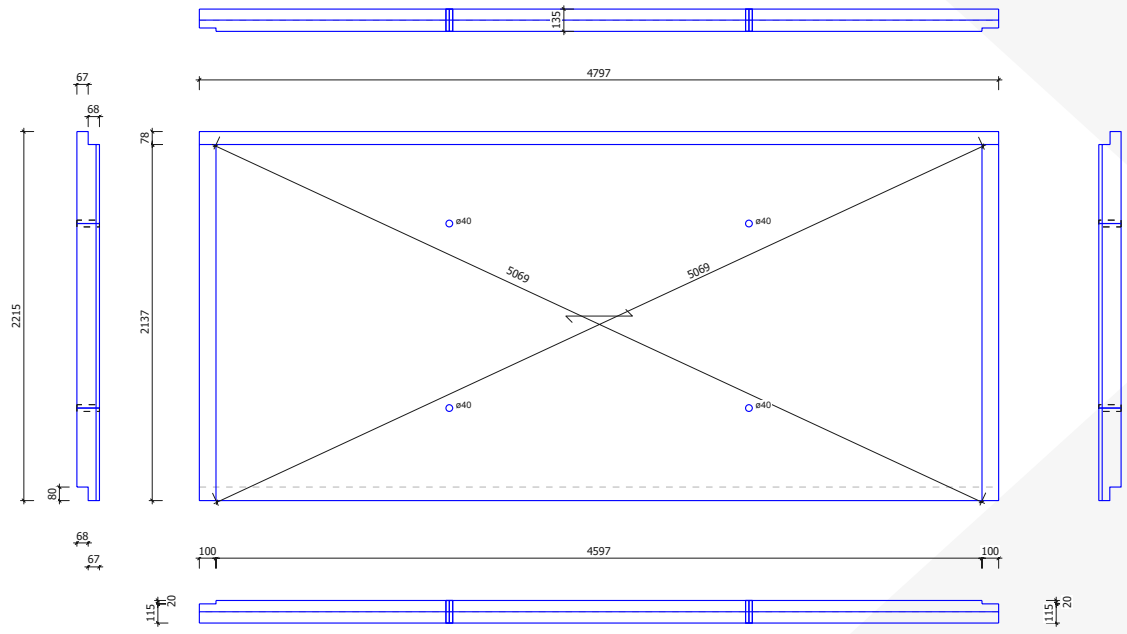
Damaged Floor Panels

To rectify the damage these steps were taken, for reasons of confidentiality project-specific information is not provided.

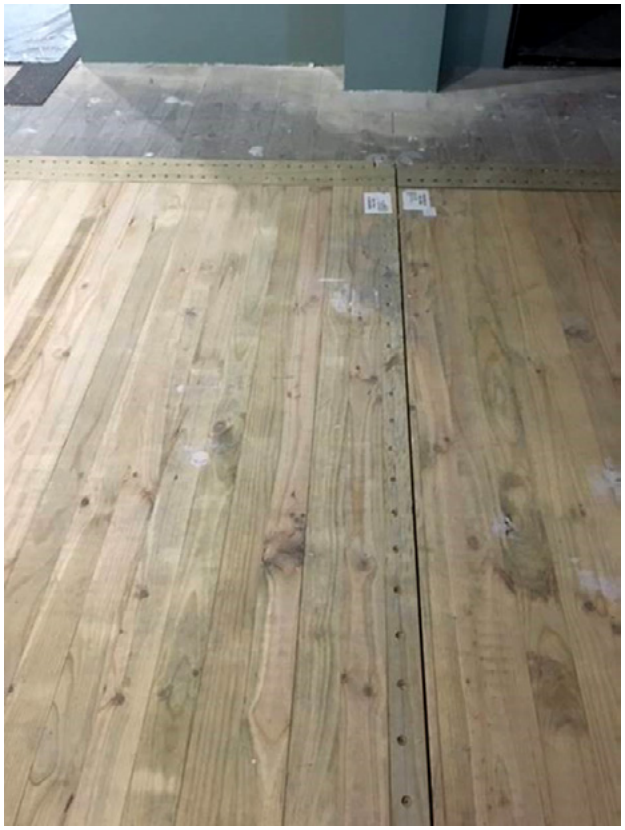
- Assessment of damage by a certified engineer.
- Determination of repairs required by a certified engineer.
- Engineer certified proposed repairs will meet fire and structural requirements of the building.
- Contractor appointed to carry out repairs.
- Measurement of areas to be repaired for manufacture of replacement CLT panels and other building elements including steel members.
- SWMS completed.
- Materials and equipment ordered including any additional PPE and site safety equipment to carry out repairs.
- Damaged panels removed as per plan.
- Steel members replaced as per plan.
- Replacement of damaged panels and steel members as per plan.
- Final inspection and sign off by engineer.



Measurement of area to be repaired



Drawing of replacement panel



Repaired Floor Panels

Developer: FAB Consortium
Architect: Design Base
Engineer: CGW (Cameron Gibson & Wells)
Engineer: Gavin Robertson Engineer
Cross Laminated Timber Supplier: XLam
Laminated Veneer Lumber Supplier: Nelson Pine

On Monday the 14th of November at approximately 12:20am a 7.8-magnitude earthquake struck the South Island of New Zealand. The quake directly impacted the cities of Christchurch, Kaikoura and Wellington, however the tremor intensity covered a wider geographic area. Following the earthquake incident a team of engineers including, Gavin Robertson (Engineer), Andy Reid (Engineer) and Sam Leslie (XLam) visited the recently constructed Kaikoura District Council (KDC) building to assess the impact of the earthquake.

The KDC building is a 3-storey office development comprising a Potius floor and roof structure, LVL beams and columns, and Cross Laminated Timber (CLT) walls. The building design included 15 CLT/LVL-composite rocking shear walls, each approximately 13m high x 3.4m wide, which were post-tensioned to the foundations. Each section was constructed with continuous macalloy bars running down the centre of each wall.

Each rocking shear wall is fitted with a threaded rod energy dissipater or more commonly known as “fuses”. These fuses are fixed to either side of the shear wall and dampen out the seismic energy from the earthquake. In a seismic event the walls are designed to rock back-and-forth which introduces ductility into the overall structural timber building system. This back-and-forth action significantly reduces the loads on both the building and its foundations. These fuses are located on the outer faces of the panels so they can be easily replaced if activated. The combination of dissipation and post-tensioning results in a low damage solution which significantly reduces downtime following a seismic event.

Prior to the inspection of the site the team discussed the likely damage to the building. The only area expected to indicate likely damage following the earthquake was the activation of the fuses. On inspection, the KDC building lived up to the timber reputation of earthquake resilience and performed extremely well in the recent earthquakes. There was

Composite LVL/XLam rocking shear wall

KDC rocking shear wall

very little sign of damage, other than slight cosmetic cracking to the pavement and some movement at the joints between elements. There was no sign of the walls rocking, or yielding of the dissipater bars. This suggests the building has capacity to withstand an event even larger than that experienced in the early morning of 14th November.

Rocking shear walls show little sign of damage

It is widely known that timber performs inherently well in earthquake events and is one of the major benefits of using mass timber construction materials and processes. Timber is about 20% the weight of concrete, and has a very high strength-to-weight ratio. Typically, the finished weight of a mass timber building will be about half that of an equivalent concrete structure. If the mass in a building can be reduced, the force required to resist the acceleration caused by earthquakes is also reduced.

Following the earthquakes, the building has been used as a post-disaster headquarters with a number of military, police and hospital staff inhabiting the office spaces. Both the Mayor and CEO of Kaikoura District Council were extremely happy with how their building had performed.

The technology found within the KDC building is not new. In 2014, XLam was also used for a number of rocking shear walls for a retail building in Richmond. This building was designed with 14 rocking shear walls, however without post-tensioning. The design in the Richmond building relies on gravity to re-centre the walls after an event. The building also has a concrete midfloor which provides sufficient gravity load to assist in resisting the overturning forces due to the earthquake As with the KDC building, threaded rod energy dissipaters either side dampen our seismic excitation.

Mass timber construction offers considerable benefits for those building in seismic zones. The recent earthquake events in Kaikoura are an unfortunate consequence of living in New Zealand, however as this case study highlights, local design technology and non-traditional construction materials are leading the way for a safer community.

Check	Location	Date	Condition/Comments	Action required	Completed
XLam CLT panel surface					
XLam CLT panel moisture content					
CLT fixings					
CLT connections					
Exterior cladding joint sealant					
Vapour membrane					
Ventilation system					
Exterior cladding					
Gutters					
Roof covering					
Down pipes					
Flashings					
Windows					
Internal linings					
Fire stopping					
Electrical penetrations					
Plumbing penetrations					
Attachments					
Moisture content of timber					
Grouting in tiles					
Sealant in wet areas					
Termite barriers					
Support beams					
Support columns					

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