Introduction
XLam commenced manufacture of Cross Laminated Timber (CLT) for the New Zealand market in Q1 of 2012, the first manufacturers in the Southern Hemisphere. Up until recently the uptake of CLT has been slow, however with the advent of deliveries into large scale commercial and residential developments the technology has been adopted and is entering mainstream markets.

With the early adopters, a small volume of projects were processed and XLam’s expertise in CLT design, engineering and construction provided the market with sufficient education and information about XLam CLT and more broadly off-site construction building science. As the uptake of XLam CLT increases, there becomes a greater risk of poor design detailing and/or poor construction quality. To mitigate this risk, there is an opportunity to build-in greater safety factors into mass timber durability by way of preservative treatment.

New Zealand Building Code
Acceptable Solution B2/AS1
The New Zealand Building Code (NZBC) compliance standards for durability are set by Clause B2/AS1, which prescribes minimum lifetimes for building elements. The lifetime periods are based on the function of the element and the degree of difficulty of access and repair.

XLam CLT is not currently specified in the NZBC Acceptable Solutions however it has been consented as an Alternative Solution through most territorial authorities in New Zealand. For sawn timber, the Acceptable Solution B2/AS1 (Amendment 9), requires treatment for Radiata pine to achieve a 50-year durability as follows:
• Interior flooring, suspended ground floors treated to H1.2
• Enclosed skillion roof framing & associated roof members treated to H1.2
• Plywood flooring to wet areas treated to H3
• Cantilevered enclosed deck joists treated to H3.2
• Framing and other members supporting enclosed decks treated to H1.2.
• Interior flooring and interior walls treated to H1.2*

Acceptable Solution NZS 3602:2003
NZS 3602 designates the durability hazard class (H1 to H6) for timber building elements, based on location and function within the building structure. The Standard is currently being revised and CLT is likely to be included within the Standard and therefore form part of the acceptable solution. However, until the Standard has been cited, XLam recommends adopting a conservative approach to durability by following the prescriptive requirements for sawn timber as currently set out in B2/AS1 (apart from interior flooring and interior walls as noted below*).

To Note:
1. * Existing NZS 3602 clause 104.5 provides an exemption for treatment of glue laminated timber in internal applications provided the completely dimensioned and finished member has a surface coating of approved insecticide and fungicide to all surfaces. The New Zealand Glulam industry has been using this approach for internal beams and columns for over 50 years and, to our knowledge, there has been no evidence of in-service failure in this application. XLam therefore consider the use of a supplementary surface treatment applied to all panel faces for elements completely within the building’s external envelope and outside of wet areas.
2. Sacrificial, non-structural decorative veneers over the CLT panel is acceptable as untreated without any coating system provided the element is located within the building’s external envelope and outside of wet areas.
3. B2/AS1 clause 3.2.2.2 permits the use of untreated Douglas fir as an Acceptable Solution for structural elements where protected from the weather, but only for buildings which meet all of ten stipulated requirements (and they seldom do).
4. Early preservative treatments of Radiata pine timber framing were exclusively to combat the risk of borer. From the 1990’s, untreated, kiln-dried Radiata pine was accepted as an appropriate treatment system for residential framing since it was less susceptible to borer attack than rough sawn, air dried framing. Untreated, kiln-dried Radiata pine has little resistance to micro-bacterial decay and following the “leaky building” crisis, this is no longer accepted in B2/AS1. The ‘leaky building crisis’ is well documented in New Zealand, with an estimated 42,000 buildings constructed between 1994 and 2004 affected and repair costs exceeding $11.3 billion. Interestingly, the leaky building crisis the NZBC Clause E2, which details Acceptable Solutions for protection against external moisture, was increased from 28 pages in year 2000 to 200 pages currently.
XLam’s Durability Solution
XLam’s treatment strategy falls outside the requirements of B2/AS1 for sawn timber and has been substantiated through an Alternative Solution which has been widely accepted by territorial authorities throughout New Zealand.

XLam’s historical treatment strategy aimed to protect CLT in wet areas, and against interstitial condensation, but relied on best practice design principles and quality construction to minimize moisture exposure to the wood. This treatment strategy relies on other products forming part of the external envelope to perform for a 50-year life which has been the common and widely accepted approach to CLT durability in Europe and Canada.

Although good design, good construction and regular maintenance practices will minimize the risk of moisture ingress, there is risk that some CLT panels will be exposed to moisture throughout the life of the building. Wood that is assumed to remain dry in buildings often does get wet because of, failures in architectural design, construction mistakes/poor craftsmanship, and/or poor maintenance. Common causes of unwanted moisture in buildings include windows and roof leaks, inadequate ventilation and insulation, condensation and internal plumbing leaks.

Moisture ingress mechanisms are not restricted to a single layer of CLT and all layers require preservative treatment to ensure durable XLam CLT panels. If the panel is subjected to high moisture content, there will be risk of decay to any untreated timber laminates within the panel.

The initial moisture content of XLam CLT panels, prior to applying linings, can also affect long term hygrothermal performance. Timber treatment will not prevent moisture absorption, or up-take, where CLT panels are exposed to weather (rain, high humidity and extreme sunlight combinations). For exposure periods of greater than 4 weeks during assembly on-site XLam recommends having a factory applied water-repellent sealer to all exposed surfaces. All XLam CLT panels should be protected as soon as is reasonably practicable after installation from both weather and UV. Exposure to high levels of moisture followed by exposure to the sun and other heat sources can create a moisture gradient across the elements resulting in warping, twisting or bowing.

Discussion Points
The risk of failure of mass timber construction is higher with an increased volume of projects entering the market due to reduced design education, lack of peer review and reduced construction quality. Simply assuming that timber will stay dry throughout a 50-year service life of the building is no longer appropriate for the given market size in New Zealand. Adding treatment to XLam CLT is a cost-effective option to provide greater durability.

Projects already constructed
Due to the small scale and small number of projects constructed during the CLT establishment phase, XLam has been able to educate each individual design and construction team to ensure a quality system. Provided general maintenance is carried out on a regular basis, XLam CLT panels are deemed to be fit-for-purpose for a 50-year durability as per XLam’s Durability Statement. XLam provides best practice maintenance schedules which focus not only on the CLT element, but also on all other products forming an integral part of the external envelope.
Cross Laminated Timber Preservative Treatment

**Design Detailing**
Detailing of mass timber structures is the primary defense mechanism against moisture ingress. There are several decay mechanisms which compromise the integrity of XLam CLT elements, these include, the deterioration of the adhesive, deterioration of the wood-adhesive bond, and deterioration of the timber. The durability of XLam CLT panels is a function of a combination of factors; design, detailing and the opportunity to preservative treat feedstock. Designers who consider durability at the early design stage (via good building science, predictive models and adoption of building monitoring systems), are at lower risk of failures.

**Treatment efficacy**
H1.2 treated XLam CLT will be durable if it remains dry, but it may decay if subjected to humid environments for prolonged periods. H3.2 treated XLam CLT has greater efficacy, but will still decay if subjected to wet environments for prolonged periods. Preservative treatment therefore adds a factor of safety into the design, but should not be relied upon in isolation to achieve a 50-year durability. Refer to XLam’s design guidance for further information about detailing for durability.

**Risk/Consequence approach to durability**
The New Zealand Building Code should be a minimum approach to preservative treatment and it is recommended that designers assign a durability hazard class based on both risk and consequence of failure for each given building project. The minimal additional cost of treatment far outweighs the risk of failure in large scale buildings. Risk should be based on the potential of moisture ingress which relates to design detailing, quality of construction, and maintenance schedules adopted. Consequence of failure should be assessed both in terms of life safety and potential economic loss. i.e. for tall timber buildings, H3.2 could be considered appropriate even for service class 1 applications (completely within the external envelope).

**Recommended Residential Treatment Strategy**

- **Roof:**
  - roof cladding
  - cavity
  - insulation (PIR)
  - wrap
  - CLT panel

- **External wall:**
  - cladding
  - drained cavity
  - insulation (PIR)
  - wrap
  - CLT Panel

- **Internal wall:**
  - membrane
  - underlay substrate
  - CLT panel

- **Balcony:**
  - Membrane
  - H3.2 Ply
  - Furring packed to fall
  - CLT panel
  - Lining to soffit

- **Ground floor:**
  - Floor lining
  - CLT panel
  - Insulation (EPS)
  - bearer and pile

- **Make wet area floor panels self-supporting**

- **Paint on surface treatment to all surfaces (Boron)**
- **Timber treated to H1.2 (Boron)**
- **Timber treated to H3.2 (CCA)**

Note: Membrane roofs to have all layers H3.2
Note: Non-structural decorative surface layers within the building external envelope can be untreated