Pure CLT – Concepts and Structural Solutions for Multi Storey Timber Structures

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1. Introduction

Over the last 20 years, Cross Laminated Timber (CLT) has grown to become a widely used and highly successful engineered timber product. Following its popularity across Central Europe, the material was first used in the UK by Eurban almost 15 years ago and is now fast becoming an established building system in the British construction industry. CLT has developed a special role in the mid-rise residential sector, promoting worldwide interest with its potential for a range of mid-rise builds and the possibility for even larger projects.

Figure 1: Press House, London © EURBAN Limited

2. Development of CLT in the Multi Storey Market

2.1. CLT Multi Storey Residential Buildings in the UK

The first mid-rise CLT building in the UK was a mixed-use development comprising commercial and residential units at Waterson Street in London. Built in 2005 by Eurban, the development rose to five storeys, making it the world's tallest residential CLT project at the time. Over the following years, Eurban has led the way for CLT. In 2011, they completed the eight-storey Bridport House, which remains the biggest residential CLT project in Britain.

Figure 2: EURBAN Multi Storey Projects 2005 – 2015 © EURBAN Limited

This was followed by a variety of multi-storey CLT buildings, including Newington Butts in London and CCG Yoker in Glasgow, Scotland's highest timber building.

Figure 3: EURBAN Multi Storey Projects 2015 – 2015 © EURBAN Limited

With a growing number of CLT buildings appearing across the UK, interest in the system is increasing, particularly for mid-rise residential sector projects where traditional timber systems have reached their limits. Recent projects have also shown that CLT offers a viable alternative to steel and concrete.

2.2. CLT – Going from strength to strength

A key part of this competitiveness lies in the faster build programme of CLT systems. Since CLT buildings are installed at a faster rate than steel or concrete ones, developers benefit from earlier income of rents and reduced financing costs. As well as reducing expenses during the construction period, a faster build programme reduces disruption to neighbours, which is a key consideration when working on tight urban sites thanks to lower noise levels and fewer material deliveries.

These benefits are bolstered by the fact that the CLT construction process is optimised by the precision of offsite manufacturing. Building elements like doors and windows can be produced from drawings and installed after the structure has been erected, avoiding the need to repeatedly take onsite measurements.

Beyond the construction process, the use of CLT has the unique ability to create low carbon or carbon neutral developments. This is particularly attractive to developers, who face challenges of delivering on their carbon reduction quotas. In terms of reducing the carbon footprint of the industry as a whole, CLT buildings are made up of recyclable structural materials. Building parts can be dismantled in the same way as they were installed, so

these parts can be reused or converted into other wood products such as OSB or chip board. And ultimately, if the timber can't be reused or recycled, it can be used as biomass fuel. A CLT building never needs to go to landfill.
As well as benefiting developers, CLT buildings benefit the residents of the developments. Due to the mass of a CLT structure, it prevents overheating in summer and controls the humidity level far better than concrete, providing residents with a highly improved indoor air quality.

2.3. CLT – Going from strength to strength

CLT has an exciting future ahead. A number of projects previously planned as concrete are set to change to solid timber, which will draw significant interest and raise awareness of the benefits of CLT systems. Of course, the best way to convince stakeholders of the benefits of CLT is simply to deliver more projects, and demonstrate how well the buildings deliver in practice.
While CLT is now an established system in the mid-rise residential sector, the next step is to consider how CLT can apply to taller structures.
For CLT to continue to reach new heights, it will be critical to achieve a European design standard, which will define the possibilities, behaviours and uses of the product. This will clearly set out the standards for CLT usage, and represent another step in the ongoing development of solid timber buildings. At the current rate of progression, it's only a matter of time before Cross Laminated Timber breaks the twelve-storey mark.

"Using CLT is no longer seen as unconventional and the technology has been proven across Europe. CLT has already been used in the UK in buildings up to 11 storeys high. In Austria, Germany, Scandinavia, as well as in Canada and Japan, use of CLT is increasingly considered mainstream."
The Farmer Review of the UK Construction Labour Model, Mark Farmer, 2016.

3. Structural Concepts/Systems

There are three generic approaches to the structural design of a solid timber multi storey residential building. The structure is designed to deliver on the architectural intent for a building.

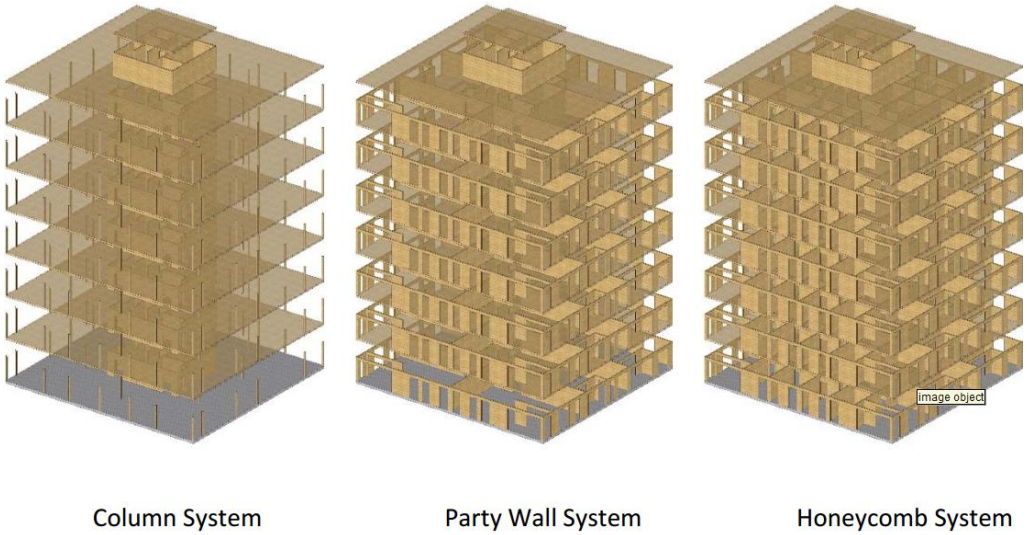

Figure 4: Structural Concepts/Systems © EURBAN Limited

3.1. Column Systems

This is straight adaption from a traditional reinforce concrete design. The core is build out of solid CLT panels to provide the stiffness to the structure. Columns are located around this core to support the floor which is made of glulam beams and CLT floor slabs. It provides the highest grade of flexibility as the structural elements are kept to a minimum. This system is only possible to a limited height and it requires a more or less square, small building footprint.

3.2. Party Wall Systems

In this system the core walls, the outside walls and the party walls between the apartments are used as structural walls. The walls and slabs are formed out of CLT panels with glulam or steel beams being used where necessary. It provides flexibility inside of the apartments and allows a certain flexibility of layout over the whole building as only the apartment party walls have to line-up between storeys. This system suits various heights and shapes of buildings.

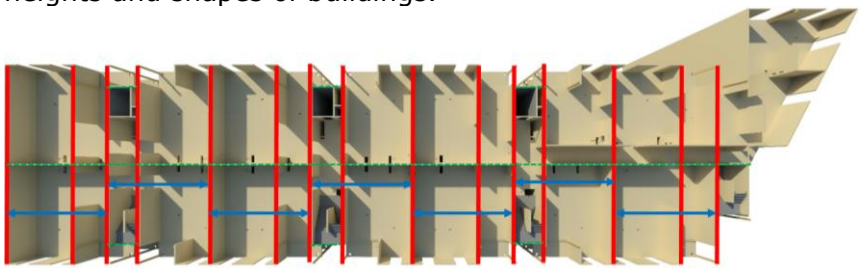

Figure 5: Structural System Newington Butts © EURBAN Limited

Figure 6: Installation Newington Butts

3.3. Honeycomb Systems

In this system the majority of the walls are used as structural walls and are made out of CLT. This reduces the wall and floor panels to a minimum thickness. It limits the flexibility of the layouts but it forms an extremely robust and efficient structure. This system is suitable for very tall and complex buildings.

Figure 7: Installation Woodberry Down