

STA Advice Note 14

Robustness of CLT Structures



No. 14 - Part 5, March 2017

Part 5 - CLT structural design and manufacturing quality assurance

The purpose of advice note 14

This series of STA advice notes provides good practice design principles to reduce errors and to provide installation guidance to deliver durable, robust panelised CLT buildings. Refer to Advice Note 14, Part 1 for the introduction and general key principles.

Part 5 provides good practice guidance for the design and manufacturing quality assurance of panelised Cross Laminated Timber (CLT) building structures.

Introduction

CLT is manufactured using quality controlled softwood material which has no natural defence against decay caused by sustained high levels of moisture; typically above the design threshold of 20% moisture content. Correctly designed CLT structures will not be subjected to high moisture, but incorrect installation may create conditions for moisture to become trapped. It is essential that the design team, installation team and follow on trades understand the building materials being adopted. This series of advice notes provides good practice design principles to reduce installation mistakes and includes guidance on installation to deliver durable, robust CLT buildings.

The advice note is set out in five parts for ease of reference and application by the building team involved in a project.

The four key design principles are:

- CLT is not positioned on the external envelope cold side, i.e. insulation is on the outside face
- Breathable walls to allow internal moisture to defuse
- Warm roofs to be appropriately designed to avoid moisture traps in service; consult specific warm roof design guidance
- Avoid water traps during installation and in service where leaks can occur.

The three key installation principles are:

- The installers understand and have knowledge of timber as a construction material
- Poor workmanship and interference by follow on trades can occur if not checked (supervision of the works is part of the durability risk mitigation process; for which the STA have provided a check list for site works contained in Part 4)
- Temporary protection of CLT end grain that can be subjected to exposure to wetting during construction.

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Structural design

Key principles

1.	CLT panels are typically used to create cellular structures of timber load-bearing walls with timber floor slabs and roofs constructed using the platform frame approach.
2.	British Standard BS EN 1995-1-1:2004 (Eurocode 5) (14) is scheduled to be updated in 2020 and will include a design procedure for CLT. Until such time, CLT should be designed using the principles given in BS EN 1995-1-1 and -1-2 together with data from the manufacturer of the product.
3.	For both wall and beam/floor components, bending stresses are typically calculated using effective section properties. The most common approach to structural design of CLT amongst European CLT manufacturers and the method believed most likely to be adopted in the forthcoming revision of Eurocode 5 is based on effective section properties determined using a modified version of the Theory of Mechanically jointed beams to EN 1995-1-1:2004 Annex B but other methods can be used.
4.	For more detailed information on the structural design of CLT reference should be made to STA Timber Engineering Bulletins 11, 12 and 13.
5.	CLT structural engineer's site inspection strategy to be agreed. Must be suitable for the scale of the building and within the quality assurance procedures, including any records of design sign off and inspections.

Codes of practice and standards for the design of CLT structures

Item	Check	Standard/Code
Section properties of CLT		EN 1995-1-1:2004 Annex B
Resistance to vertical and horizontal loading	Wall elements Axial buckling resistance due to loading in the plane of the panel* Wind load resistance Bearing resistance on floors/soleplates Resistance at concentrated loads Lintels over openings Floor and roof elements Bending and shear stress due to loading perpendicular to the plane of the panel Deflection and vibration performance* Bearing resistance on walls/plates	EN 1995-1-1:2004 Eurocode 5 For the CLT element EN 1995-1-1:2004 Eurocode 5 For loading EN 1991 Eurocode 1, Part 4 - wind actions
Stability design	The necessary stability checks should include the following: Global overturning Global sliding Individual wall panel overturning Individual wall panel sliding Individual wall panel shear	Eurocode 0 clause 3.3 using the design values of actions in BS EN 1990:2002 (Eurocode 0) and the UK National Annex for Ultimate Limit State EQU (Set A)
Disproportionate collapse	Check of vertical and horizontal tying requirements for resistance to accidental actions	Building Regulations 2000 Approved Document Part A3 BS EN 1991-1-7:2006 Eurocode 1 NA to BS EN 1991-1-7:2006
Fire resistance of CLT	Can be provided by plasterboard linings or can be provided by charring resistance of the timber which can be calculated using the reduced cross-section method **	BS EN 1995-1-2:2004

Table 1 Relevant codes of practice for the structural design of CLT

* Deflection and vibration limits should be agreed at project commencement with the Client in accordance with EC5.

** In-service fire resistance can be achieved by a combination of the resistances provided by lining materials and charring of CLT for system assemblies subject to the necessary test results/approvals being available.



Requirements for accredited 3rd party assessment and certification for key components and elements, ETA and CE marking

In addition to manufacturer's own ETA certificates, the harmonised European Product Standard (hEN) for CLT published in 2015 enables CE marking to be undertaken against a product standard specific to CLT.

CLT product standard

The performance characteristics for straight and curved cross laminated timber (CLT or X-Lam) both without and with large finger joints as a material for the manufacture of structural elements to be used in buildings and bridges are set out in the CLT product standard BS EN 16351:2015 Timber structures - Cross laminated timber - Requirements.

The characteristics of and requirements for the components used to make up CLT, such as the strength characteristics of the timber laminates, requirements for adhesives, requirements for preservative treatments etc, are determined in accordance with the procedures described in Section 5 of the CLT Product Standard.

CE marking

CLT products should be CE marked in accordance with product standard **BS EN 16351:2015** Timber structures - Cross laminated timber - Requirements and **NSTS Section 5.2.7**

CE mark compliance is achieved by an audited Factory production Control leading to a Declaration of Performance certificate. The Factory production Control applies to each company that alters the product in a way that impacts on the product performance criteria. If a change has occurred to the product, for example a CLT panel that has had a treatment applied after production, that in turn alters the product from what has been declared on the CE mark and a new CE mark is required to cover the change and performance level expectation.

For more information on CE marking of timber products including CLT and factory production control (FPC) procedures, reference should be made to **STA Advice Note 1, Parts 1 and 2 - CE Marking and the timber frame industry**



Fig 1 CE mark labelling of a CLT panel



Information to be supplied by the timber contractor

The information that the Timber Contractor is required to submit are to be clearly defined at project commencement in accordance with National Structural Timber Specification (NSTS) Section 4.0

References

1. **British Standard BS EN 1990:2002 Eurocode 0: Basis of structural design**
2. **British Standard EN 1995-1-1:2004 Eurocode 5: Design of timber structures**
Part 1-1: General - Common rules and rules for buildings
3. **British Standard BS EN 1995-1-1 UK National Annex to Eurocode 5: Design of timber structures**
Part 1.1: General - Common rules and rules for buildings
4. **PD6693-1:2012 UK Non-Contradictory Complementary Information (NCCI) to Eurocode 5: Design of timber structures**
5. **STA Engineering Bulletin 11 - Cross laminated timber construction**
6. **NA to British Standard BS EN 1991-1-7:2006 National annex to Eurocode 1: Actions on Structures**
Part 1.7: Accidental actions
7. **British Standard BS EN 1995-1-2:2004: Design of Timber Structures**
Part 1.2: Structural fire design
8. **British Standard BS EN 16351:2015 Timber structures - Cross laminated timber - Requirements**
9. **National Structural Timber Specification (NSTS) v1 (2015)**
10. **Trada Wood Information Sheet 2-3_62 - Cross laminated timber, structural principles (2009)**
11. **Trada Technology Ltd - Innovative timber construction (2012)**
12. **STA Advice Note 1 Parts 1 and 2 - CE Marking and the timber frame industry**
13. **STA Timber Engineering Bulletins 11, 12 and 13**
14. **BS EN 14080:2013 Glulam manufacture**
15. **GD10 Cross-laminated timber, Eurocode 5 - design guide for project feasibility**

Steering Group

Sincere thanks for the time and contribution given to this project by members of the CLT steering group.

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