Quality Assurance and route to certification of Homegrown Mass Timber Systems

Transforming Timber

CONTENTS

OVERVIEW

Manufacturing of mass timber products, such as Cross Laminated Timber (CLT) and Glue Laminated Timber (GLT), requires considerable precision in board preparation, glue preparation and application, pressure, and timing. For CLT and GLT, adhesive application is usually the critical factor in ensuring the requisite quality and strength.

This summary contains key considerations and recommendations associated with developing a quality assurance strategy for homegrown CLT and GLT, including plant pre-qualification requirements, means of evaluating of mechanical properties, factory production control measures, and operating procedures. Accompanying this publication are also some examples of document templates designed to capture the most relevant information related to the quality assurance of homegrown mass timber products.

RELEVANT STANDARDS

Internal control measures are usually verified by an approved third-party organisation, which can issue a certification of manufactured product (such as CE marking).

This usually involve checks and verification of the company's internal controls. The precondition for certification is the existence of a harmonised standard. This means that for certified CLT panel or GLT beams used for construction purposes, their properties must be verified in line with the requirements in the following standards:

- BS EN 16351:2021 Timber structures — Cross laminated timber — Requirements
- BS EN 14080:2013 Timber structures — Glued laminated timber and glued solid timber — Requirements

These standards state which documents are required for verification. To prove that CLT and GLT products meet the requirements, they must be accompanied by a performance declaration.

PLANT PRE-QUALIFICATION

Plant pre-qualification is intended to ensure that the CLT plant is qualified for the various manufacturing factors, such as assembly time, timber moisture control, adhesive application rate, clamping pressure, pressing and curing time, and wood surface temperature, prior to the normal production. BS EN 16351:2021 lists detailed set of requirements that must be met during plant pre-qualification stage. Pre-plant qualification should also cover factors related to the manufacturing environment within which the plant aims to operate, such as ambient temperature and relative humidity. A detailed description of plant pre-qualification requirements can be found in the full report.

EVALUATION OF MECHANICAL PROPERTIES

Prior to certification of a mass timber product, its mechanical properties must first be verified for given manufacturing circumstances, specific to each manufacturing plant. Essential characteristics of the CLT and GLT associated with evaluation of mechanical properties are listed below.

1. Cross Laminated Timber:

- Mechanical resistance - bending strength, compressive strength, tensile strength, shear strength, modulus of elasticity, and density. Mechanical resistance can be determined through geometric data or through laboratory tests. A diagram outlining all possible mechanical resistance verification procedures for CLT can be found in the full report.
- Durability of bonding strength, which should be expressed as timber species, adhesive type and family, and declaration of minimum pressing time.
- Bonding strength of glue lines between layers verified either by a delamination test or through shear tests.
- Resistance to fire declared through the proxy parameters of geometrical data and charring rate.
- Reaction to fire either declared as the fire class of the timber layers or tested according to harmonised standards.
- Release of formaldehyde-containing adhesives assessed by testing and the corresponding class according to Annex A of BS EN 16351.
- Dimensional stability declared either as moisture deformation factor or as a species.

2. Glued Laminated Timber:

- Mechanical resistance - bending strength, compressive strength, tensile strength, shear strength, modulus of elasticity, and density. These can be verified either through classifications from layups and lamination properties or from calculations using the cross-sectional layup and documented properties of boards from full scale tests. A diagram outlining all possible mechanical resistance verification procedures for GLT and a description of all three verification methods can be found in the full report.
- Bonding strength and durability declared as strength of finger joints, and bonding strength of glue lines between laminations by reference to species, adhesive type, and adhesive family. Bonding strength of glue lines are verified either by delamination or shear tests.
- Reaction to fire determined and declared by one of two methods depending on whether the GLT product meets the requirements of the fire class given or sought.
- Release of formaldehyde-containing adhesives assessed by testing and the corresponding class according to Annex A of BS EN 16351.

The methods for deriving all these properties can be found in the aforementioned standards. Technical details including test setups, calculations, and verification procedures can be found in the full report. A considerable amount of test work has already been carried out on UK homegrown CLT and GLT. For this reason, it is recommended that manufacturers carry out an initial type tests on panels produced, which will allow for confirmation of their mechanical properties. A test programme for initial type testing carried out for homegrown mass timber systems is included in the full report.

FACTORY PRODUCTION CONTROL

As mentioned in the overview, manufacturing CLT and GLT requires a considerable amount of precision during board preparation, glue preparation and application, pressure, and timing. Factory production control (FPC) brings together the operational techniques allowing for control of the compliance of the product with the declared performances of the essential characteristics. Manufacturers must establish, document, and maintain an FPC system consisting of procedures, regular inspections and tests, and the use of results in controlling materials, components, equipment, production processes, and the product.

Detailed and accurate production records are essential, and the following should be recorded as part factory production control: quality of incoming raw material, relative humidity and temperature of the production facility, pressing and curing records as well as moisture content and dimensions of the panels. All of the above should be monitored regularly through internal checks to ensure that the products maintain appropriate quality and consistency. This often involves taking regular samples to check for strength and delamination. Results from these tests should be used to correct any deviations, treat non-conformities, and if necessary, revise the FPC to rectify these issues.

OPERATING PROCEDURES

Ensuring safe, efficient, and consistent manufacturing of homegrown CLT and GLT can be achieved through appropriate operating procedures that meet production requirements contained in relevant standards. These procedures address activities associated with board preparation, lamella layup, pressing and post processing of the panels. All relevant operating procedures that should be adopted during the manufacture of mass timber systems are detailed in the full report. Samples of quality assurance documents and records are also provided.

Personnel performing work affecting the constancy of the product's performance should be deemed competent on the basis of appropriate education, training, skills, and experience for which records should be maintained. The responsibility and authority of managers and their relationship between those performing and/or verifying work should also be defined.

The manufacturer should draw up and keep up-to-date documents defining the quality assurance of the mass timber systems being produced. The manufacturer's documentation and procedures should be appropriate to the product and manufacturing process. Moreover, the quality assurance procedures should achieve an appropriate level of confidence in the constancy of performance of the product. This involves:

- the preparation of documented procedures and instructions relating to factory production control operations, in accordance with the requirements of the technical specification to which reference is made;
- the effective implementation of these procedures and instructions;
- the recording of these operations and their results;
- the use of these results to correct any deviations, repair the effects of such deviations, treat any resulting instances of non-conformity and, if necessary, revise the FPC to rectify the cause of nonconstancy of performance.

CONCLUSIONS

This summary captures the most relevant information related to the quality assurance of homegrown mass timber systems and shows how a quality assurance and factory production control measures can achieve an appropriate level of confidence in the constancy of performance of CLT and GLT. These procedures are a first step towards implementation of appropriate quality assurance protocols and ultimately certification of homegrown mass timber products.

FORM QA001

Incoming material. Actual dimensions and moisture content measurements

1	Delivery information							
Delivery date	Pack number / ID	No. of pieces	Species	Strength grade	Nominal dimensions (mm)			Notes
					Thickness	Width	Length	

2	Measured dimesions and moisture content (mm)																					
Pack number / ID	Date	Thickness					Width					Length					Moisture content (%)					Initials
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	

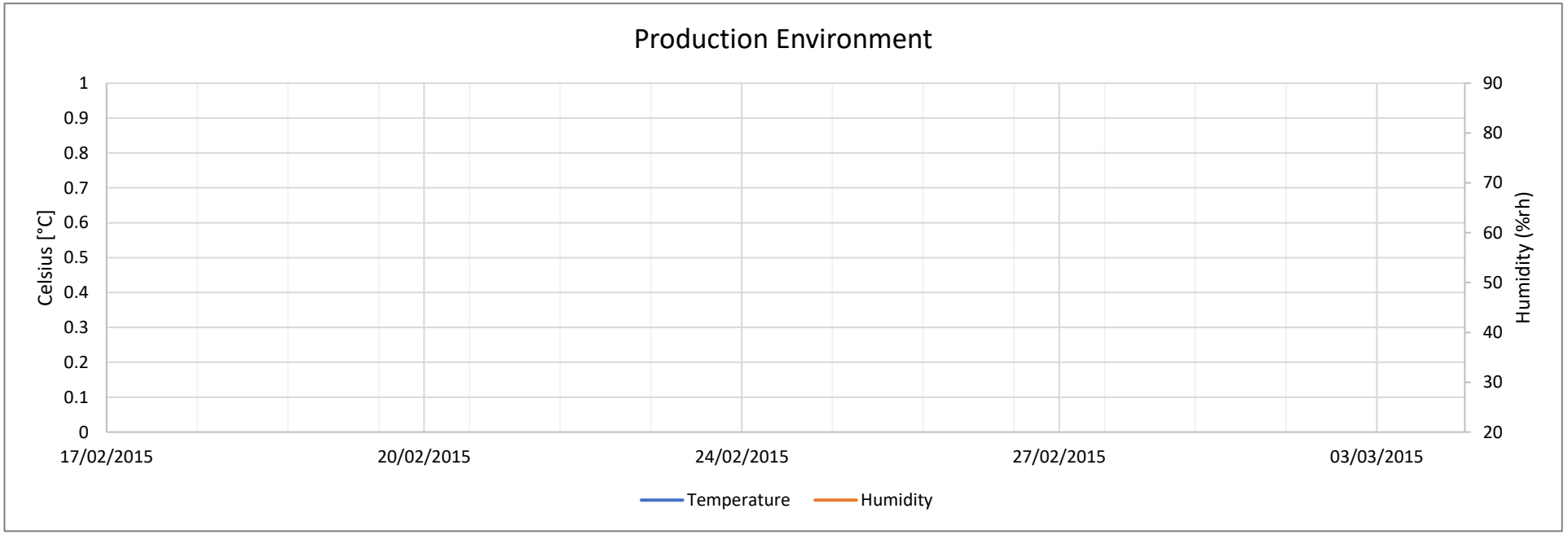
FORM QA002
Production Environment

Month / Year	Sep-21

1	Production environment during manufacture

Panel ID	Date / Time	Temperature (°C)	Humidity (%rh)
		#N/A	#N/A
		#N/A	#N/A
		#N/A	#N/A
		#N/A	#N/A
		#N/A	#N/A

Panel ID	Date / Time	Temperature (°C)	Humidity (%rh)
		#N/A	#N/A
		#N/A	#N/A
		#N/A	#N/A
		#N/A	#N/A
		#N/A	#N/A



QA003_Pressing record

Project name:

1	Panel specification and nominal dimensions				
Panel ID	No. of layers	Layup	Length (mm)	Width (mm)	Thickness (mm)

2	Lamella specification and nominal dimensions					
Layer	Orientation	Species	Est. MC [%]	Length (mm)	Width (mm)	Thickness (mm)
Layer 1						
Layer 2						
Layer 3						
Layer 4						
Layer 5						

3	Adhesive type and requirements		
Type	Purbond HB S609	Min. storage time @ 20°C [h]	10
Max. open time @20°C [min]	60	Application rate per layer (g/m^2)	150
Min. press time @20°C [min]	180	Vacuum pressure [mbar]	150

4	Production record					
Date	Time (adhesive) [h:min]		Time (pressing) [h:mm]		Environment	
	Start	End	Start	End	Temperature	Humidity

5	Lamella - measured dimensions and moisture content											
Layer	Length [mm]	Width [mm]			Thickness [mm]			Moisture content [%]				
Layer 1												
Layer 2												
Layer 3												
Layer 4												
Layer 5												

6	Panel - measured dimensions								
Length (mm)			Width (mm)			Thickness (mm)			

7	FPC test sample
Yes/No	

QA003_Pressing record

Project name:

1	Panel specification and nominal dimensions		
Panel ID	Length (mm)	Width (mm)	Thickness (mm)

2	Lamella specification and nominal dimensions			
Species	Est. MC [%]	Length (mm)	Width (mm)	Thickness (mm)

3	Adhesive type and requirements		
Type	Purbond HB S609	Min. storage time @ 20°C [h]	10
Max. open time @20°C [min]	60	Application rate per layer (g/m^2)	130
Min. press time @20°C [min]	180	Vacuum pressure [mbar]	150

4	Production record					
Date	Time (adhesive) [h:min]		Time (pressing) [h:mm]		Environment	
	Start	End	Start	End	Temperature	Humidity

5	Lamella - measured dimensions and moisture content									
Length [mm]	Width [mm]			Thickness [mm]			Moisture content [%]			

6	Panel - measured dimensions								
Length (mm)			Width (mm)			Thickness (mm)			

7	FPC test sample
Yes/No	

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