STA | STRUCTURAL TIMBER ASSOCIATION

Moisture management strategy

Process guidance for structural timber buildings

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1. Introduction

Many structural timber-based buildings have stood for centuries all over the world. The STA has spent time reviewing what differentiates a good durable building from one that can become defective from moisture ingress. The findings are not surprising in that good practice can be found when projects are planned, designed, built, and maintained by those who understood the building materials used. Historically there would have been more time-served skilled designers and builders. It is now known that skills and material types in construction process are changing with a drive towards more prefabrication being involved, combined with quality-controlled repeatability and engaging with upskilling new entrants to the industry.

Durability is a key component of sustainability which reduces waste and must be considered before making a large investment in a building. Although structural timber systems are capable of meeting service-life objectives, as with any material there are potential threats to longevity to be considered. There's a need for more systematic procedures to engage professionals to review durability as a topic throughout the building process. Moisture management strategy for building projects provides appropriate attention to design and installation which is required to ensure long lasting buildings.

The guidance objective is for a systematic process based on the 7 steps of the RIBA Plan of Work stages, where time and effort is given to consider and mitigate the risk of defects that may come from moisture entrapment during the construction process and in-service.

This guidance provides the industry with additional knowledge and the benefit of experience that is needed to connect the ideas of the design team with the outcomes of site installation. To embed into the construction the process the opportunity to stop, look and act on designs - and also to be aware of warning signs during construction or in-service that indicate if moisture may be causing distress to the structure.

STA steering group members

The guidance is written by Martin Milner with support from the steering group. The STA would like to thank the members of the steering group who have provided direction and peer reviewed the document.

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2. This guidance

What is the purpose of this guidance?

To provide all stakeholders in the planning, design, procurement, construction and management of a structural timber buildings with examples of good practice to avoid moisture defects.

What is the objective of the guidance?

To outline a process to establish a moisture management strategy relevant to the stage of works. The guidance is based on the Stages 0 to 7 in RIBA Plan of Work 2020 and provides strategic steps to allow relevant parties to put in place plans, designs, materials and construction processes that, executed properly, will avoid moisture defects in new structural timber buildings. The RIBA driven steps address each stage in the building from concept, design, build and in use.

Why is this strategy needed?

The STA has recognised that the industry does not establish roles and responsibility for durability, leading to confusion and ignorance of moisture management in the process of commissioning a new building, with the accountability for it always being thought as "by others".

The STA steering group on durability recognised the gap in the construction process and requested a change in the approach to include a moisture management strategy. Whilst good practitioners have years of experience of how to manage the avoidance of moisture induced defects, there are new entrants to the market for structural timber buildings.

This strategy is intended to support the industry to achieve long-lasting, durable and sustainable buildings. Using a set of key steps, the relevant parties can adopt a strategy at the appropriate stage in the process to avoid defects in the design, construction and service caused by excessive moisture.

Who is this for?

The users of this document are clients and owners of buildings, design professionals, structural building system supply chain designers, constructors, cladding/roofing design and assemblers, and building maintenance advisors.

The advice is written with new developments or the refurbishment and reuse of buildings in mind, but some of the information will be of use for existing buildings and maintenance.

There are many examples of good durable structural timber buildings, some of which are hundreds of years old. As with all material types there are some projects that have clearly not been planned, designed, constructed and well-managed, leading to defects caused by moisture ingress. As growth in the use of structural timber buildings takes place the STA has recognised that leading companies demonstrate good practice in the approach to managing moisture in their projects. Taking lessons from this good practice, the STA presents a more formal and effective process, to be adopted across the industry to ensure that durability of structural timber buildings fulfils the sustainable objectives.

Moisture management strategy

Buildings are complex assemblies of different materials and conditions where defects and issues can lead to deterioration before the design life is achieved. No building or material is designed to last forever, so design life is an important point to understand and establish. Potential defects can be from how it was designed, constructed and how or if it has been maintained. Of course, there can be a change in circumstances that alter the movement of moisture, which may cause deterioration in the building and the question of "what if?" should be part of the design process and included in the operations manual, so all stakeholders are aware of their responsibility. Through the design process, construction period and in use a moisture management strategy is recommended. The process is as presented in Part 4.

What is the problem with moisture?

Damage to buildings from moisture occurs in all material types. Where structural timber is involved, excessive moisture can lead to structural deterioration and defects relatively rapidly. Whilst some materials can harmlessly absorb moisture, timber is susceptible to the natural process of decay which can reduce strength, leading to a loss of structural integrity in a building. Moisture defects in timber structures can be a costly problem to remediate. Water ingress or accumulation of high humidity, leading to moisture absorption by the wood, is a cause of distress which should be avoided.

Once timber products absorb water above the intended in-service moisture content, then loss of strength, dimensional changes and a higher likelihood of decay will occur. Different structural timber products and species behave differently.

Why is this strategy guidance?

There are many guidance books, papers and sources of good practice to avoid moisture defects. A list of these resources is provided in the appendix.

3. Application of this guidance

Scope of document

This guidance is for structural timber elements in a building. This does not address cladding or finishes except where they are structural.

Readers of this guidance shall be aware of the characteristics of structural timber. This document is not intended to provide education in timber decay, defects and deterioration as this is covered in many textbooks and advice documents (see the appendix for further reading).

The guidance is about wood based products including:

Solid timber, glue laminated timbers, cross laminated panels, laminated veneer lumber, plywood, orientated strand board (OSB) and medium density fibreboard.

Defects and deterioration in other materials such as concrete and steel are outside the scope of this document; readers should seek other guidance for these materials, noting that all materials are vulnerable to design and construction errors that allow moisture ingress.

Terminology and explanation of key terms

STA

The Structural Timber Association (www.structuraltimber.co.uk)

RIBA Plan of Works 2020

An up-to-date version can be found through an internet search, which will direct to the correct page on architecture.com (RIBA's website)

Design life

Period of a timber structure, component or assembly to perform for a specified period of time the function to which it was intended with specified maintenance where relevant.

Note it is the duty of the designer to consider the level of maintenance, repair or replacement that may be required within the design life of the structure for the elements that they are responsible for.

Change control procedures

Procedures for controlling changes to the design and construction following the sign-off of the RIBA Stages.

Basis of structural design

Provides a technical description of the structural principles and criteria to be used in the design. It provides a confirmation (and technical interpretation) of the final project brief as well as providing the basis for the detailed development of the structural design and a record of the design criteria to be used.

Client requirements

A statement or document that defines the project outcomes and sets out what the client is seeking to achieve. It is used to develop the business case, which examines any viable options that meet the client requirements.

Designer/Principal Designer

The design team is led by the principal designer who controls and manages the design process with direct liaison for decisions with the building client. Under the management of the Principal Designer are designers from other disciplines that will contribute to the project design and may be responsible for durability, in which moisture shall be managed.

Movement and tolerances report

A report describing the anticipated movements of the structure over its design life and how these movements are to be accommodated within the design (including any contractor designed items). It also provides the structural tolerances assumed within the design and those to be achieved within the manufacturing and construction stage.

Performance specification

A detailed specification providing the performance (descriptive) requirements to enable others, typically specialist sub-contractors, to complete their design in accordance with the project brief.

Project strategies

A number of project strategies will occur in the life of a project. These may be anything from a single sentence to a multi-page document depending on the scale and complexity of the project. These strategies have an important role in good project management and, where relevant, include the following:

- Project planning strategy
- Sustainability/design impact on material conservation and regeneration strategy
- Cost strategy
- Design strategy - including moisture management strategy, fire safety strategy (FSS), CDM strategy
- Plan for use strategy - including moisture management strategy, fire safety strategy (FSS)
- Procurement strategy
- Installation/inspection strategy

How to use steps to durability

The guidance is relevant to many project stakeholders including the client and building user.

For the design and build team the full process is required. For the client and end user, the key point checks in Part 4 are required.

Scale of a project

All projects require a moisture management strategy. For small projects the process may be straightforward with a single page document. For large or complex buildings, a more detailed strategy will be required.

What is excessive moisture?

A level of moisture in a product that causes loss of shape, reduction of strength and stiffness and the onset or likely onset of wood destroying fungi.

Surface wetting is not to be confused as excessive moisture. Timber products can withstand wetting of their surfaces when there is a ventilated space above the product to avoid accumulation of moisture over time.

Where water is allowed to lie on timber product for periods beyond a few days and ventilation is not present to dry out the timber, then moisture will be absorbed by the wood and if not dried this often leads to moisture induced problems.

Expertise to understand avoiding excessive moisture

This guidance does not provide details or solutions to avoid moisture problems but rather puts the topic as part of the agenda for designers, contractors and end users to create and follow a moisture management strategy. It is the responsibility of a client appointing professional teams to advise them that these teams have an expertise or access to expertise to ensure the project has the right details, correct compliant construction and appropriate maintenance of the conditions to which the building is designed for.

Durability and moisture management

The strategy of any project starts with defining the design life and expectations of the building structure, including when maintenance and replacements are likely. Moisture management is part of design and build for durability.

Durability is defined as the performance of a product, component, or system to achieve its function for a specified period of time for which it was intended, whether it be structural safety, serviceability, amenity, or aesthetic.

Duties

Each party in the process, including the client, has a responsibility to ensure that the design life of the structural timber building is not reduced on account of their actions.

The 7 steps in the moisture management strategy presented in Part 6 sets out the principles of the process but it is the duties of the participants that can stop or progress the strategy.

Key causes of excessive moisture

PERIOD	CAUSE OF EXCESSIVE MOISTURE	RISK MITIGATION
FROM FABRICATION TO DELIVERY	Inadequate protection from heavy rainfall/snow during pre-delivery storage and transport Trapped rainwater following heavy rain or snow into closed panels from pre-delivery storage	Allowance for ventilation and drying period during the storage and build process Checks on products at delivery
DURING CONSTRUCTION	Inadequate protection during site storage Heavy rainfall or snow during the build process leaving pre-assembled elements to absorb moisture continuously over days without drying out periods Materials left in standing water Trapped moisture in the products that are encased before drying	Allowance for ventilation and drying period during the build process Checks on products before encapsulation, particularly closed panel elements Pre-insulated panels protected during the build process Vulnerable assemblies with weather protection temporary works Design allowing structural elements to breath and dry out Quality control checks on as built
IN THE USE OF THE BUILDING	Long-term condensation Long-term and repeat humid conditions Leaks in water membranes designed to protect the structure Ineffective water protection or no protection In-service pipe leaks Flood damage	Design allowing structural elements to breathe and dry out Designed where appropriate for flood resilience Service pipes accessible pipe zones and structural design to avoid movement leading to stress on pipes, structural opening of joints in the weather facade Design to avoid water ledges Consider failure of protection and allow the surfaces to fail safe with passive measures such as ensuring water can shed off all roof surfaces without becoming trapped at valleys, parapets, or low points Provide weep holes where necessary Design timber structures with adequate up-stands above ground or terrace levels Design floors to consider drainage in the event of flooding or leaks. In addition to considering heavy rain during the construction process In the design of mass timber buildings avoid flat roofs, excessively shallow falls, flat valleys and flat gutters

Design and build for durability rules to follow

In design

RULES	TO THINK
1. Prevention is better than a cure 2. Design structures for the appropriate service class (exposed, unheated, heated) 3. Design matched to the project build supervision, product warranties, location and use of the building/history of use. 4. Avoid encasement, ledges and pockets where moisture can be trapped 5. Design assembly to allow timber to breathe	Where water can go during the construction process or during the in-service conditions should a leak occur What is the weakness in the design? e.g. movement of the structure and weather seals to windows Are services designed to be accessible? Protection systems are likely to have a design life less than the life of the building. How will they be replaced? How can you tell if they have failed?

During the build

RULES	TO THINK
1. Prevention against consistent wetting is better than a cure 2. Remedial works undertaken before closing in defects 3. Inform the design team where timbers have become wetted from standing water 4. Consider the weathertightness process as a critical path, where not possible consider temporary weather cover 5. Have a sign off process that checks the moisture content is within acceptable limits and that the enclosure of all structural timber elements does not occur before this check has been undertaken	Is there standing water on timber products? Are there processes that create pockets with timber and water? Do the design details address how water is managed? Are services built to be durable and accessible?

In use

RULES	TO THINK
1. Prevention is better than a cure 2. Maintenance schedule to be followed or else accept reduced design life consequences 3. Leaks to be dealt with as soon as recognised and engage with specialist to check impact of leak to the timber structure 4. Classic water management red flags are standing water on flat roofs, prolonged water leaks (waste or pipes), damp spots not investigated and blocked gutters or downpipes not attended to 5. Inform the design team if adverse change of building use is proposed that may increase the moisture levels	Is it time for maintenance? What is the lifespan of elements and should repairs be programmed before it is a problem? The designer should consider increasing the slope of minimum flat roof falls where the structure is sensitivity to moisture build up - such as where mass timber and wood boarded decks are present. Section 4.4 of BS6229 (Flat roofs with continuously supported flexible waterproof coverings) is considered not suitable and too little for timber flat roofs.

Above all understand and clarify the design and build responsibilities on a project

5. Responsibility for durability

Each project will have a different make up of professional designers, managers, quantity surveyors, buyers, constructors, material supply chain, specialists and building facilities management.

PERIOD	CLIENT	DESIGNER	MATERIAL/ PRODUCT SUPPLY CHAIN	FABRICATION SUPPLY CHAIN	CONSTRUCTION	BUILDING FACILITY MANAGERS
APPOINTING A COMPETENT PROFESSIONAL DESIGN TEAM	✓	Duty to warn				✓ In use
APPOINTING A COMPETENT TEAM FOR FABRICATION AND CONSTRUCTION	✓			Duty to warn	Duty to warn	✓ In use
DESIGNING FOR DURABILITY		✓	Duty to warn	Duty to warn	Duty to warn	
SPECIFICATION OF MATERIALS FOR DURABILITY		✓	✓	Duty to warn		
TECHNICAL SUPPORT ON DURABILITY			✓			
DUTY TO WARN OF VULNERABILITY AND LIMITATIONS		✓ Duty to warn	✓ Duty to warn	✓ Duty to warn	✓ Duty to warn	
QUALITY OF BUILD SPECIFICATION/ DETAIL		Check			✓	
HANDOVER OF ELEMENT TO WHICH YOU'RE RESPONSIBLE		✓	✓	✓	✓	
MAINTENANCE SCHEDULE		Specify				✓
UNDERTAKE MAINTENANCE						✓

Durability starts with the building client

Ensure the right appointment of a Principal Designer who will manage and monitor the design, including moisture management.

This also applies to the right appointment of a Principal Contractor who will have the structure and management process to ensure designs are carried out correctly in the build.

Check that the works are completed to project specification and that all possible impacts from moisture are removed prior to handover.

To understand that decisions may be needed to agree to comply with recommendations in the moisture strategy outcomes or accept in writing where a compromise may cause a moisture driven defect.

The steps and key parties to the strategy

STA STRATEGY STEPS IN LINE WITH RIBA PLAN OF WORK			
KEY PROJECT OUTPUTS; THE 7 STEPS	**LEAD PARTY TO PLAN AND MANAGE**	**REVIEW AND AGREEMENT**	**DUTY TO WARN**
STEP 1 Outline responsibility matrix	Principal Designer[1]		
STEP 2 Outline moisture management strategy	Principal Designer[1]		Engineers/ designers
STEP 3 Updated stage 3 moisture strategy document including 'what if' list of issues and risk mitigation	Principal Designer[1]	Principal Designer[1] pre-engagement	Contractor pre-engagement Supply chain Engineers/designers
STEP 4 Updated stage 4 moisture strategy document and risk mitigation check list	Principal Designer[1]	Principal Contractor[2]	Supply chain fabricators Engineers/designers
STEP 5 Manual for moisture management; audit trail and remedial action recorded	Principal Contractor[2]	Principal Designer[1]	Supply chain fabricators Engineers/designers
STEP 6 Carepoint document to handover to in use customer plus maintenance schedule hand over	Principal Designer[1]	Principal Contractor[2]	Engineers/designers
STEP 7 Care points on condition maintained	Facilities Management		Specialists engaged by the facilities management

Table 1: Seven steps of the STA moisture management strategy

1 *The term Principal Designer is used in line with CDM regulation (2015) terminology and in the context of the moisture management strategy the term includes other design management roles, for example lead designer, lead architect and design and build manager.*

2 *The term Principal Contractor is used in line with CDM regulation (2015) terminology role for the management of the construction phase, from which input from contractors working on the project under the Principal Contractor will be provided.*

RIBA stages - inputs to the process

RIBA PLAN OF WORK		
	RIBA STAGES DESCRIPTION	**REVIEW AND AGREEMENT**
STAGE 1 **Preparation and briefing**	Detailed requirements for the project brief	Durability objectives declared Design life target noted for building
STAGE 2 **Concept design**	Development of the design	Design life objective declared divided into key elements with sensitive items noted in the ***outline moisture strategy document***
STAGE 3 **Spatial co-ordination**	Integrate with the other design disciplines	***"What if?"*** Project team question durability impacts of design? Engage with feedback from Structural Timber Building supply chain
STAGE 4 **Technical design**	Final design period	Specific specifications and details for moisture management and durability Engage with feedback from structural timber building supply chain
STAGE 5 **Manufacturing and construction**	Production and construction period	Submission of statement of compliance or review/changes design and specification on moisture management
STAGE 6 **Handover**	Practical completion until the end of the defects period	Checklist and quality works sign off sheets, matched to moisture management details
STAGE 7 **In Use**	Operation of the building for the design life	Maintenance schedule programmed and updated Building alterations processed with new design team as appropriate

Table 2: Durability objectives

RIBA stages - inputs to the process cont.../

RIBA PLAN OF WORK		
	KEY MOISTURE MANAGEMENT	KEY MOISTURE MANAGEMENT OUTPUT (2)
STAGE 1 Preparation and briefing	Design life statement	
STAGE 2 Concept design	Outline moisture strategy document Scope of maintenance needed for an in-service responsibility matrix	Project responsibility matrix Project timber products, elements and assemblies with risks noted of where moisture may occur to produce outline risk mitigation checklist. Approval of moisture durability points of design
STAGE 3 Spatial co-ordination	Risk weighting output depending on consequence of the risk with consequent resolution of risks noted Design changes to protect as appropriate	***"What if?"*** workshop Engagement with feedback from structural timber building supply chain Add to the strategy document output of a ***"what if?"*** checks on the concept design Update risk mitigation checklist
STAGE 4 Technical design	Methodology statements to achieve design life Timber specification items Responsibility matrix updated with sub-contractor expectations	Feedback from structural timber building supply chain Likely defects in timber products, elements and assemblies that would occur if unacceptable levels of moisture are present Plan for moisture control and monitoring during construction Update risk mitigation checklist
STAGE 5 Manufacturing and construction	Onsite technical manual for moisture management for audit and management	Workshop to explain design and moisture management Update risk mitigation checklist Implement moisture control and monitoring during construction
STAGE 6 Handover	Key points signed off; check against ***"what if?"*** conditions	Maintenance schedule handed over
STAGE 7 In Use	Moisture monitoring	Maintenance schedule

Table 3: Outputs of the process

RIBA stages - inputs to the process cont.../

RIBA PLAN OF WORK	
	RIBA STAGES DESCRIPTION
STAGE 1 **Preparation and briefing**	Client, Principal Designer
STAGE 2 **Concept design**	Project design team to RIBA Stage 2 lead by Principal Designer Each discipline presents their key moisture management points assumed in the moisture strategy document as relevant to the concept Architect and project structural engineer inputs at a minimum
STAGE 3 **Spatial co-ordination**	Key team members Architect and project structural engineer inputs at a minimum Where appropriate for the scale and complexity of the project structural timber building supply chain
STAGE 4 **Technical design**	Project design team to RIBA Stage 4 lead by Principal Designer Where appropriate for the scale and complexity of the project structural timber building supply chain
STAGE 5 **Manufacturing and construction**	Project design team to RIBA Stage 5 lead by Principal Designer Structural timber building supply chain Appointed persons for checks on compliance
STAGE 6 **Handover**	Key persons all confirm sign-off allocated to of their areas of durability work Structural timber building supply chain
STAGE 7 **In Use**	Facilities management

Table 4: Parties to the process

Moisture management guidance

There are many guidance books, papers and sources of design and construction good practice to avoid moisture defects which will provide useful information to those responsible for the moisture management strategy.

Documents available from the Structural Timber Association

Advice Note 2 - Design life

Advice Note 3 - Introduction the construction of commercial timber frame

Advice Note 4.2 - Sole plate tolerances

Advice Note 4.3 - Timber frame wall tolerances

Advice Note 5.1 - Podium support structures

Advice Note 10 - Separating walls

Advice Note 12.1 - Specifying metal fasteners

Advice Note 14 - CLT key principles

Technical Note 19 - STA Assure engineering procedures

Technical Note 23 - Durability by design

Technical Note 24 - Moisture protection during construction

Technical Note 31 - Vocabulary of roles

Differential movement in platform timber frame

Living in a timber frame house

Pocket guides (timber frame and SIPs)

Documents available from BM TRADA

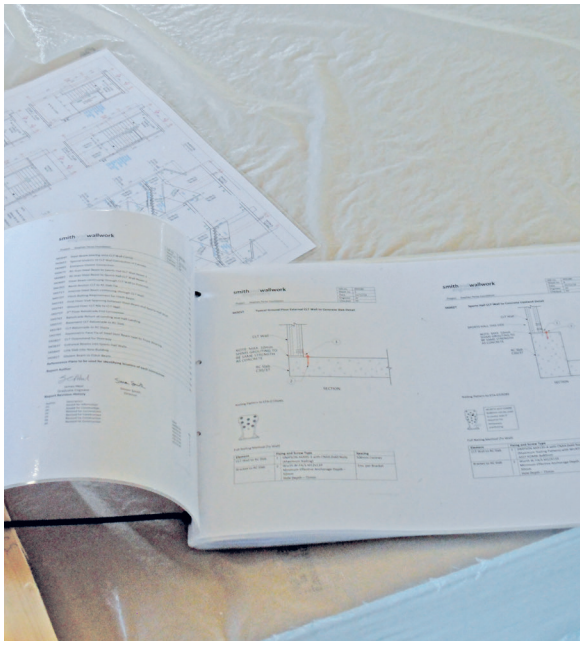
Wood information sheet WIS 4-14, Moisture in timber

Wood information sheet WIS 4-28, Durability by design

Timber Frame Construction 5th edition

British Standards documents

BS6229:2018 Flat roofs with continuously supported flexible waterproof coverings



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