

A vertical bar on the left side of the slide, transitioning from yellow at the top to blue in the middle and green at the bottom.

**STA Technical Conference May 24<sup>th</sup> 2023**

Technical Challenges facing our industry

Martin Milner

Technical Consultant

# Fire Safety Wood in Construction

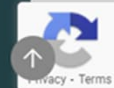
This site is suitable for a wide range of users, with technical information levels 1 and 2 available on closed toggles.

Technical level 1

Technical level 2

## LATEST NEWS

- One month until the Wood Awards 2023 Close
- Performance figures make encouraging reading for 2023, says latest CPA survey
- Constructing fire-safe timber buildings
- Softwood imports resilient in early 2023, says TDUK



# Fire Safety Wood in Construction

This site is suitable for a wide range of users, with technical information levels 1 and 2 available on closed toggles.

Technical level 1

Technical level 2

## Key elements of Designing for fire safety



Reaction-to-fire performance



Load-bearing structures











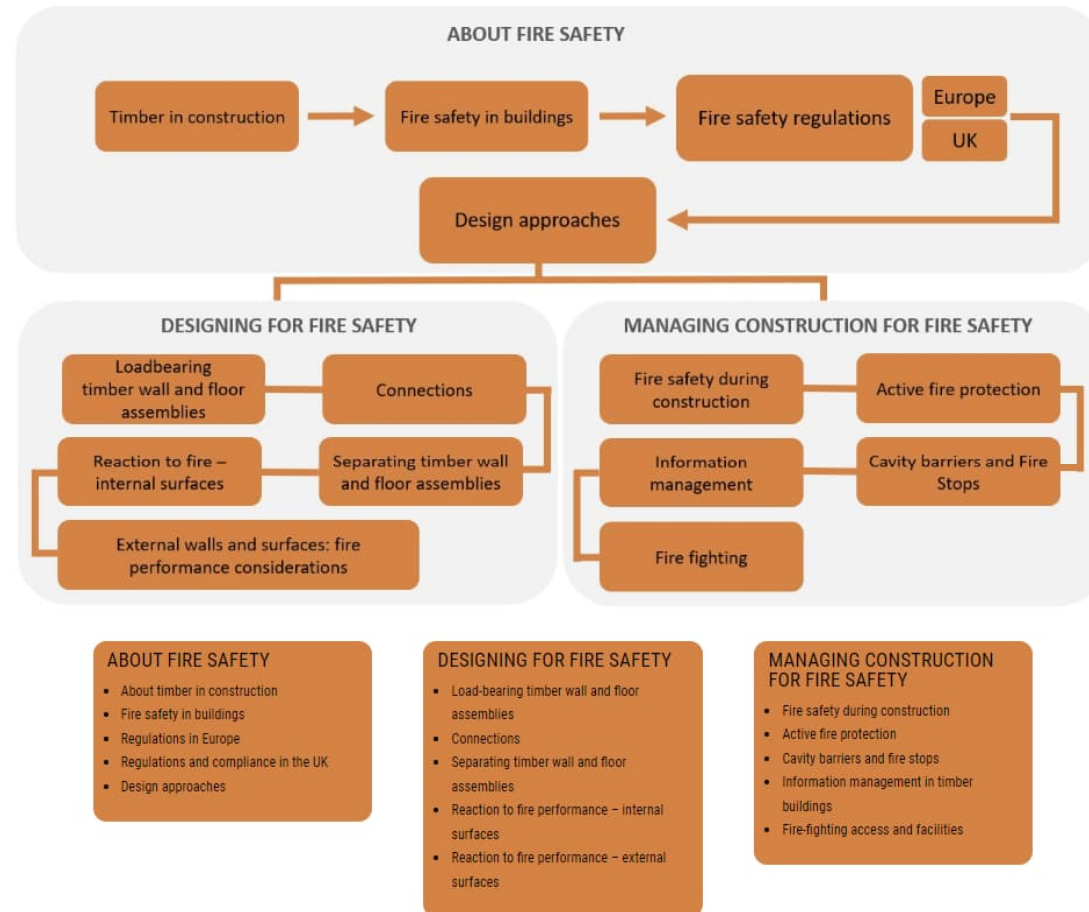
Connections



Separating construction

Fire safety is complex. Although this site allows you to navigate to specific areas, we recommend you visit all sections to get a thorough understanding of the subject – see [this site map](#) for a visual flow of information on the site.

Users	Technical level 1	Technical level 2
<b>Design</b> Architects, structural engineers, fire engineers and structural fire engineers		
<b>Construction</b> Timber-specific and fire product supply chain for timber construction, and contractors		
<b>Regulation</b> Building Control, LABC (UK), standardisation and regulators		
<b>Clients/project management</b> Developers, owners, mortgage lenders, insurers, architects and project managers		
<b>Fire brigade</b>		



## ABOUT FIRE SAFETY

Timber in construction

Fire safety in buildings

Fire safety regulations

Europe

UK

Design approaches

performance considerations

fire fighting

### ABOUT FIRE SAFETY

- About timber in construction
- Fire safety in buildings
- Regulations in Europe
- Regulations and compliance in the UK
- Design approaches

### DESIGNING FOR FIRE SAFETY

- Load-bearing timber wall and floor assemblies
- Connections
- Separating timber wall and floor assemblies
- Reaction to fire performance – internal surfaces
- Reaction to fire performance – external surfaces

### MANAGING CONSTRUCTION FOR FIRE SAFETY

- Fire safety during construction
- Active fire protection
- Cavity barriers and fire stops
- Information management in timber buildings
- Fire-fighting access and facilities

## DESIGNING FOR FIRE SAFETY

Load bearing  
timber wall and floor  
assemblies

Connections

Reaction to fire –  
internal surfaces

Separating timber wall  
and floor assemblies

External walls and surfaces: fire  
performance considerations

## MANAGING CONSTRUCTION FOR FIRE SAFETY

Fire safety during  
construction

Active fire protection

Information  
management

Cavity barriers and Fire  
Stops

Fire fighting

## ABOUT FIRE SAFETY

- About timber in construction
- Fire safety in buildings
- Regulations in Europe
- Regulations and compliance in the UK
- Design approaches

## DESIGNING FOR FIRE SAFETY

- Load-bearing timber wall and floor assemblies
- Connections
- Separating timber wall and floor assemblies
- Reaction to fire performance – internal surfaces
- Reaction to fire performance – external surfaces

## MANAGING CONSTRUCTION FOR FIRE SAFETY

- Fire safety during construction
- Active fire protection
- Cavity barriers and fire stops
- Information management in timber buildings
- Fire-fighting access and facilities



## ABOUT FIRE SAFETY

- external fires (commonly starting on a balcony) traveling through the eave
- cavity fires traveling to the attic

- Design approaches

## DESIGNING FOR FIRE SAFETY

- assemblies
- Reaction to fire performance - internal

## MANAGING CONSTRUCTION FOR FIRE SAFETY

- Fire safety during construction
- Active fire protection
- Cavity barriers and fire stops
- Information management in timber buildings
- Fire fighting access and facilities

### Fire statistics (Technical level 1)

The fire statistics collated for the year end March 2022, concluded 'nearly one third (30%) of dwelling fires had no fire damage, in around a third (33%) the damage was limited to the item first ignited and in roughly a quarter (24%) the damage was limited to the room of origin. The remaining 14 per cent of dwelling fires were larger fires, either "limited to floor of origin", "limited to 2 floors", "affecting more than 2 floors", "limited to roofs and roof spaces" or the "whole building'. (*FIRE0203*).

- Fire spread through the attic to large parts of the building.
- Fire spread along the facade entering the building (most commonly into the attic).
- Fire spread through wall and floor cavities.

- external fires (commonly starting on a balcony) traveling through the eave
- cavity fires traveling to the attic

## ABOUT FIRE SAFETY

- Fire spread through
- Fire spread along
- Fire spread through

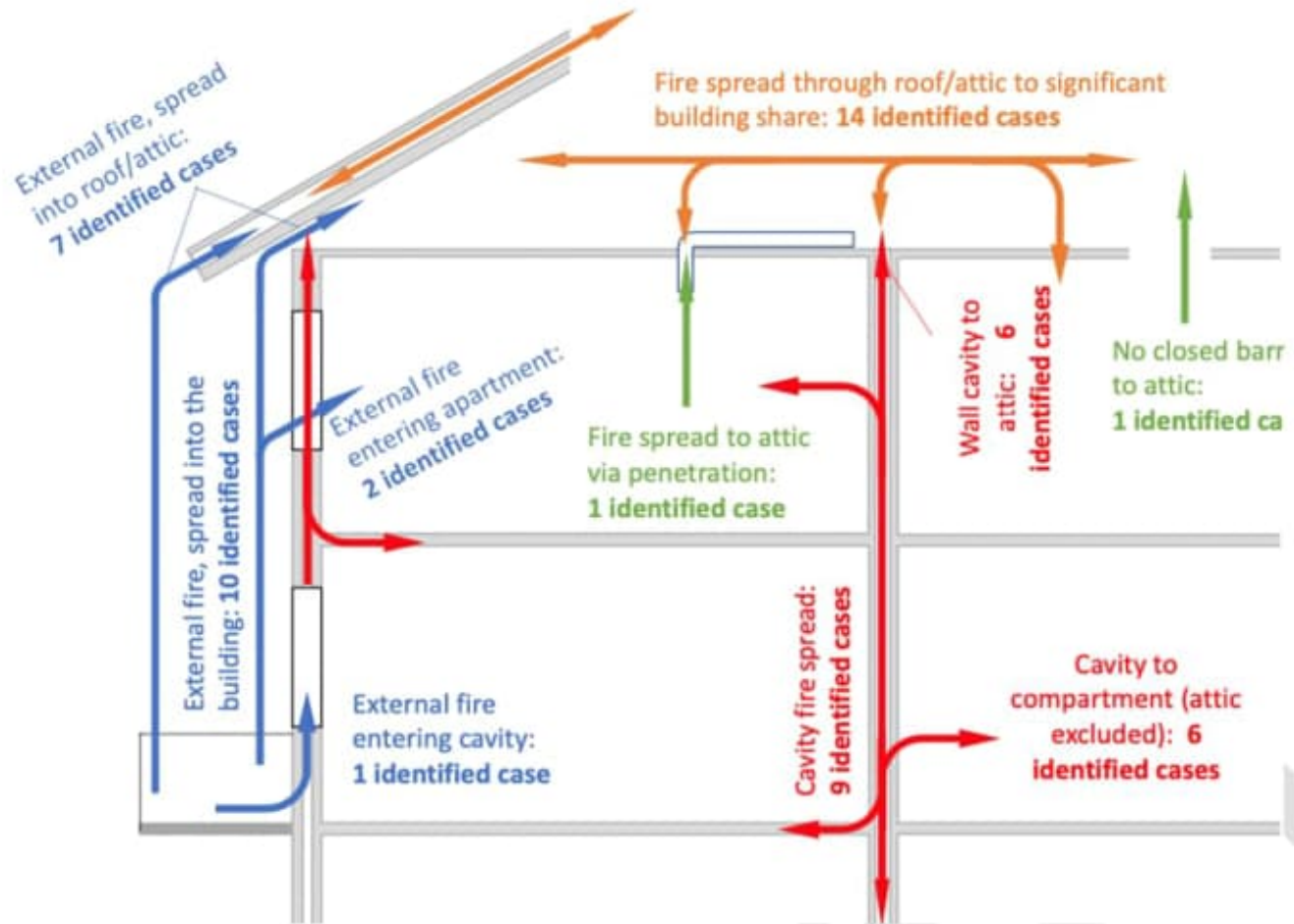
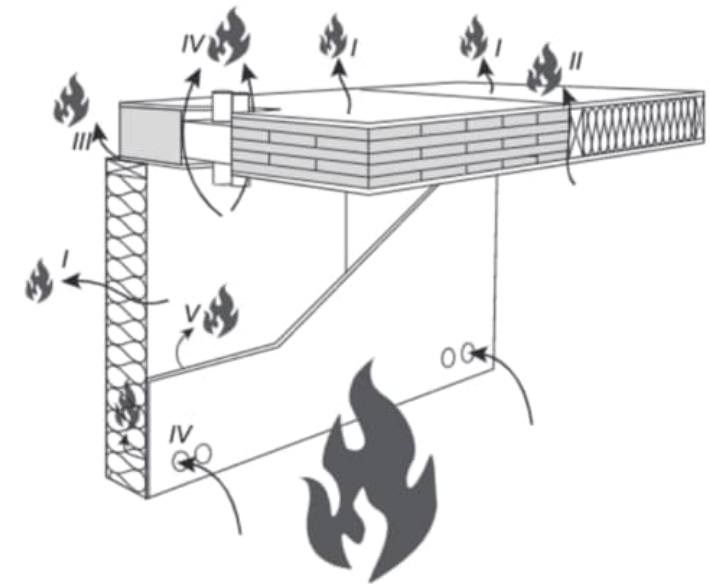


Figure 3: Identified paths of fire spread in fires that involved at least three fire compartments.

1. Through separating elements, typically walls and floors of a building
2. Through joints between separating elements to neighbouring compartments and associated construction tolerances
3. Through junctions between building parts or intersections
4. Through building services, penetrations and openings
5. Through concealed construction cavities

#### Specific considerations for timber construction

In addition to guidance in the Building regulations, other publications are available: for example for lower rise construction, *The Structural Timber Association Fire Safety In use guidance Volume 2 – Cavity barriers and fire stopping*



- *Fires in cavities in residential buildings* (2013) The performance of cavities barriers in external walls with combustible materials, NHBC Foundation, 2013
- *Design principles for fire safe detailing in timber structures* (2020), Werther N. et al World Conference of Timber Engineering Santiago, Chile

## Load-bearing assemblies

- Charring and verification of load-bearing capacity

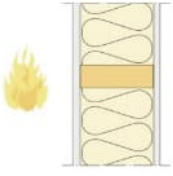
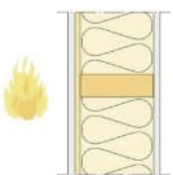
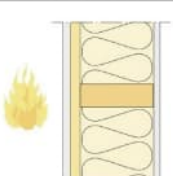
## European standards

- Timber frame floor and wall assemblies
- Structural stability at fire exposure

## Load-bearing timber wall and floor assemblies

Glass wool (T)


[Return to the top](#)

REI 60			Load-bearing capacity at fire [kN]				
Cladding	Cross section [mm]	Insulation	Strength class of timber				
			C14	C16	C18	C24	C30
<b>GtF</b>			Cladding failure time $t_f = 55$ min				
	45 x 95	Glass wool	–	–	–	–	–
	45 x 120	Glass wool	–	–	–	–	–
	45 x 145	Glass wool	–	–	–	–	–
	45 x 195	Glass wool	10.4	11.1	11.6	12.1	12.0
	45 x 220	Glass wool	20.0	21.1	21.8	22.6	22.4
<b>GtF + WB10</b>			Gypsum failure time $t_f = 55$ min				
	45 x 95	Glass wool	–	–	–	–	–
	45 x 120	Glass wool	0.3	0.3	0.3	0.4	0.4
	45 x 145	Glass wool	2.9	3.1	3.3	3.5	3.4
	45 x 195	Glass wool	19.6	20.7	21.4	22.1	22.0
	45 x 220	Glass wool	24.5	25.9	26.8	27.7	27.5
<b>GtF + WB20</b>			Gypsum failure time $t_f = 55$ min				
	45 x 95	Glass wool	–	–	–	–	–
	45 x 120	Glass wool	4.7	5.1	5.3	5.6	5.5
	45 x 145	Glass wool	14.2	15.1	15.6	16.3	16.1
	45 x 195	Glass wool	27.0	28.5	29.4	30.5	30.3
	45 x 220	Glass wool	32.0	33.7	34.8	36.1	35.8

## Load-bearing timber wall and floor assemblies

6.8

[Return to the top](#)

	45 x 220	Glass wool	7.2	8.2	9.1	11.2	12.1
---	----------	------------	-----	-----	-----	------	------

Note: For walls, buckling around the weak axis of the stud may be relevant and in these cases the values are given as italics.

Table 5: Characteristic load-bearing capacity at fire from one side for CLT walls (Technical level 2)

Table 6: Load-bearing capacity at fire for floors insulated with stone wool (Technical level 2)

Table 7: Load-bearing capacity at fire for floors insulated with glass wool (Technical level 2)

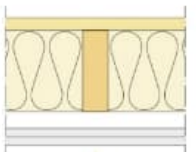
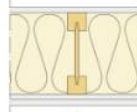

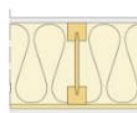
REI 60			Load-bearing capacity at fire [kN]				
Cladding	Cross section [mm]	Insulation	Strength class of timber				
			C14	C16	C18	C24	C30
GtF + GtF + void Particle board 22 mm on non-exposed side			Cladding failure time $t_f = 60$ min				
	45 x 145	Glass wool	1.37	1.57	1.76	2.35	2.94
	45 x 195	Glass wool	2.85	3.25	3.66	4.88	6.10
	45 x 220	Glass wool	3.78	4.32	4.86	6.48	8.10

Table 8: Load-bearing capacity at fire for floors with I-joists insulated with stone wool (Technical level 2)

## Load-bearing timber wall and floor assemblies

[Return to the top](#)

Table 8: Load-bearing capacity at fire for floors with I-joists insulated with stone wool (Technical level 2)

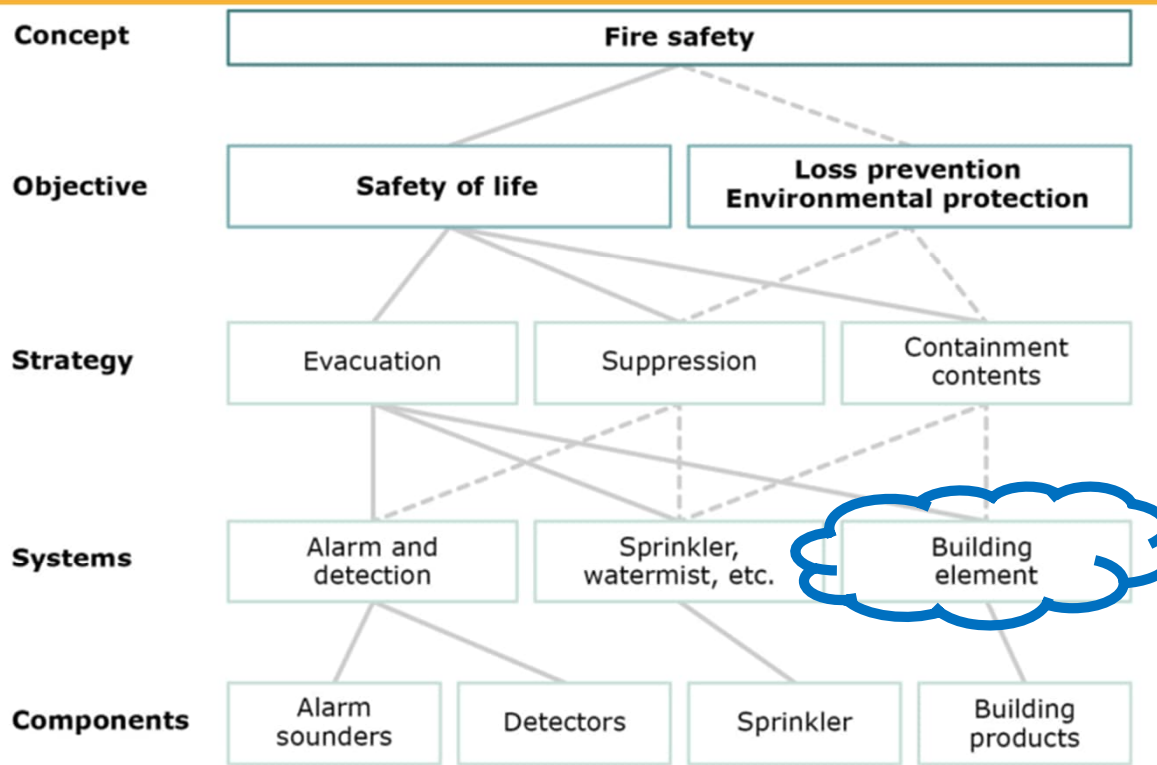
REI 60			Load-bearing capacity at fire [kN]	
Cladding	Cross section [mm]	Insulation	Strength class of timber	
			C24	C30
GtF + GtA			Cladding failure time $t_f = 55$ min	
	H150	Stone wool	1.34	1.7
	H200	Stone wool	2.04	2.61
	H250	Stone wool	2.80	3.59
	H300	Stone wool	3.62	4.63
	H350	Stone wool	4.49	5.73
GtF + GtF			Cladding failure time $t_f = 60$ min	
	H150	Stone wool	1.37	1.8
	H200	Stone wool	2.08	2.67
	H250	Stone wool	2.86	3.67
	H300	Stone wool	3.69	4.72
	H350	Stone wool	4.57	5.84
GtF + WB10			Gypsum failure time $t_f = 35$ min	
	H150	Stone wool	0.21	0.3
	H200	Stone wool	0.35	0.44
	H250	Stone wool	0.63	0.79
	H300	Stone wool	1.02	1.28
	H350	Stone wool	1.49	1.88

Differences in UK and European views on protection of structures (Technical level 2)

The above calculation methods/build-ups are not available to designers in the UK.

In the UK it is common for specifiers to use manufacturers' guidance for composite build-ups, which have been confirmed by testing.

It is important to note that testing will apply to the tested configuration only and cannot be assumed to cover even minor variations in set-up. Test houses and supply chain partners can be consulted for guidance.









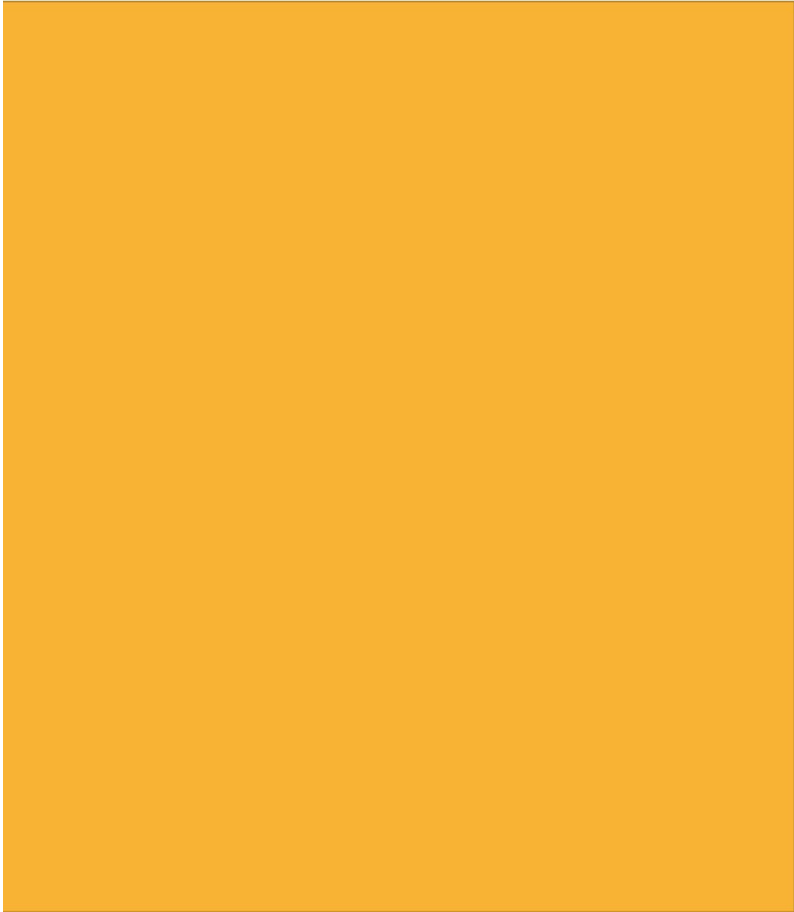
Predominant design approach	Prescriptive	Prescriptive	PB <sup>1</sup>	PB	PB
Property protection requirements <sup>2</sup>	Unlikely	Some <sup>3</sup>		Yes	Yes
Fire fighting strategy (incl. need for assisted escape)	Unlikely	No <sup>3</sup>	Yes	Yes	Yes
					
	Low-rise <11 m top storey floor	Mid-rise with some complexities 11 – 18 m top storey floor		Tall with some complexities 18 – 30 m top storey floor	Very tall and complex >30 m top storey floor

Figure 1: Influencing factors for Prescriptive and Performance-based design

Note 1: Performance-based design (PB)

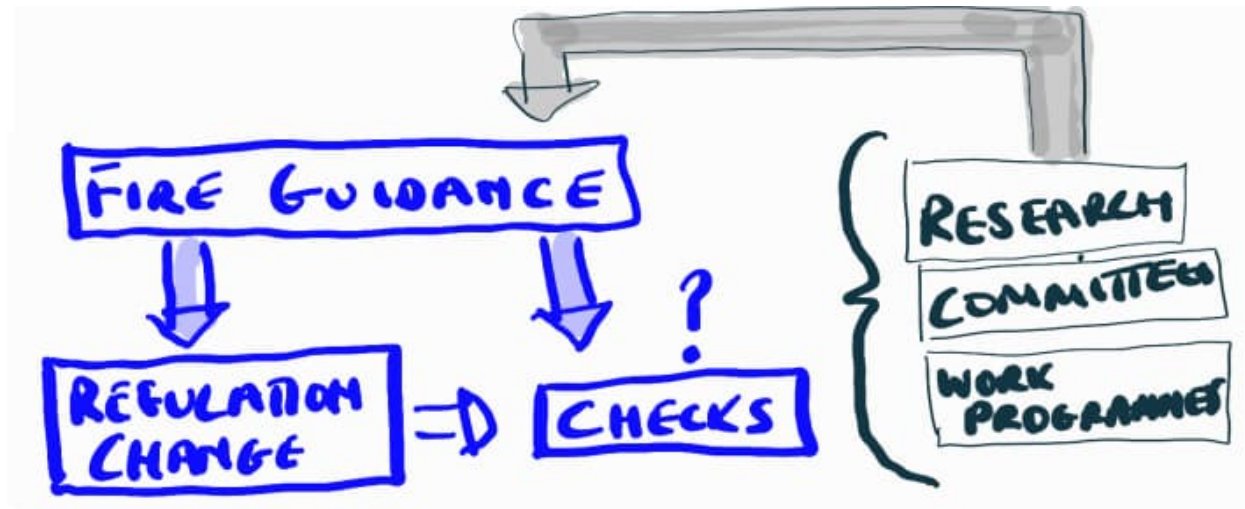
Note 2: Subject to the insurance requirements of the project

Note 3: The most appropriate design approach will depend on building type and use. In this application, a combination of design approaches is common









CONFUSION



FIRE RESISTANCE

BUILDING REGULATION

FIRE ENGINEERING

STATUTORY GUIDANCE

APPENDIX B

STANDARD FURNACE TESTING → ASSEMBLY TESTS → THROUGH THE ASSEMBLY

MINIMUM VALUES OF FIRE RESISTANCE



DESIGN PROCESS



PROJECT STRUCTURAL FIRE SAFETY OBJECTIVE

PROJECT WALLS, FLOOR, ROOF FIRE SAFETY REQUIREMENTS

MATCH ASSEMBLY TO TEST ASSEMBLY

✓ TEST RESULT ≥ MINIMUM ASSEMBLY VALUE

# Fire Safety

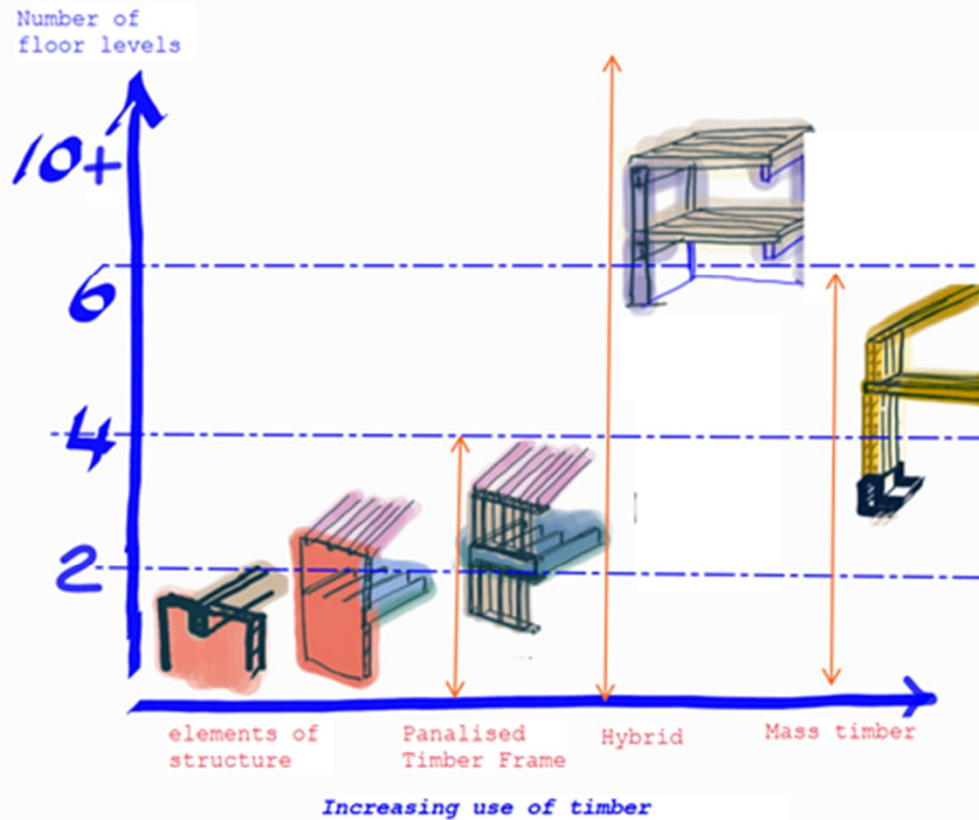


BS 9991:2015



BSI Standards Publication

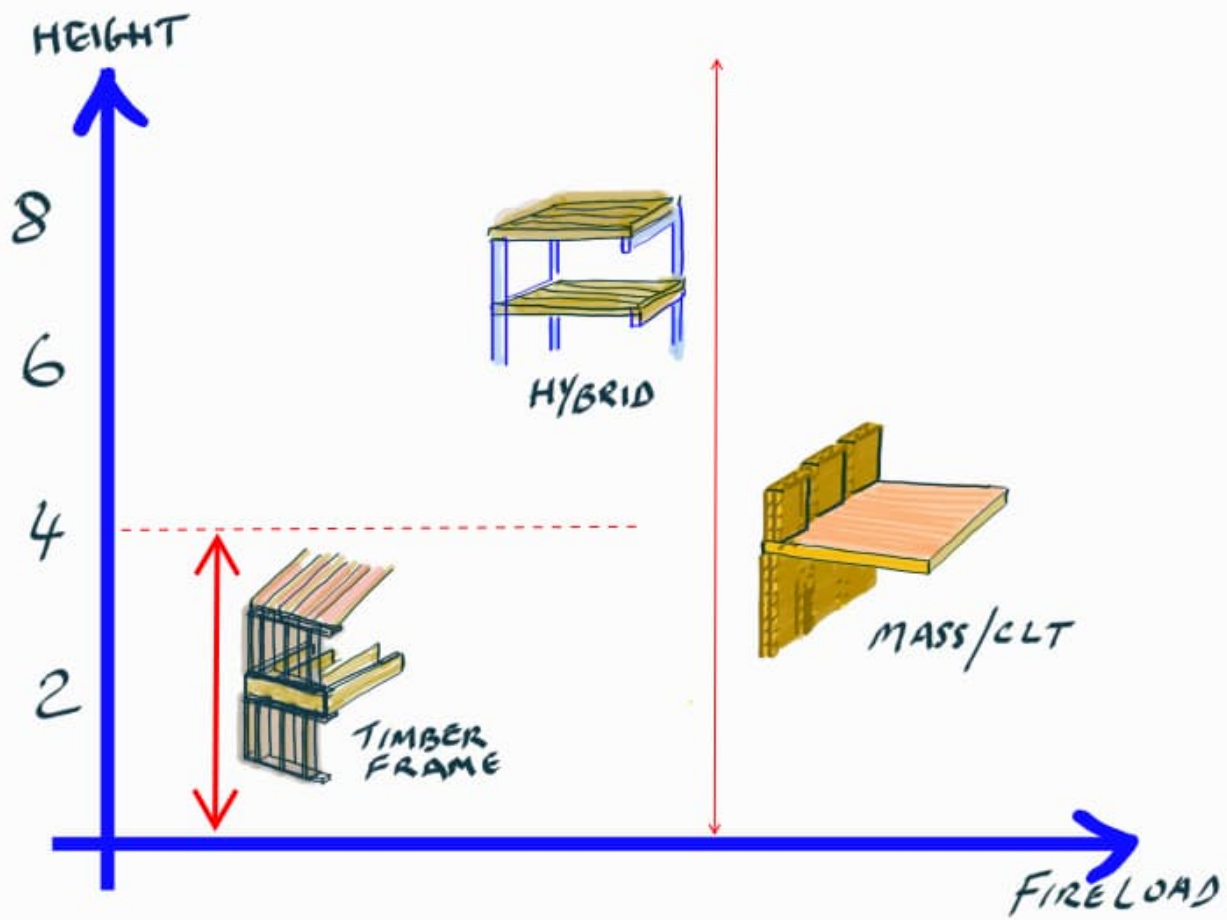
Fire safety in the design, management and use of residential buildings. Code of practice



bsi.

...making excellence a habit™







# Structural Fire Safety





### B3 (1) Internal fire spread (structure)

The building shall be designed and constructed so that, in the event of fire, its stability will be maintained for a reasonable period

Structural (fire) safety objective

Provision of adequate time cognisant of building size and use

Adequate likelihood of surviving burn-out

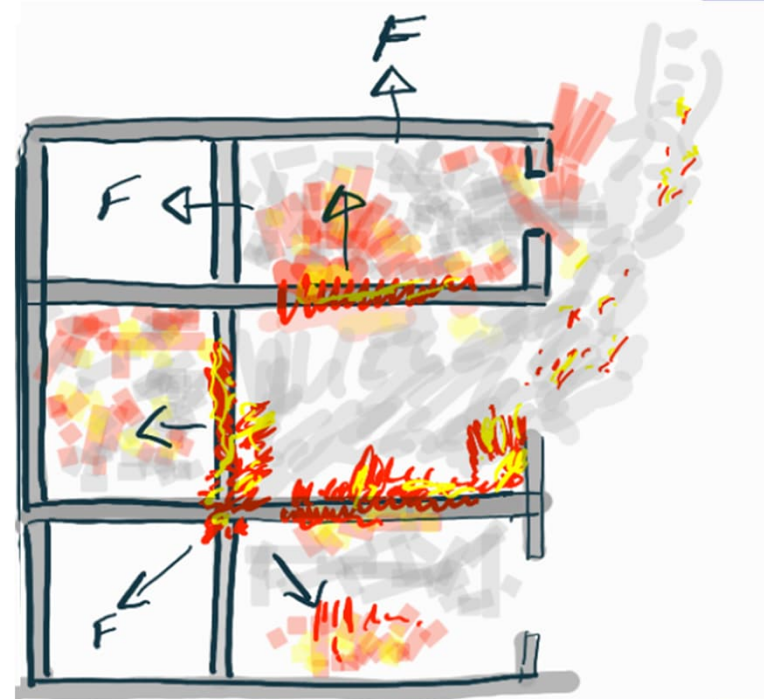
### B3 (1) Internal fire spread (structure)

The building shall be designed and constructed so that, in the event of fire, its stability will be maintained for a reasonable period

Structural (fire) safety objective

Provision of adequate time cognisant of building size and use


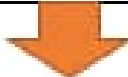


Adequate likelihood of surviving burn-out







# fire resistance strategy for residential buildings

What is the Consequence class of structure

*Consequence class to EN 1991 1-7*

Consequence class 1	Consequence class 2a	Consequence class 2b	Consequence class 3
			
<b>Prescriptive approach</b>	Prescriptive approach <b>likely</b> to be acceptable	Prescriptive approach <b>may not</b> be suitable and is to be checked against user and escape strategy	Not suitable for external walls Performance design for internal elements

## What is the use of the building

Single dwelling	Multi occupancy - Below 11m upper floor level	Multi occupancy but no greater than 18m upper floor level	Multi occupancy
			
<b>Prescriptive approach</b>	Prescriptive approach <b>likely</b> to be acceptable	Prescriptive approach <b>may not</b> be suitable and is to be checked against user and escape strategy	Not suitable for external walls Performance design for internal elements



# ADB changes

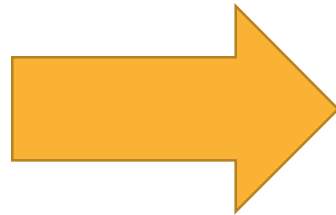
Pre 2023  
And all  
Other states

**Table B3 Specific provisions of the test for fire resistance of elements of structure, etc.**

Part of building	Minimum provisions when tested to the relevant European standard (minutes) <sup>(1)</sup>	Alternative minimum provisions when tested to the relevant part of BS 476 <sup>(2)</sup> (minutes)			Type of exposure
		Loadbearing capacity <sup>(3)</sup>	Integrity	Insulation	
1. <b>Structural</b> frame, beam or column.	R see Table B4	See Table B4	Not applicable	Not applicable	Exposed faces
2. <b>Loadbearing wall</b> (which is not also a wall described in any of the following items).	R see Table B4	See Table B4	Not applicable	Not applicable	Each side separately

**Table B5 Continued**

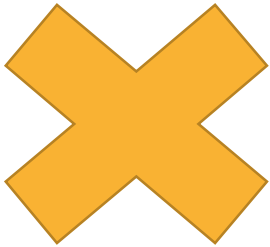
Part of building	Minimum provisions when tested to the relevant European standard (minutes) <sup>(1)</sup>	Alternative minimum provisions when tested to the relevant part of BS 476 <sup>(2)</sup> (minutes)			Type of exposure
		Loadbearing capacity <sup>(3)</sup>	Integrity	Insulation	
<b>5. External walls</b>					
a. any part a maximum of 1000mm from any point on the relevant boundary <sup>(6)</sup>	REI see Table B4	See Table B4	See Table B4	See Table B4	Each side separately
b. any part a minimum of 1000mm from the relevant boundary <sup>(6)</sup>	RE see Table B4 and I 15	See Table B4	See Table B4	15 min	From inside the building
c. any part beside an external escape route (Section 2, Diagram 2.7 and Section 3, Diagram 3.11).	RE 30	30 min	30 min	No provision <sup>(7) (8)</sup>	From inside the building



Jan 2023

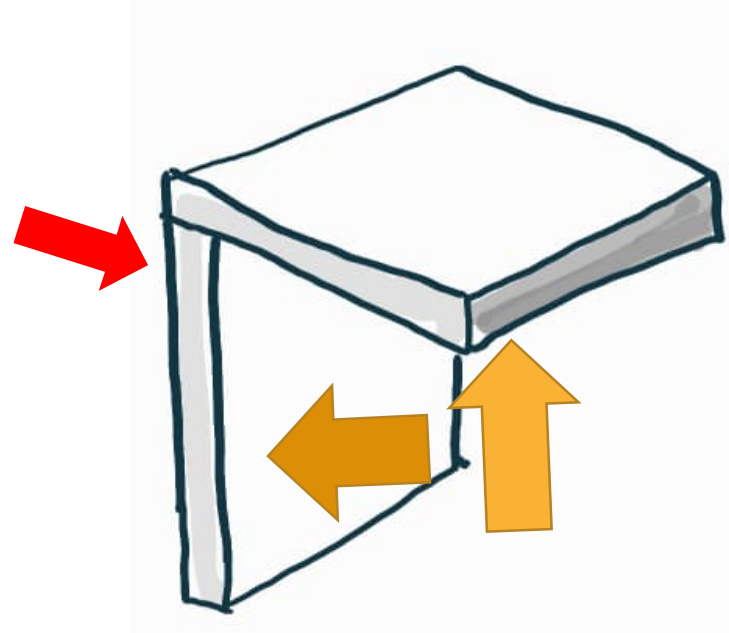
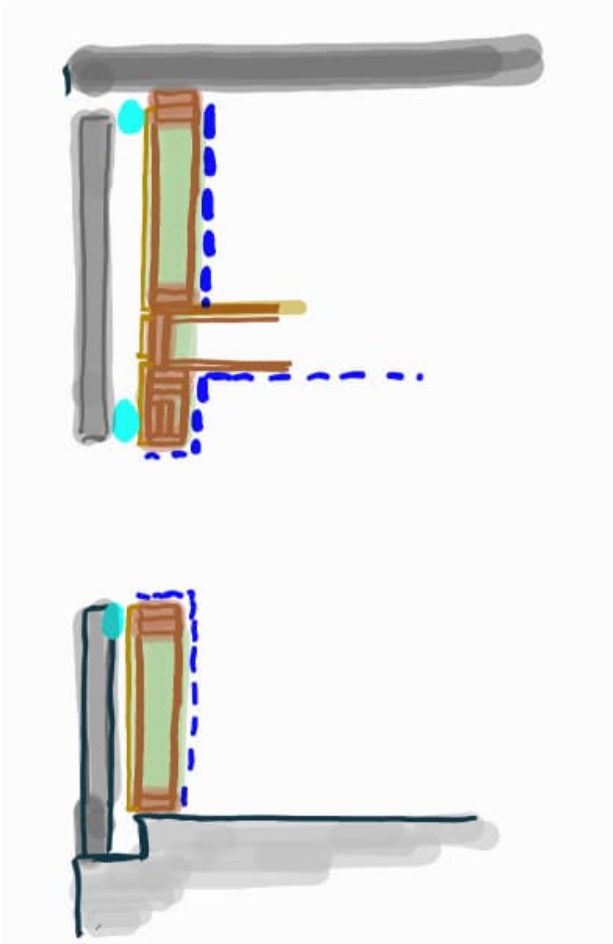
**Table B3 Specific provisions of the test for fire resistance of elements of structure, etc.**

Part of building	Minimum provisions when tested to the relevant European standard (minutes) <sup>(1)</sup>	Alternative minimum provisions when tested to the relevant part of <b>BS 476</b> <sup>(2)</sup> (minutes)			Type of exposure
		Loadbearing capacity <sup>(3)</sup>	Integrity	Insulation	
1. <b>Structural</b> frame, beam or column.	R see Table B4	See Table B4	Not applicable	Not applicable	Exposed faces
2. <b>Loadbearing wall</b> (for a wall which is also described in any of the following items, the more onerous guidance should be applied).	R see Table B4	See Table B4	Not applicable	Not applicable	Each side separately

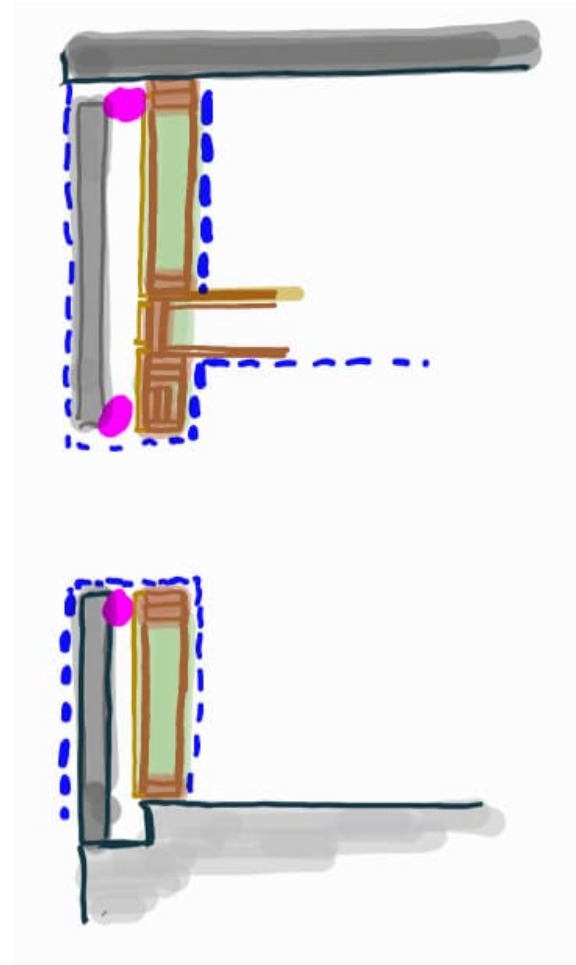
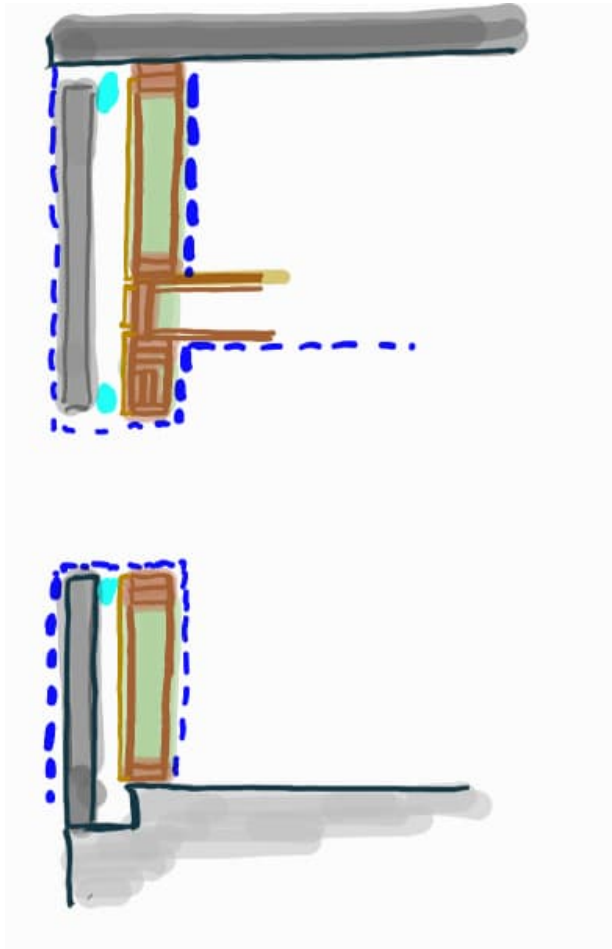


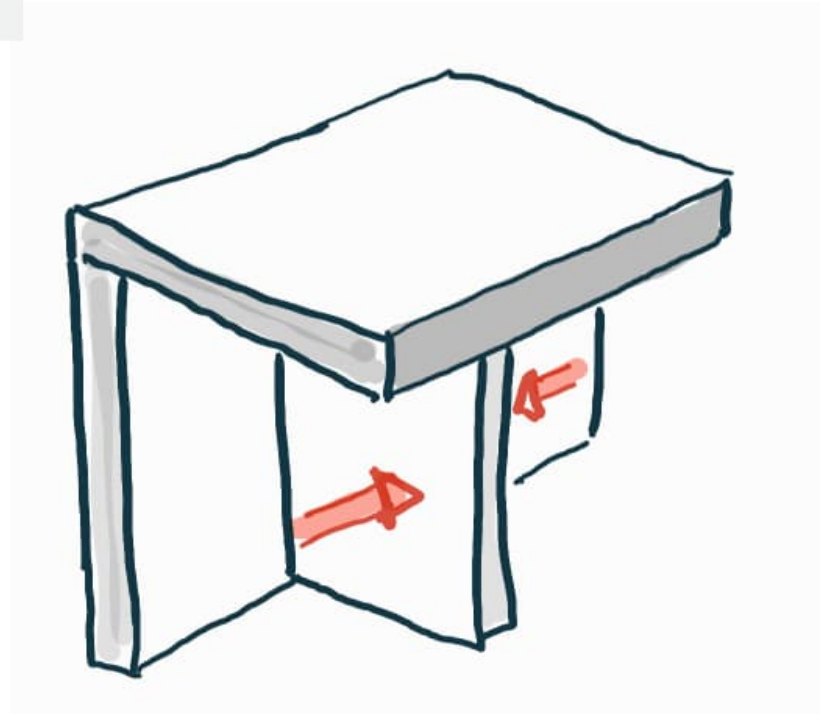
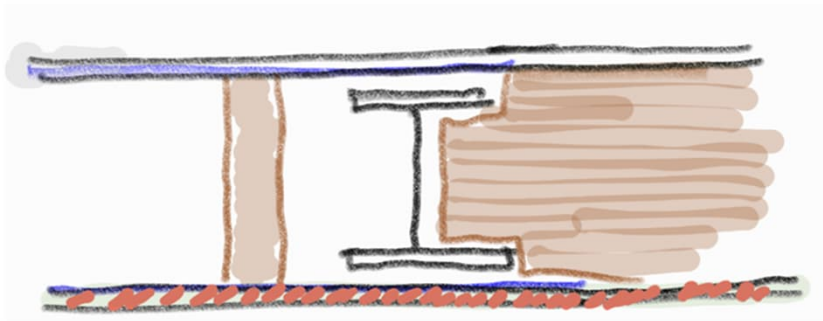
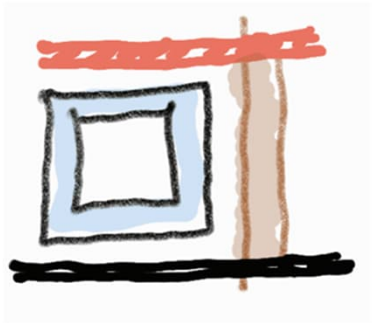
**Table B3 Continued**

Part of building	Minimum provisions when tested to the relevant European standard (minutes) <sup>(1)</sup>	Alternative minimum provisions when tested to the relevant part of <b>BS 476</b> <sup>(2)</sup> (minutes)			Type of exposure
		Loadbearing capacity <sup>(3)</sup>	Integrity	Insulation	
<b>5. External walls</b>					
a. any part a maximum of 1000mm from any point on the relevant boundary <sup>(6)</sup>	REI see Table B4	See Table B4	See Table B4	See Table B4	Each side separately
b. any part a minimum of 1000mm from the relevant boundary <sup>(6)</sup>	RE see Table B4 and I 15	See Table B4	See Table B4	15 min	From inside the building
c. any part beside an external escape route (Section 2, Diagram 2.7 and Section 3, Diagram 3.11).	RE 30	30 min	30 min	No provision <sup>(7) (8)</sup>	From inside the building









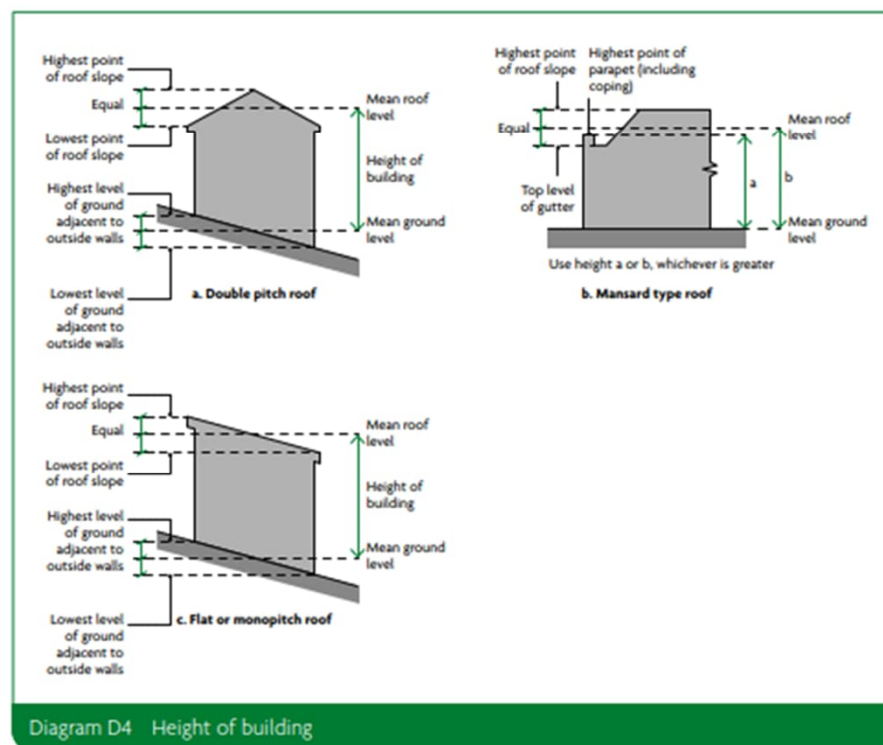
## External surfaces

floor or building ?

10.5 The external surfaces (i.e. outermost external material) of external walls should comply with the provisions in Table 10.1. The provisions in Table 10.1 apply to each wall individually in relation to its proximity to the relevant boundary.

**Table 10.1 Reaction to fire performance of external surface of walls**

Building type	Building height	Less than 1000mm from the relevant boundary	1000mm or more from the relevant boundary
'Relevant buildings' as defined in regulation 7(4) (see paragraph 10.14)		Class A2-s1, d0 <sup>(1)</sup> or better	Class A2-s1, d0 <sup>(1)</sup> or better
All 'residential' purpose groups (purpose groups 1 and 2)	More than 11m	Class A2-s1, d0 <sup>(2)</sup> or better	Class A2-s1, d0 <sup>(2)</sup> or better
	11m or less	Class B-s3, d2 <sup>(2)</sup> or better	No provisions
Assembly and recreation	More than 18m	Class B-s3, d2 <sup>(2)</sup> or better	From ground level to 18m: class C-s3, d2 <sup>(2)</sup> or better From 18m in height and above: class B-s3, d2 <sup>(2)</sup> or better
	18m or less	Class B-s3, d2 <sup>(2)</sup> or better	Up to 10m above ground level: class C-s3, d2 <sup>(2)</sup> or better



# Insurance



# Project Questionnaire for Builder's Risk Insurance

## About RISCAuthority

RISCAuthority is a research scheme administered by the Fire Protection Association and supported by many UK insurers which, through the operation of its technical working groups, seeks to support measures that improve and promote property and business resilience measures.

The Massive Timber Working group was formed to analyse, address, and communicate the insurance challenges that these newer proposed building methods give rise to with a view to assisting future dialogue in creating buildings that meet all needs of safety, carbon reduction, and resilience to the insured perils of fire, escape of water and flood.



## Insurance challenges of massive timber construction and a possible way forward



David Wilson  
Chairman of RISCAuthority

“It should not be a surprise that insurance models and insurance customer expectations developed around historic solid walled, non-combustible construction types, may need to alter quite radically to address these very substantial changes in construction methods and material use.”



## 1. Resilience Strategy Definition



COMPLIANCE

INSURANCE

CLIENT



# Unintended consequences

# CONCERNS:

## FIRE SPREAD

SMALL FIRE GROWTH INTO A LARGE FIRE

## ↳ REACTION TO FIRE

LARGE FIRE GROWTH BEYOND COMPARTMENT OF ORIGIN

## ↳ FIRE RESISTANCE



Structural timber buildings fire safety in use guidance Volume 1 - Pattern book systems

Structural timber buildings fire safety in use guidance Volume 2 - Cavity barriers and fire stopping STA fire safety research and guidance project Revision v1.1 March 2020



Structural timber buildings fire safety in use guidance Volume 6 - Mass timber structures; Building Regulation compliance B3(1)

STA fire safety research and guidance project Version 2.0 - April 2023



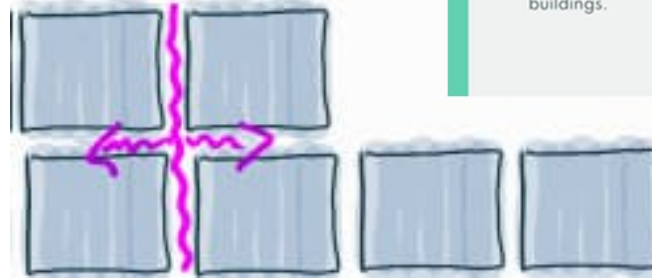
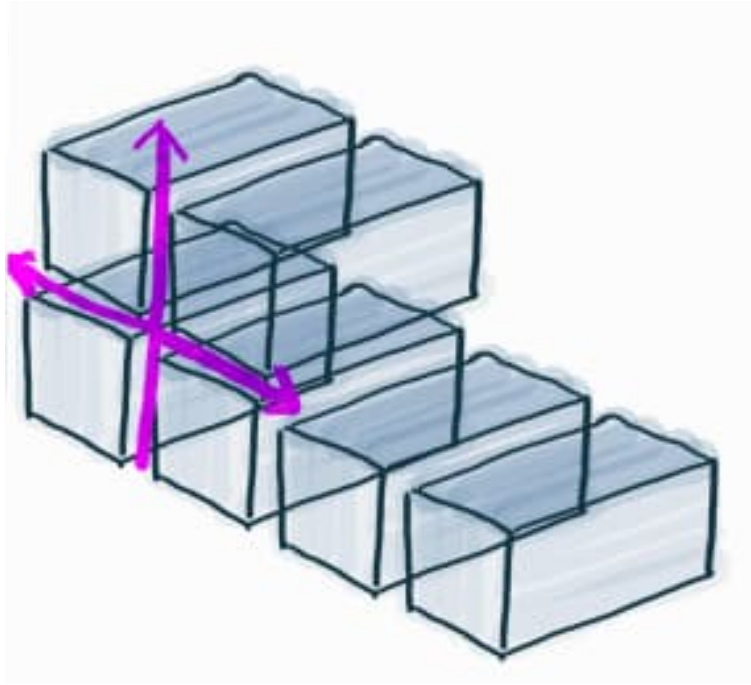
STA Advice Note 7 Robustness against fire



No.7, Part 3 - June 2021

### Part 3 - Fire Safety Strategy (FSS) for structural timber buildings

- This forms part of Advice Note 7 on structural timber building robustness against fire. Advice Note 7 comprises:
  - Part 1 - Design concepts for the in-service life of the building
  - Part 2 - Structural timber external wall compliance route for fire safety
  - Part 3 - Fire Safety Strategy (FSS) for structural timber buildings (this document)
  - Part 4 - Fire safety of façade systems for structural timber buildings
  - Part 5 - Design of escape distances during the construction process.



 CROSS UK

### Volumetric modular buildings and fire

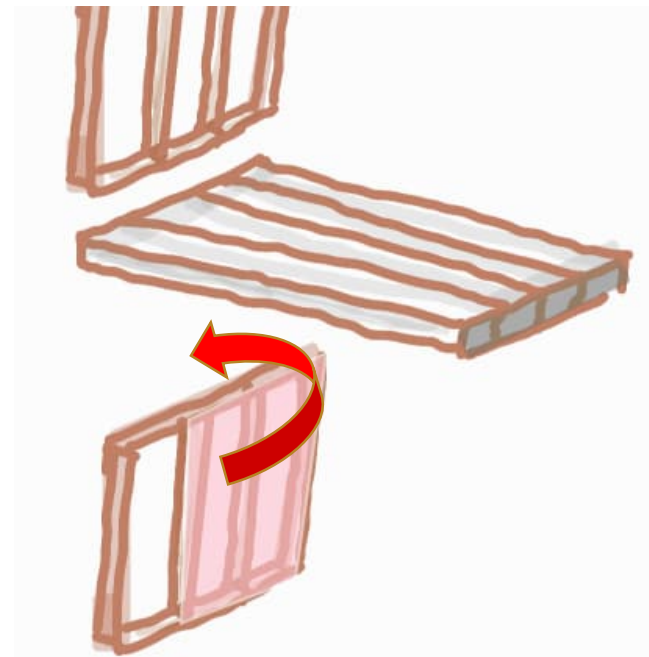
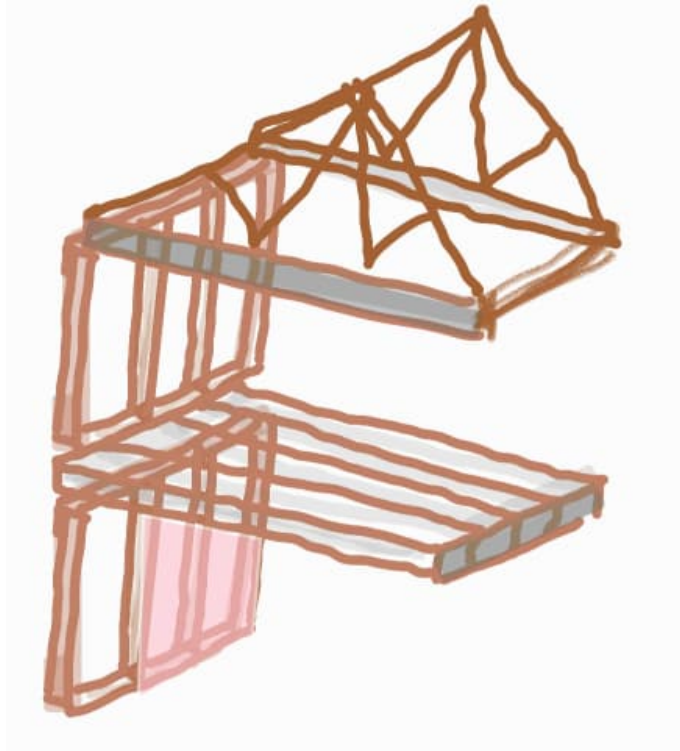
Report ID: 1065

A report has been received concerning volumetric modular construction, in the form of permanent stacked modular buildings.

#SaferStructures

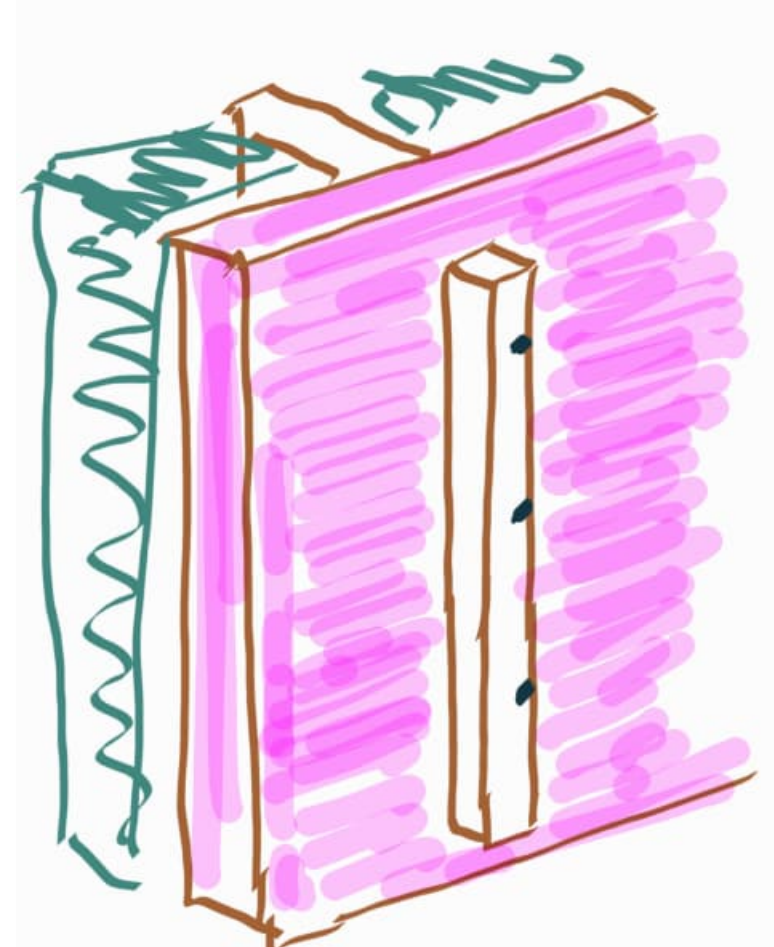
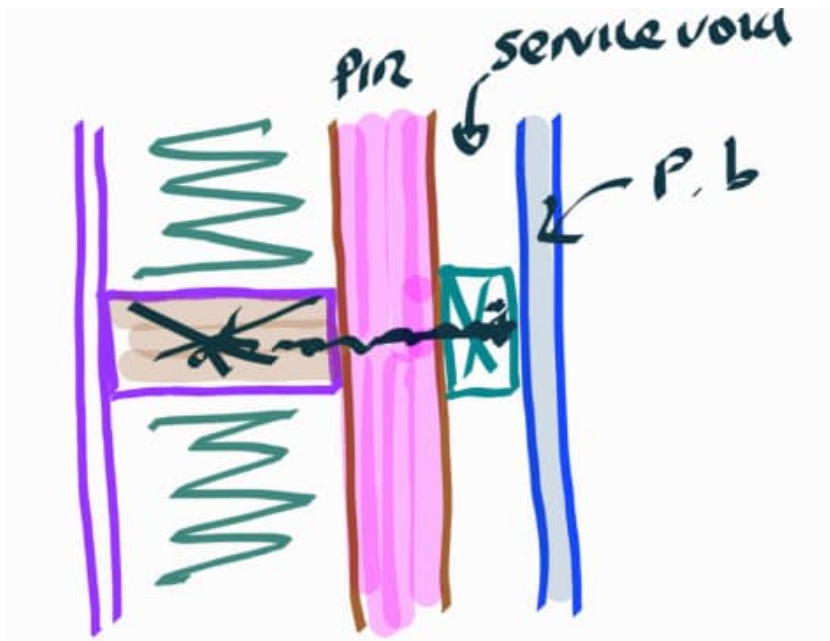


# 3D testing





# Battens over insulation over studs



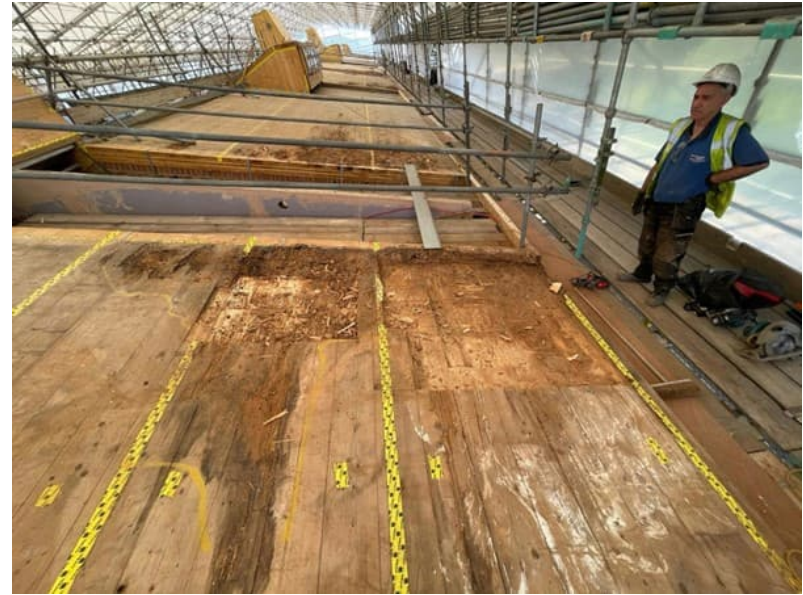
# DURABILITY

# PRESS

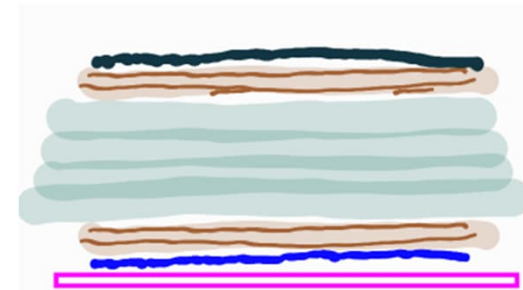
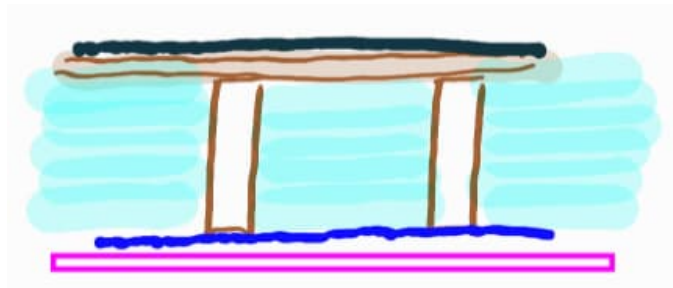
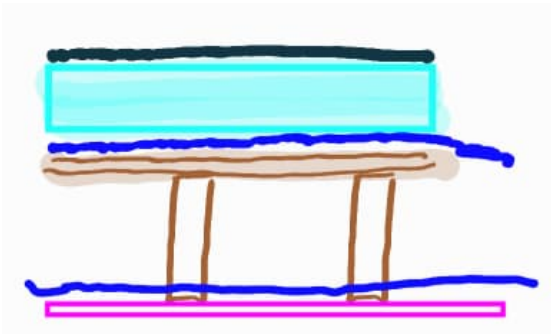
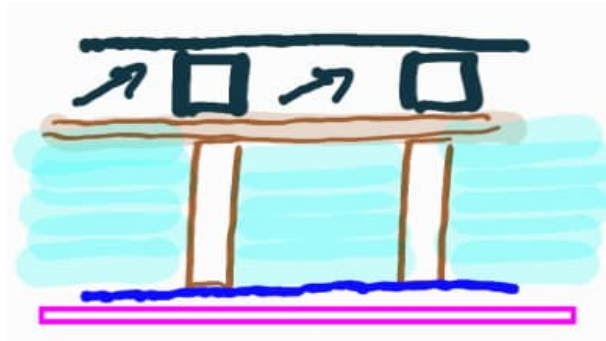
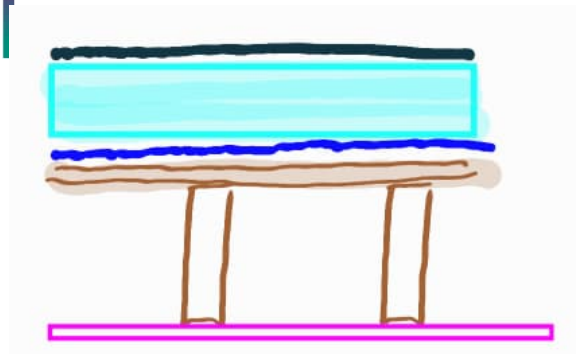
## Flats to be pulled down after just six years

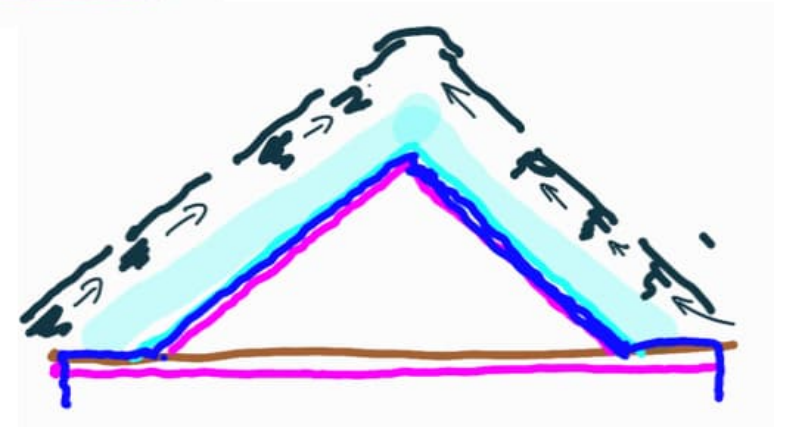
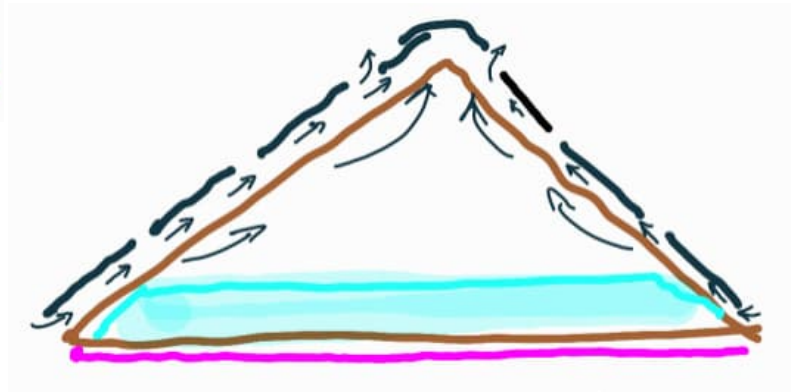
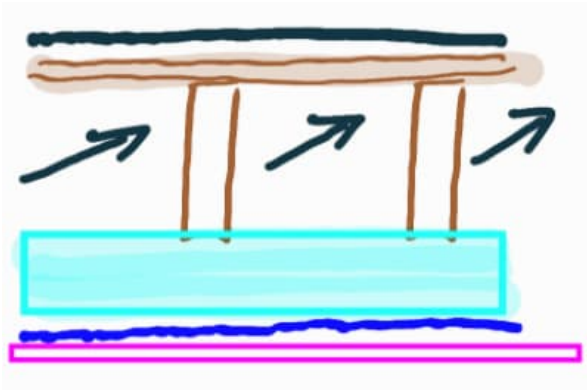
In 2014, following further reports of water damage in two ground floor flats, they undertook more investigations, at which point they said it became clear that more detailed work was needed to “ensure the buildings were suitable as long term homes”.

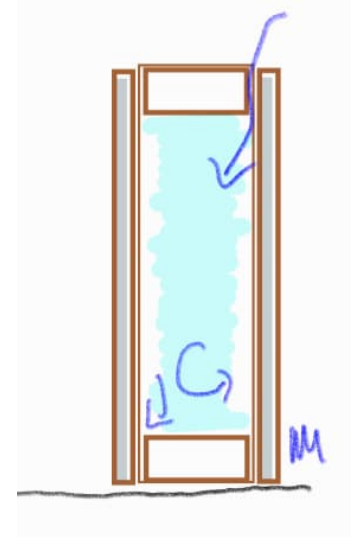
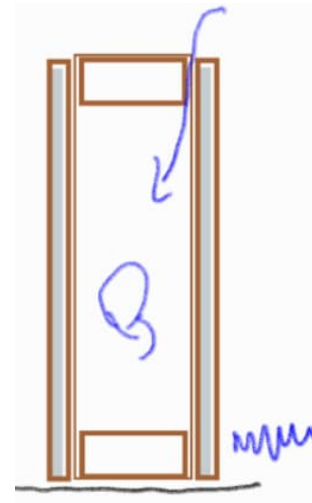
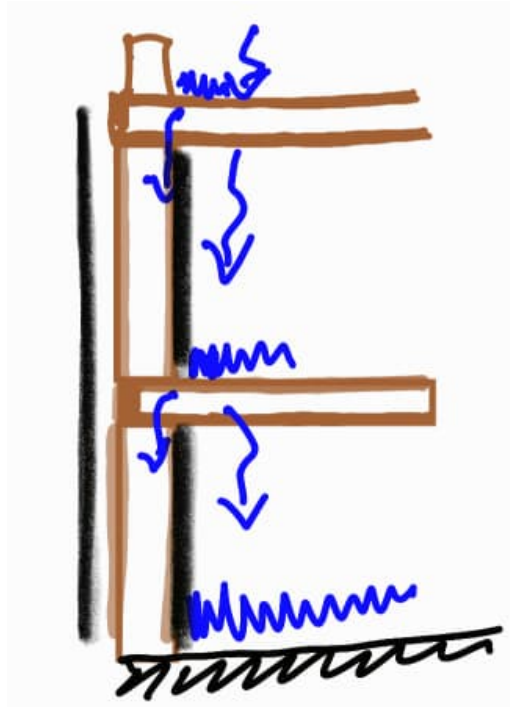
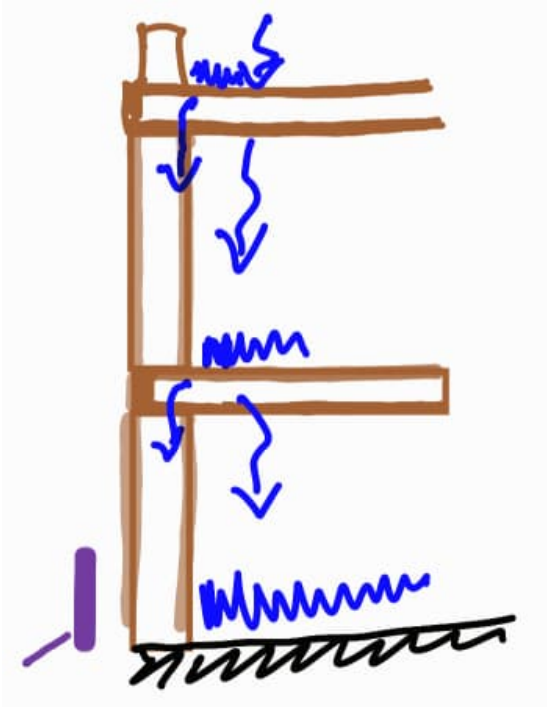
*X appointed a team of experts who identified 10 “significant” problems, including water damage to the buildings’ timber frames, defective balconies, problems with the roofs and fire protection issues.*



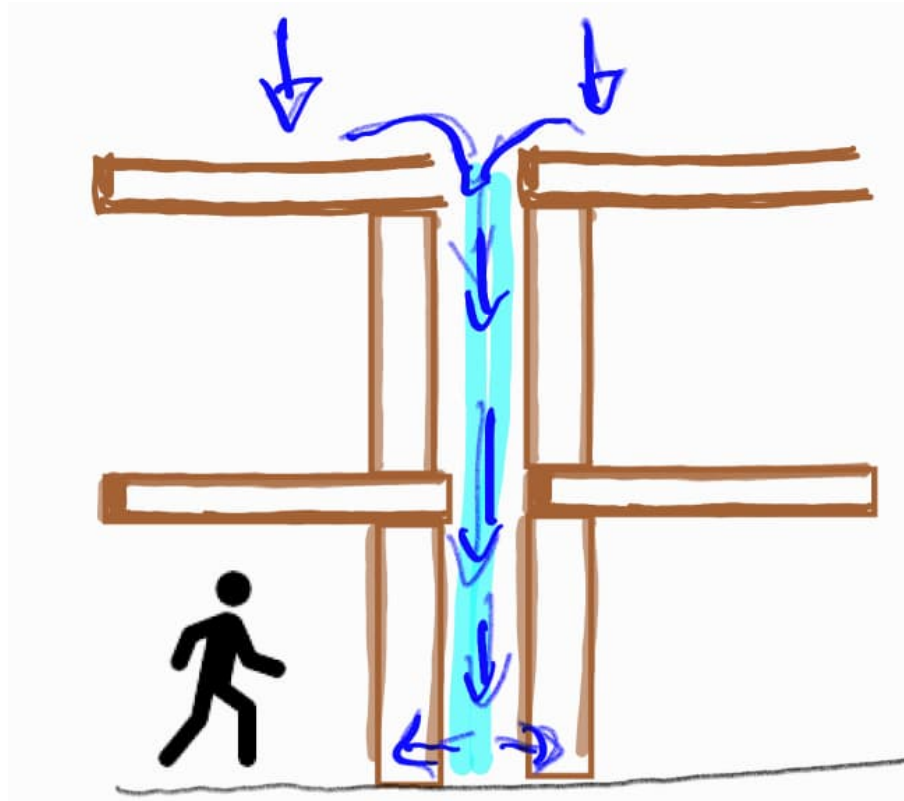















Durability

Robustness

Moisture

Fire