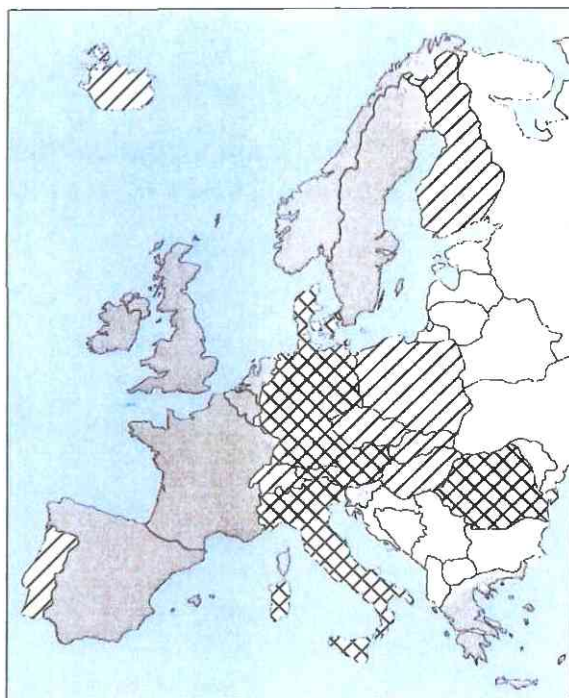


RAPPORT

Birgit Östman, Daniel Rydholm

National fire regulations in relation to the use of wood in European and some other countries 2002



Trätek

Birgit Östman, Daniel Rydholm

NATIONAL FIRE REGULATIONS IN RELATION TO THE USE OF WOOD
IN EUROPEAN AND SOME OTHER COUNTRIES 2002

Trätekt, Rapport P 0212044

ISSN 1102 – 1071

ISRN TRÄTEK – R – – 02/044 – – SE

Keywords

building materials
facade claddings
fire regulations
fire resistance
floorings
load-bearing structures
multi storey buildings
reaction to fire
residential sprinklers
separating structures
timber structures
visible wood
wall linings
wood products



Stockholm December 2002

Content:	Page
Summary in Swedish – Svensk sammanfattning	4
Summary	5
European harmonisation	6
Two stages in building fires	7
Reaction to fire – Material surface properties	8
Fire resistance – Structural fire performance	8
National limitations – Regulations	9
Use of wood in different applications	9
Load-bearing structures	12
Facades	14
Wall and ceiling linings in flats and escape routes	16
Floorings in flats and escape routes	20
Regulations per country	23
Europe	27
Outside Europe	50
New design possibilities	55
Conclusions	55
References	56
Acknowledgements	57

Summary in Swedish – Svensk sammanfattning

Brandbestämmelser i Europa och i några utomeuropeiska länder har kartlagts med avseende på möjligheter att använda trä, särskilt i högre bostadshus. Resultaten presenteras på ett enkelt och överskådligt sätt i form av tabeller och kartor. De kan användas både för att identifiera befintliga exportmöjligheter och för att på sikt kunna påverka bestämmelserna.

Brandbestämmelser i nationella byggregler är ett av de största hindren för ökad träanvändning i många exportländer. Nya europeiska metoder för provning, beräkning och dimensionering håller på att tas fram, men det nationella ansvaret för säkerhetsnivåer kommer att bibehållas. Nationella byggföreskrifter kommer således även fortsättningsvis att styra bl a möjligheter till användning av olika byggnadsmaterial. Det är därför viktigt att ha god kunskap om de nationella systemen för att kunna påverka dem i mer funktionsorienterad riktning, dvs mot möjligheter till ökad träanvändning på samma sätt som under senare år skett i Norden.

Det finns två områden för brandsäkerhet som regleras i byggregler i flertalet länder. Det ena är ytmaterial på väggar, tak och golv som är viktiga i brandens tidiga skede och har betydelse särskilt i utrymningsvägar. Det andra är hela konstruktionselement, t ex väggblock och bjälklag, som är viktiga vid fullt utvecklad brand och har betydelse för brandens eventuella spridning till andra brandceller (t ex andra lägenheter) och för byggnadens stabilitet vid brand. Båda dessa områden ingår i denna översikt.

De nationella bestämmelserna i Europa (drygt 20 länder) och i några utomeuropeiska länder (Australien, Japan, Nya Zeeland, Kanada, USA) har kartlagts med avseende på möjligheter att använda trä i högre hus som

- bärande konstruktion
- fasad
- tak-, vägg- och golvytor i lägenheter och i utrymningsvägar

Dessutom redovisas hur installation av sprinkler kan öka möjligheterna till träanvändning. Situationen i varje land inklusive krav på brandmotstånd i den bärande stommen redovisas också.

Stora skillnader mellan de studerade länderna har identifierats både vad anser tillåtet antal våningar med bärande trästomme i trä och möjligheter att använda synligt trä på väggar och tak och som fasad.

Summary

National fire regulations in relation to the use of wood in buildings in Europe and some non-European countries have been reviewed, especially in multi-storey residential buildings. The results are presented in tables and maps.

Fire regulations form the main obstacle to the use of wood in buildings in many countries. European standards for the fire safety in buildings mainly deal with harmonised methods for verification of performance. These standards exist on the *technical level*, while fire safety is governed by national legislation, thus being on the *political level*. National fire regulations will thus remain.

Two main stages in building fires, the initial and the fully developed fire, are considered. Both are important for the fire performance of all buildings and are used in most building codes, but they focus on different properties of the materials involved in the fire. In order to minimize the effects of a fire, it is required that, during the initial stage of a fire, the contribution from surface linings is limited (often called reaction to fire), while during the fully developed fire, the fire resistance of boundaries and structural elements is decisive.

The national limitations for the use of wood for these two cases have been reviewed. The results from more than 20 European countries and some non-European countries (Australia, Japan, New Zealand, Canada, USA) are included. They are presented as number of storeys permitted for the use of wood in:

- load-bearing structure
- wooden facade claddings
- visible wood surfaces on walls, ceilings and floors in flats and escape routes

Further possibilities to increased use of wood by installation of sprinkler systems are included. The requirements in each country regarding fire resistance are also presented.

Major differences between the countries included in the survey have been identified both for the number of storeys with wood structure and for visible wood surfaces in interior and exterior applications.

Attention: Building regulations are very complicated documents. Simplifications may lead to misunderstandings. This survey should only be used for initial guidance. For building projects the national building regulations must always be checked.

Please, report any mistakes or changes to the authors.

birgit.ostman@tratek.se
daniel.rydholm@tratek.se

European harmonisation

In many countries the building regulations are being altered towards functional or performance criteria rather than being prescriptive. In Europe this development was speeded up by the Construction Products Directive (CPD) of the European Union and EFTA, which was adopted in 1988. The CPD gives six essential requirements, one of which is Safety in the case of fire. The consequences of the move to performance-based requirements are especially pronounced for the fire regulations that traditionally have been prescriptive. The CPD gives the following definition of the essential requirement on fire:

The construction works must be designed and built in such a way that in the event of an outbreak of fire:

- the load-bearing capacity of the construction can be assumed for a specific period of time,
- the generation and spread of fire and smoke within the construction works are limited,
- the spread of fire to neighbouring construction works is limited,
- occupants can leave the construction works or be rescued by other means,
- the safety of rescue teams is taken into consideration.

In the field of fire safety in buildings, European standards deal mainly with harmonised methods for verification. These standards exist on the *technical level*, but fire safety is on the *political level* governed by national legislation. National or local authorities will also in the future set the level of requirements to maintain present national safety levels.

Even if the European harmonisation will reduce the obstacles to trade and facilitate a wider use of wood and timber products in buildings, there are still limitations since the national building regulations are not harmonised with respect to safety levels. A main problem is also that the link between required national safety level and knowledge about the performance of wood in building fires often is unclear. Other factors that influence the possibilities of using wood are the organisation, strategies and resources of national or local rescue services.

However, on a longer term, the national building regulations will probably be more unified. A first step in mapping the present situation has recently been taken /1/.

Two stages in building fires

There are two different stages of a fire scenario to be considered in the fire safety design of buildings in relation to building materials and structures. These are the initial and the fully developed fire, see Figure 1. In the initial fire, the building content and furnishing, e.g. furniture, is of major importance both for the initiation of the fire and its development, but these are not subject to building regulations. Surface linings also play an important role in the initial fire, especially in escape routes. Limitations of their reaction to fire performance are required in most building regulations. In the fully developed fire, the performance of load-bearing and separating structures is important in order to limit the fire to the compartment of fire origin. This is called the fire resistance of the building structure.

Generally speaking, timber structures can obtain high performance for fire resistance, while the performance of wood or wood-based linings in the initial fire may be less favourable and also more difficult to quantify.

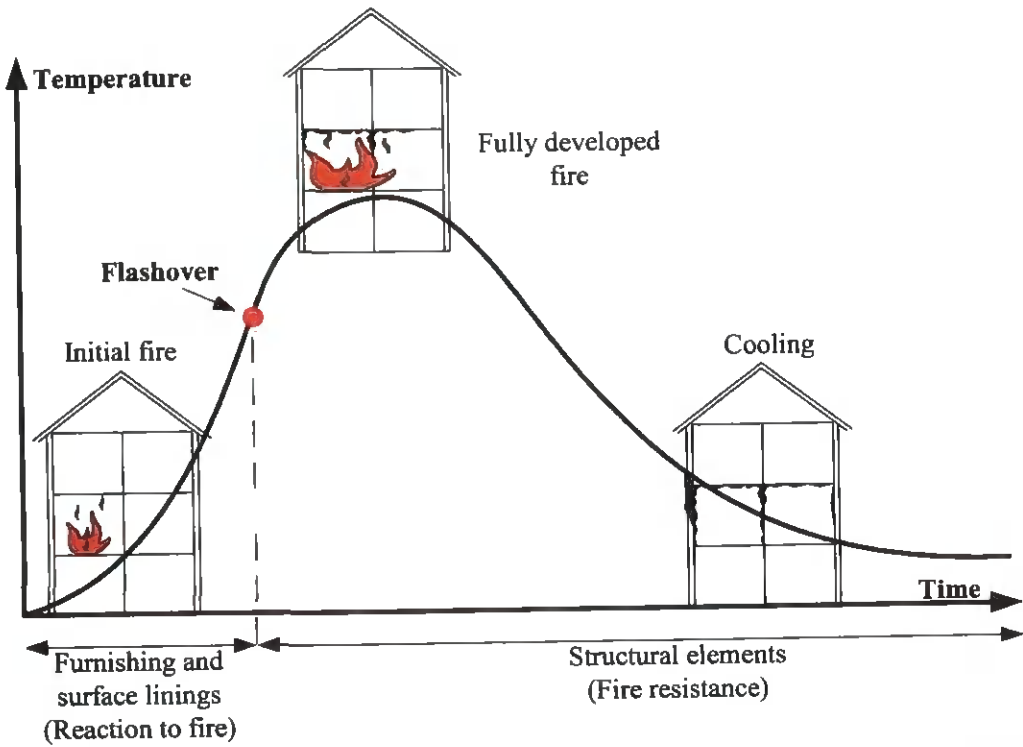


Figure 1. There are two main stages that are relevant for the fire safety in buildings in relation to building materials and structures. One is the initial fire in which the properties of surface linings may be important. The other is the fully developed fire in which the load bearing and separating structures are essential to limit the fire to the room or fire compartment of origin.

Reaction to fire – Material surface properties

Reaction to fire means the response of materials to an initial fire attack and includes properties like time to ignition, flame spread, heat release and smoke production, see [Figure 2](#). These properties are relevant in the early fire development, which is the stage when wood products may contribute to fires.

The use of combustible linings such as wood panelling or wood-based panels in buildings is restricted in many national building regulations in order to limit the rate of fire growth, but their contribution is often overemphasised in relation to the building content. However, some limitations are needed e.g. in escape routes.

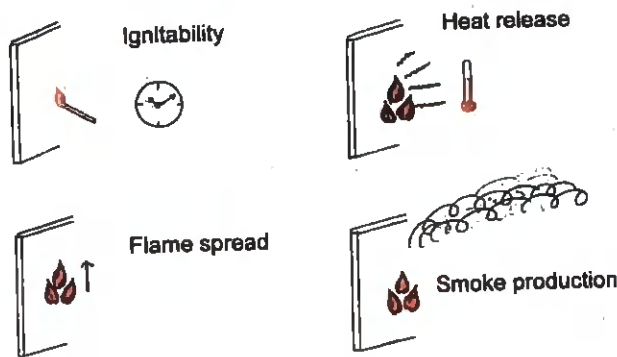


Figure 2.

Reaction to fire properties of surface products such as wall and ceiling linings.

A new system with Euroclasses has recently been adopted and will gradually replace the old national classification systems, which have been hard to translate between countries, and formed obstacles to trade. The Euroclasses are of two types, one class for all products excluding floorings, i.e. mainly wall and ceiling linings, and one class for floorings. Wood products usually fulfil the criteria of Euroclasses D and D_{FL}.

Fire resistance - Structural fire performance

Fire resistance means that building elements such as walls and floors shall withstand a fully developed fire and fulfil requirements of load bearing, integrity and insulation capacities during a specified period of time, e.g. 60 minutes, see [Figure 3](#). The fire exposure is usually according to the so-called standard time-temperature curve. This curve is defined in the international standard ISO 834 and referred to in almost all national building regulations. It specifies a fire exposure with ever increasing temperatures, that building elements are expected to withstand. Timber structures can perform a high fire resistance, e.g. REI 60, REI 90 or even higher.

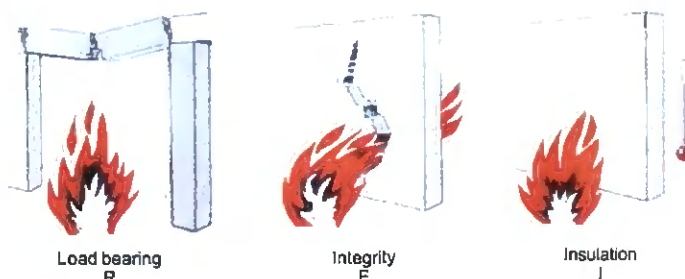


Figure 3.

Performance criteria for fire resistance. They are used together with a time value, e.g. REI 60 for an element that maintains its load bearing and separating functions in 60 minutes.

New European standards corresponding to ISO 834 have recently been adopted or are close to be adopted. They are generally speaking more detailed and divided into different applications, e.g. walls, floors etc.

National limitations - Regulations

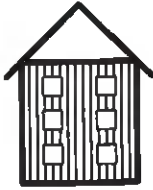
The present situation in Europe for multi-storey residential buildings in timber is reviewed. A few non-European countries with traditions in timber building are also included. Several countries do not have any specific regulations or do not limit the number of storeys in timber buildings. However eight storeys are often used as a practical and economical limit for the use of timber structures. For facades, linings and floorings this limit may be higher since these applications may also be used in e.g. concrete structures.

Use of wood in different applications

To visualise national legislations and to be able to compare the situation in different countries, maps are presented on the following pages. At the headline graphic symbols describe which application the map presents. The graphic symbols are explained below.



Load-bearing structure



Facade claddings



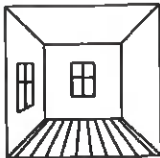
With sprinklers



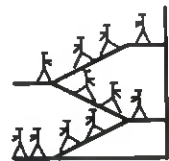
Without sprinklers



Wall and ceiling linings



Floorings



Escape routes



Fire retardant treated wood (FRT wood)

Ten maps show the legislation for

- load-bearing structure with and without sprinklers,
- facades with and without sprinklers,
- wall and ceiling linings in flats and escape routes,
- wall and ceiling linings with FRT wood in flats and escape routes and
- floorings in flats and escape routes.

Each map presents number of storeys for each application in three groups

- ≥ 5 storeys
- 3-4 storeys
- ≤ 2 storeys (incl. 0)

The following countries are included:

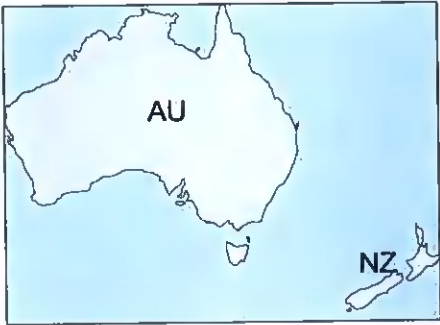
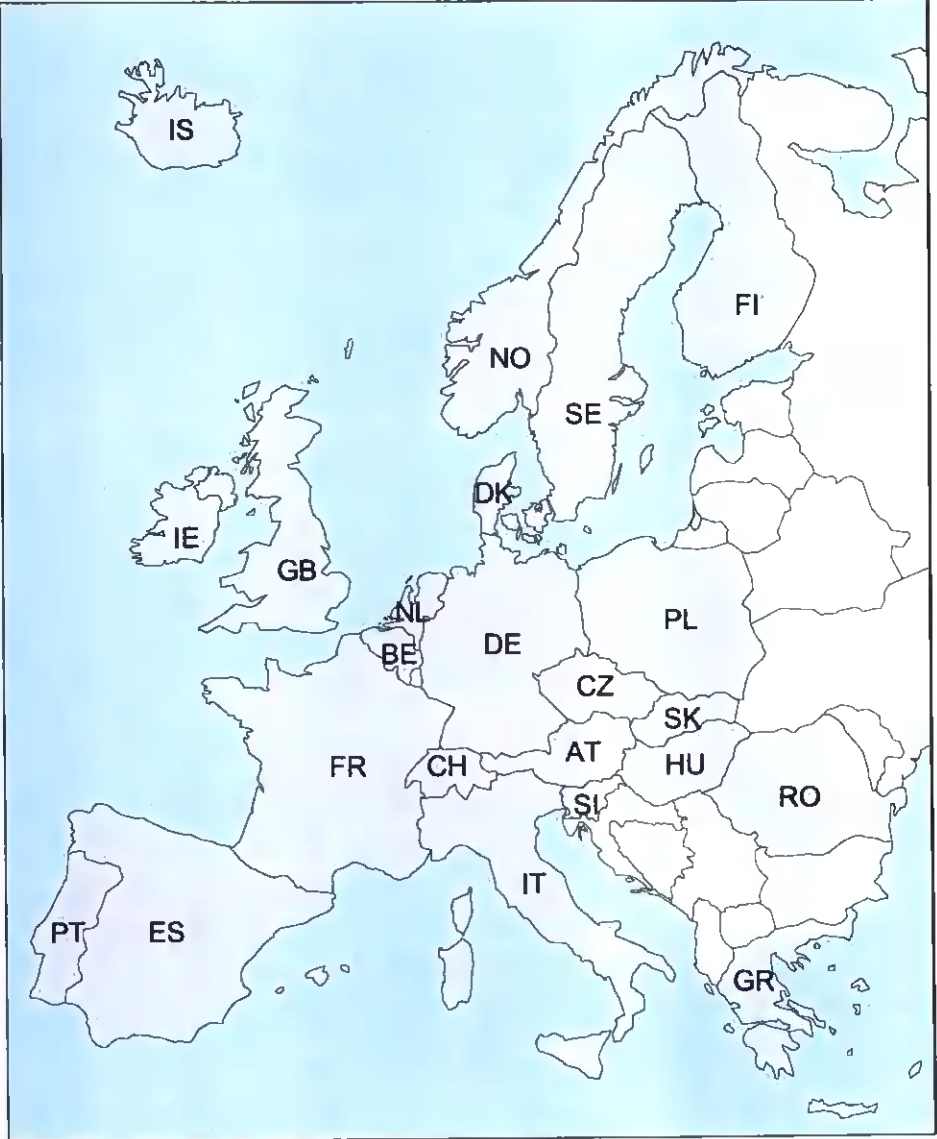
Europe:

Austria	AT
Belgium	BE
Czech Republic	CZ
Denmark	DK
Finland	FI
France	FR
Germany	DE
Greece	GR
Hungary	HU
Iceland	IS
Ireland	IE
Italy	IT
Netherlands	NL
Norway	NO
Poland	PL
Portugal	PT
Romania	RO
Slovakia	SK
Slovenia	SI
Spain	ES
Sweden	SE
Switzerland	CH
UK	GB

Outside Europe:

Australia	AU
Canada	CA
Japan	JP
New Zealand	NZ
USA	US

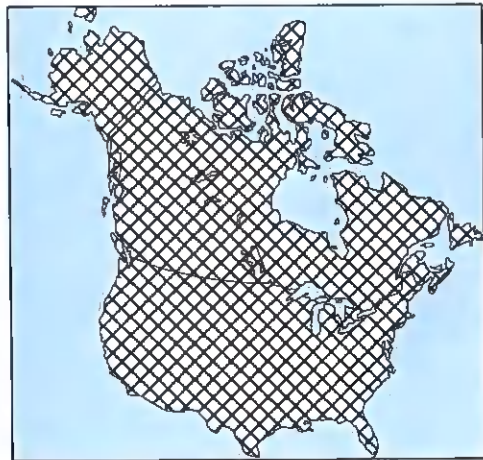
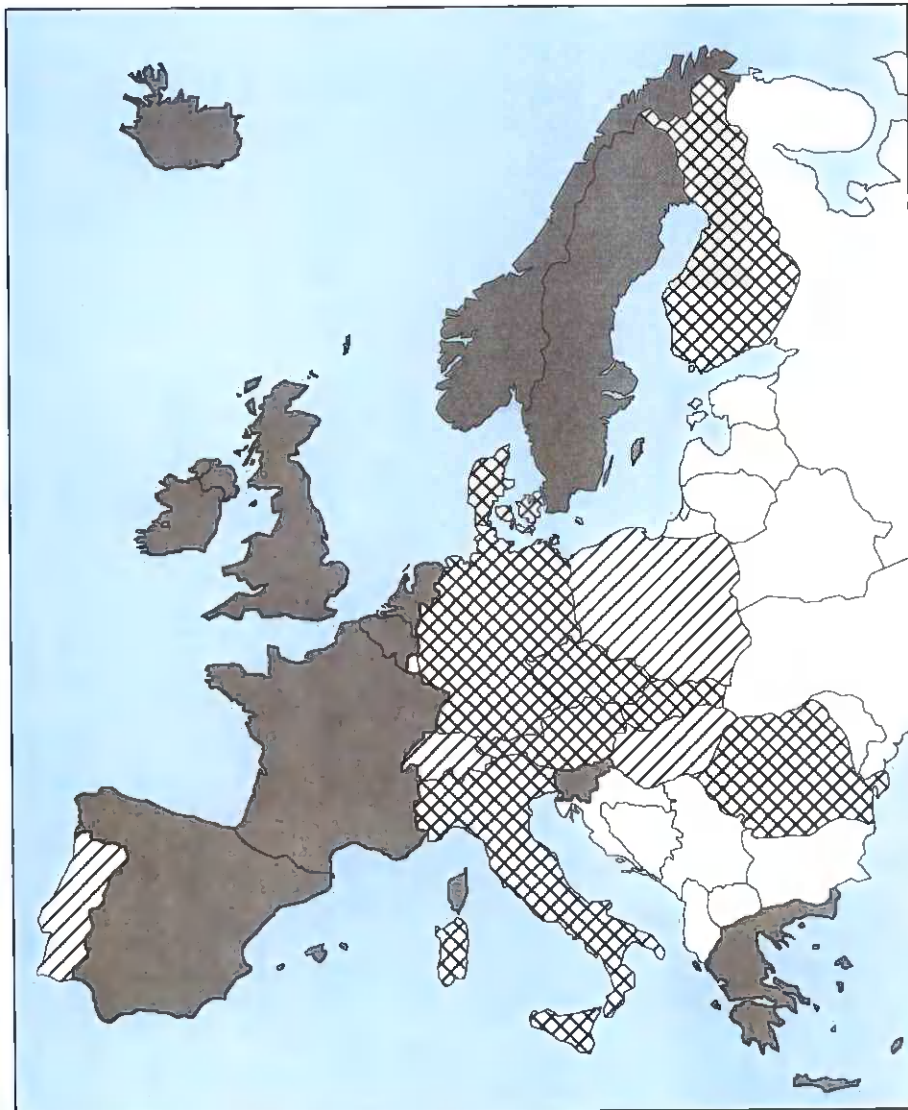
Countries included in the survey



Map 1:

Load-bearing structure with sprinklers

Maximum number of storeys in timber

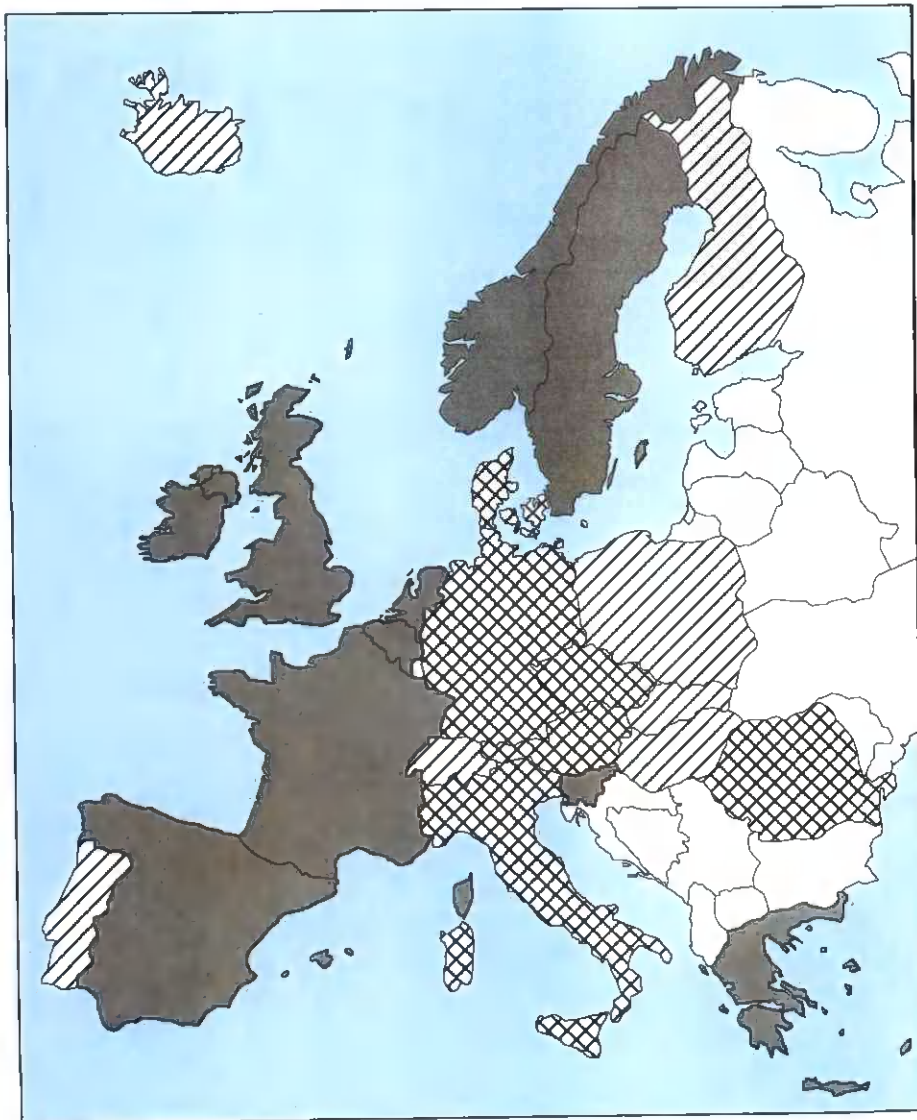






In USA, 5 storeys are allowed according to some codes.

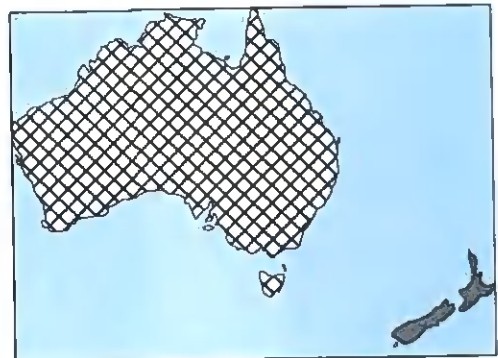
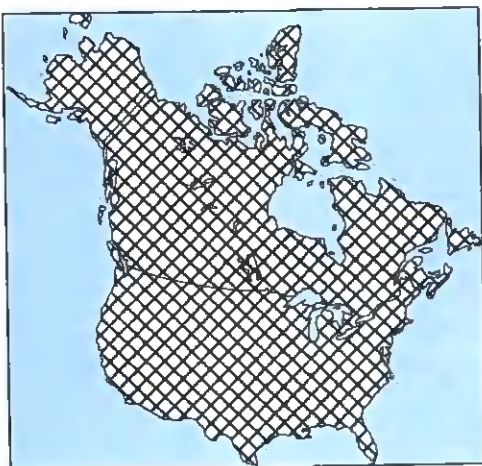
Map 2:

Load-bearing structure without sprinklers

Maximum number of storeys in timber



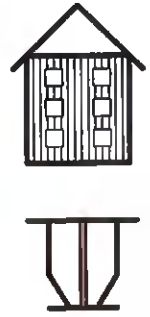
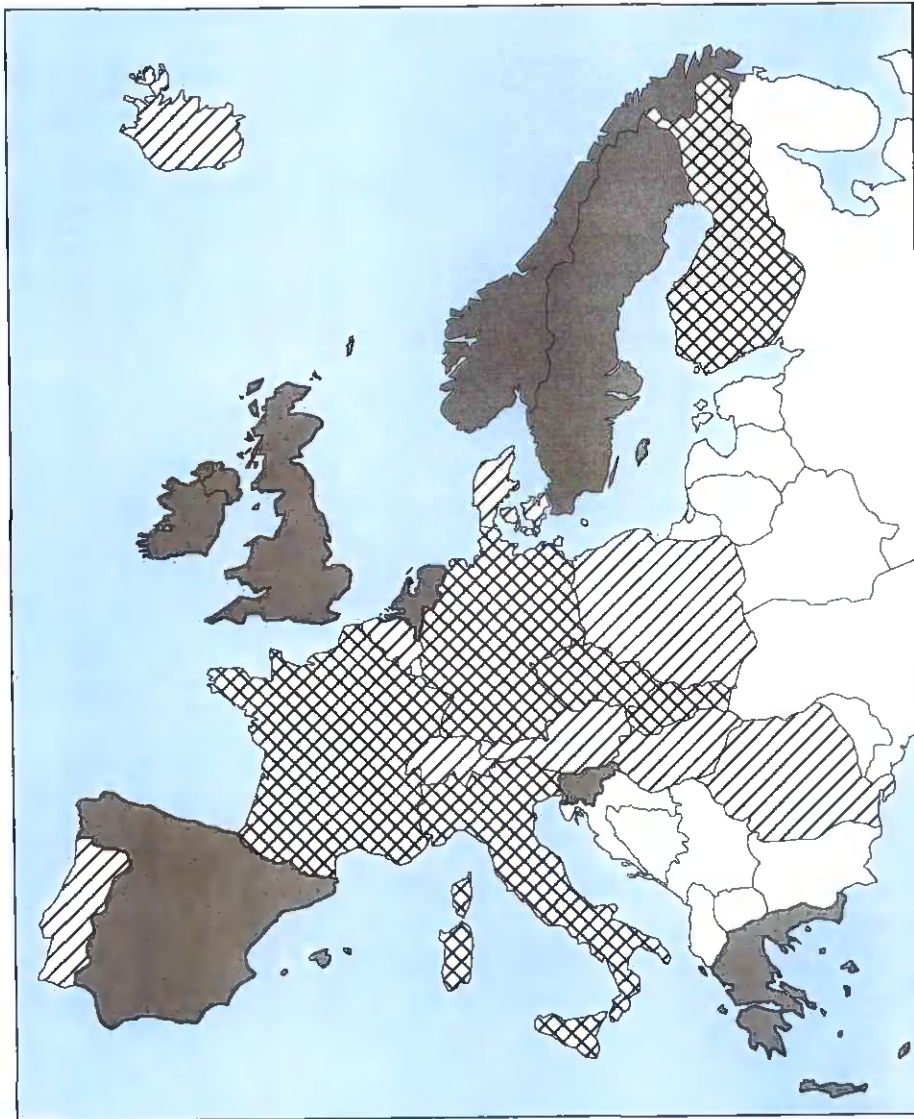
-  ≥ 5 storeys
-  3-4 storeys
-  ≤ 2 storeys (incl. 0)
-  No information







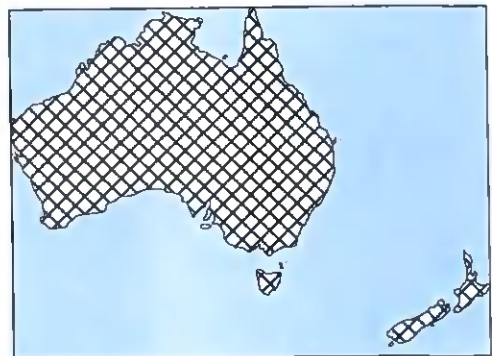
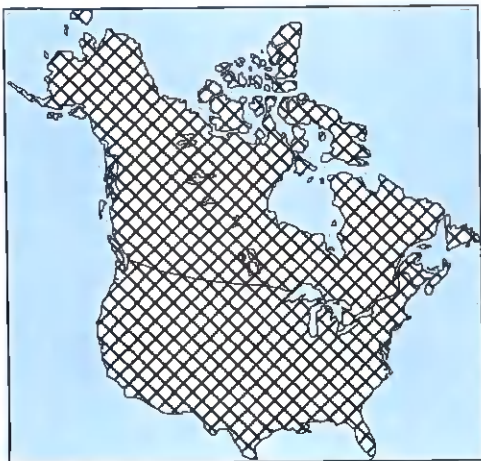
Map 3:

Facade claddings with sprinklers

Wooden facade claddings



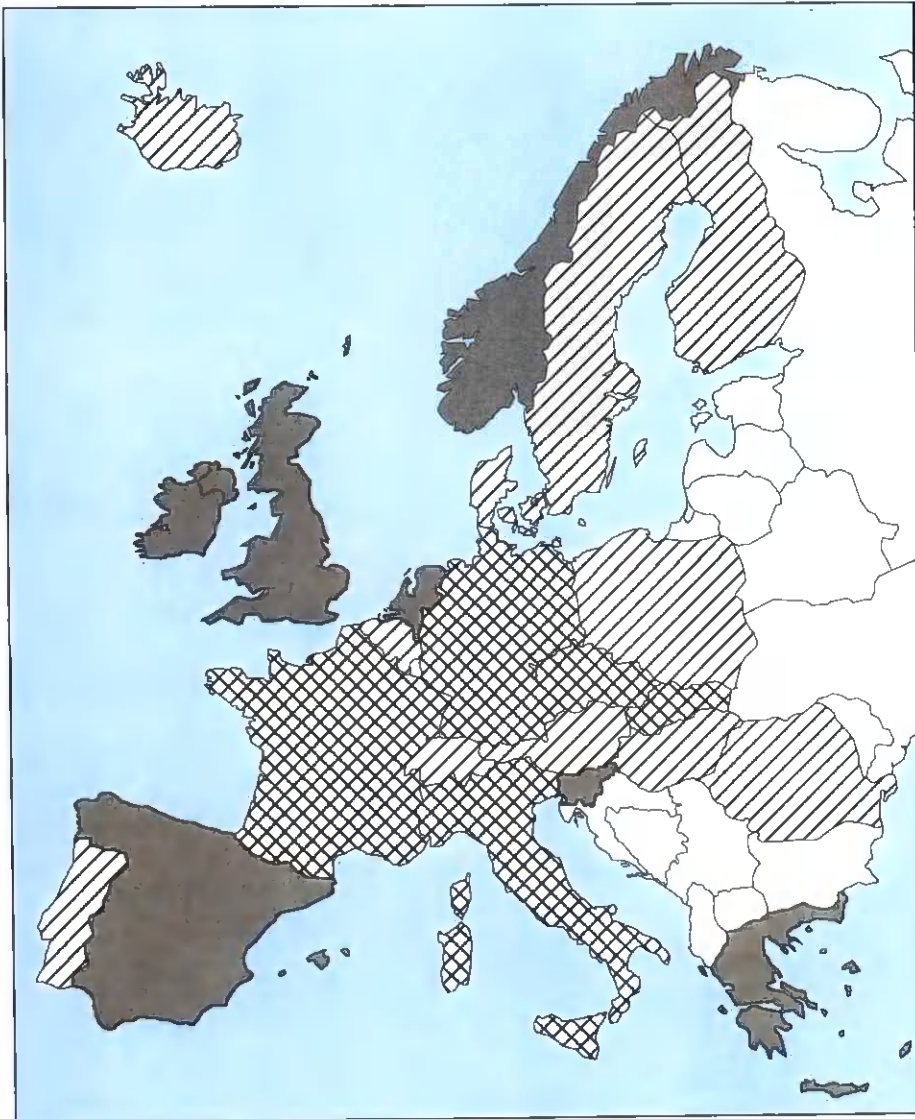
-  ≥ 5 storeys
-  3-4 storeys
-  ≤ 2 storeys (incl. 0)
-  No information







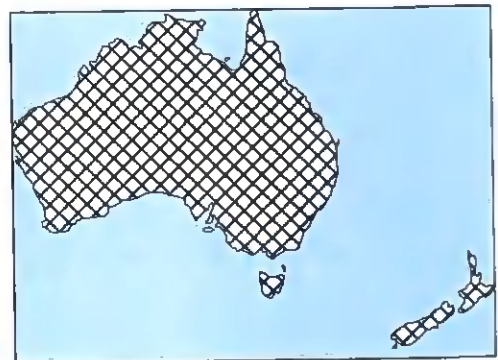
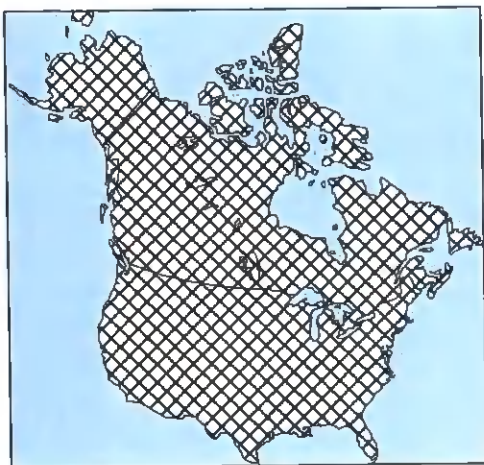
Map 4:

Facade claddings without sprinklers

Wooden facade claddings



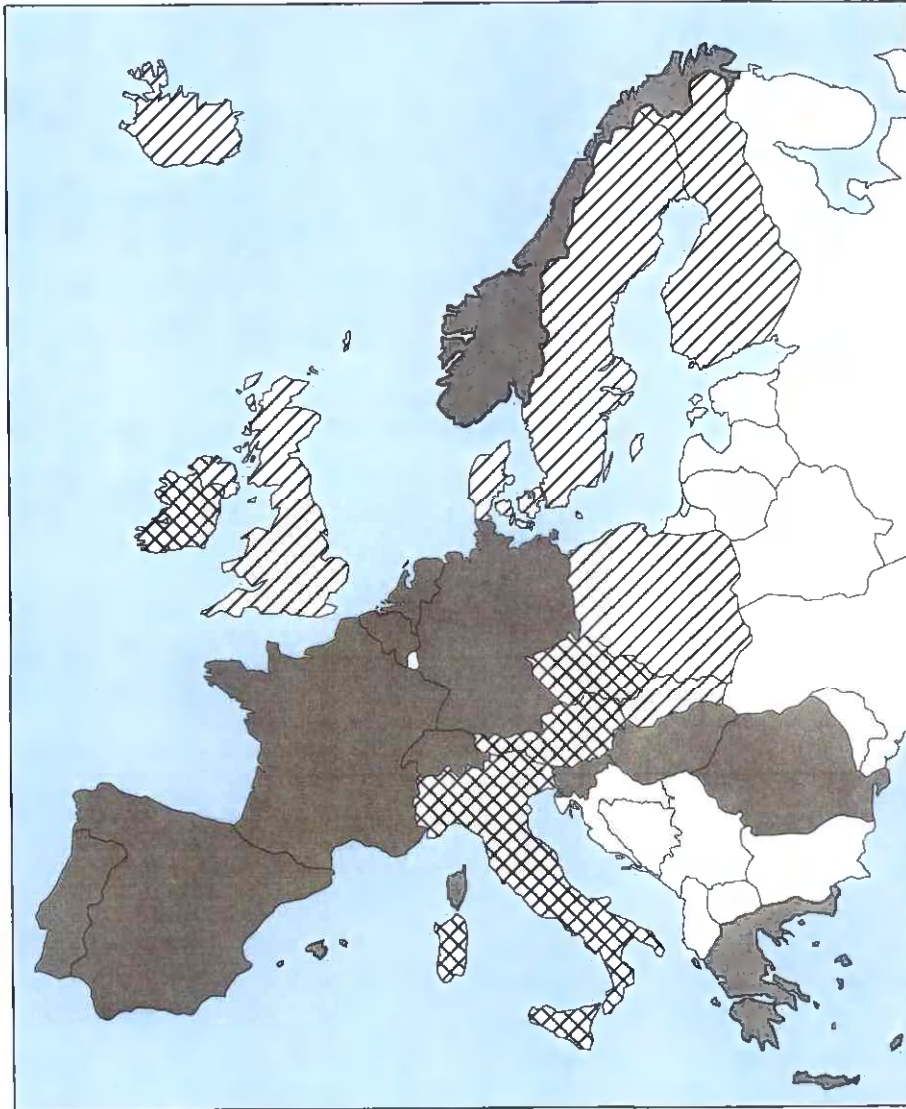
-  ≥ 5 storeys
-  3-4 storeys
-  ≤ 2 storeys (incl. 0)
-  No information



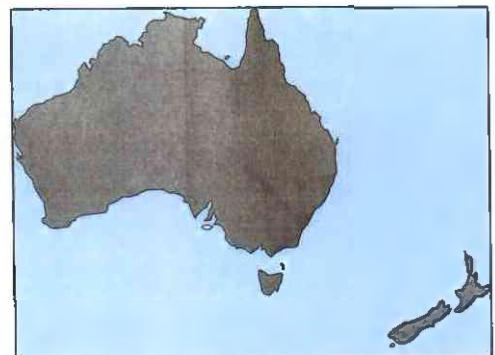
Map 5:

Wall and ceiling linings in flats without sprinklers

Surface linings of ordinary wood



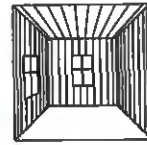
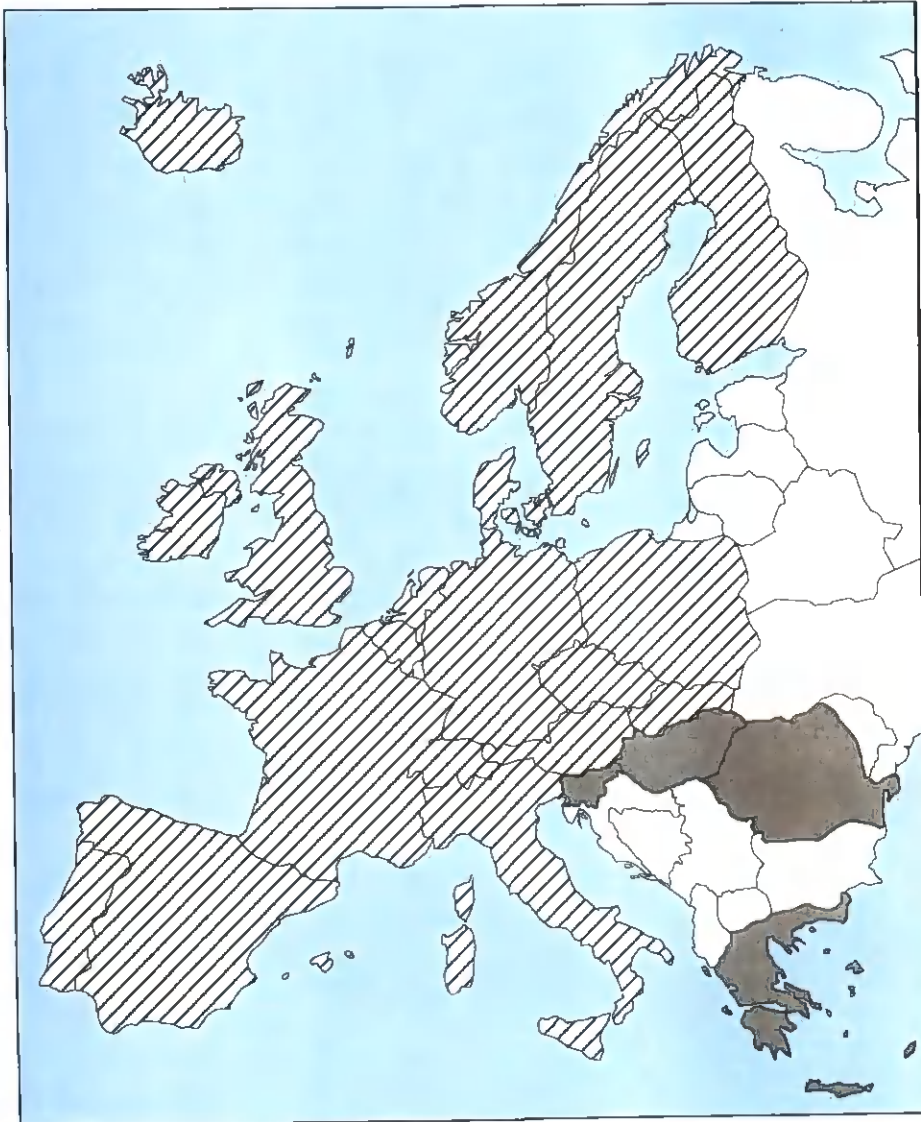
- ≥ 5 storeys
- ▣ 3-4 storeys
- ▨ ≤ 2 storeys (incl. 0)
- No information







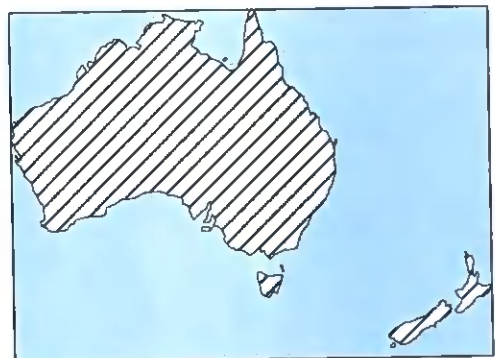
Map 6:

Wall and ceiling linings in escape routes without sprinklers

Surface linings of ordinary wood



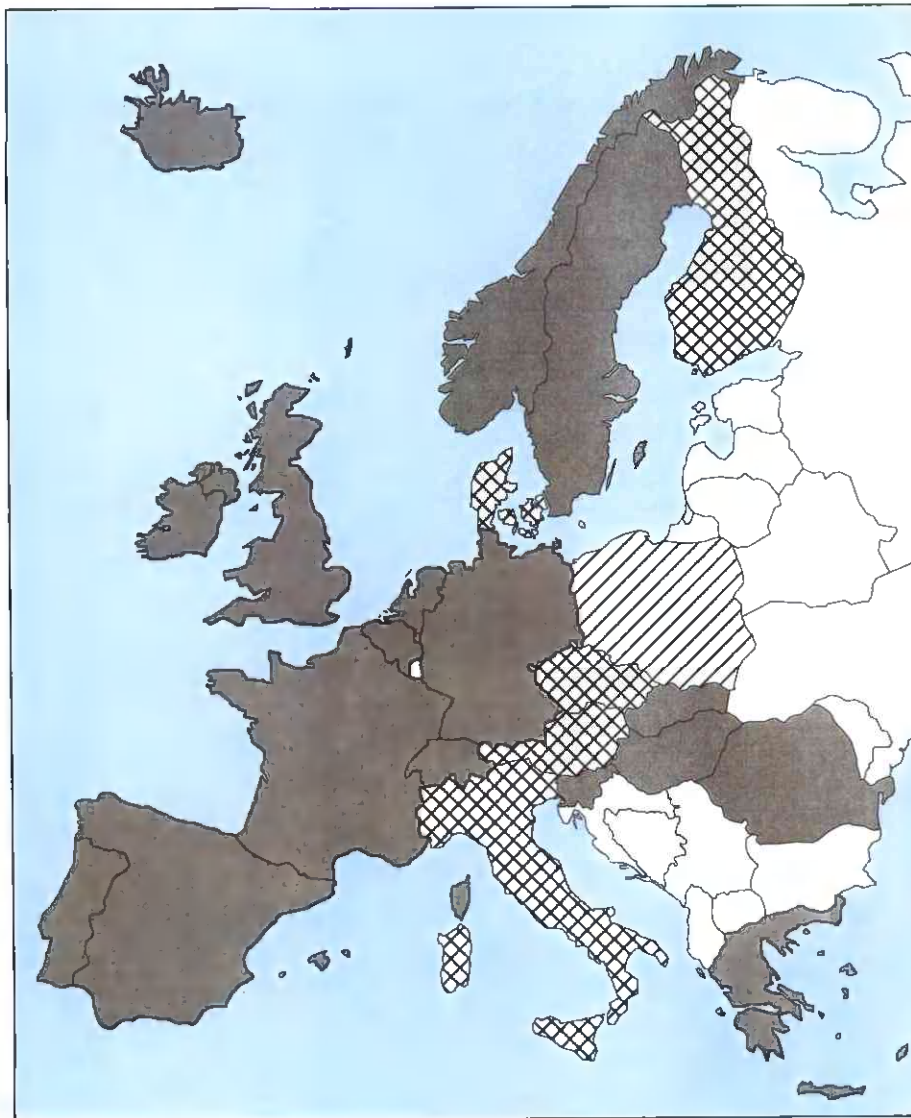
-  ≥ 5 storeys
-  3-4 storeys
-  ≤ 2 storeys (incl. 0)
-  No information



Map 7:

Wall and ceiling linings in flats with FRT wood*

Surface linings of fire retardant treated, FRT, wood

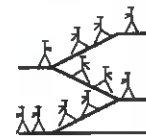
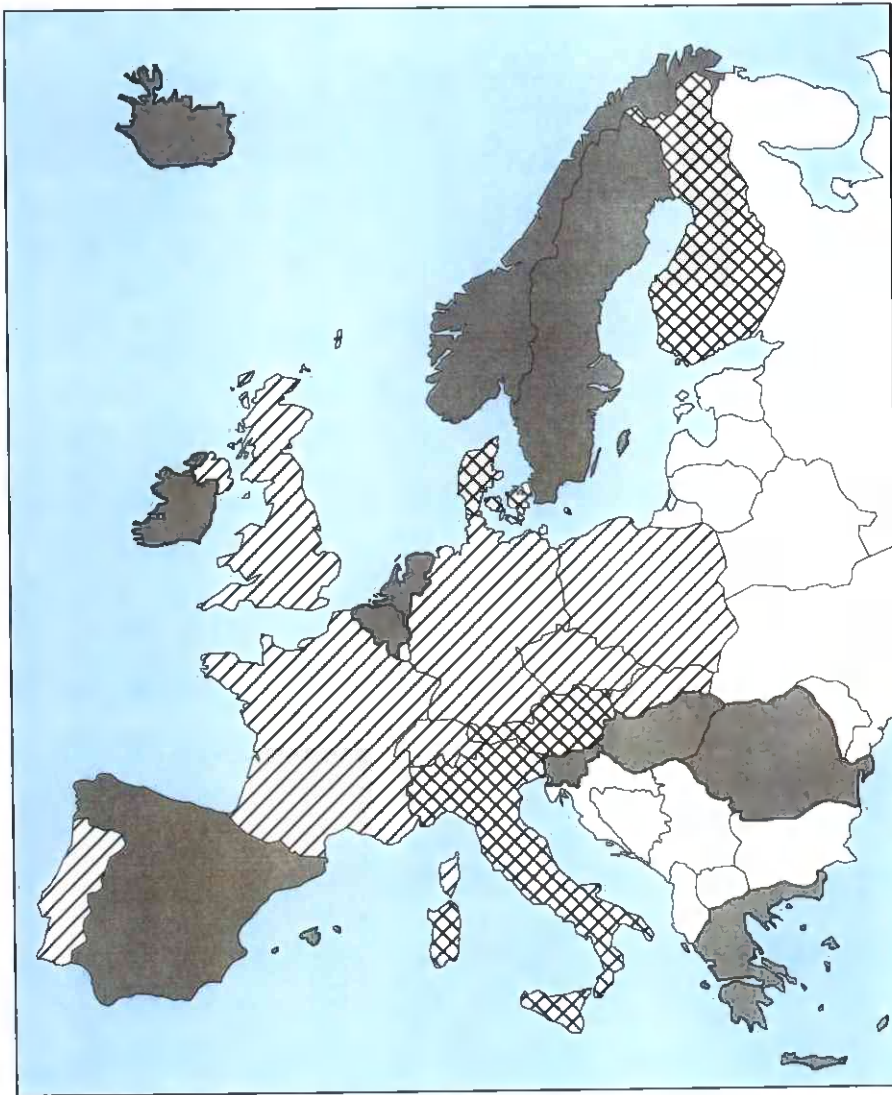


* Only if meeting required class

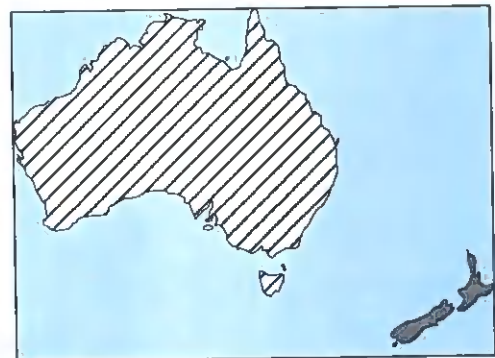
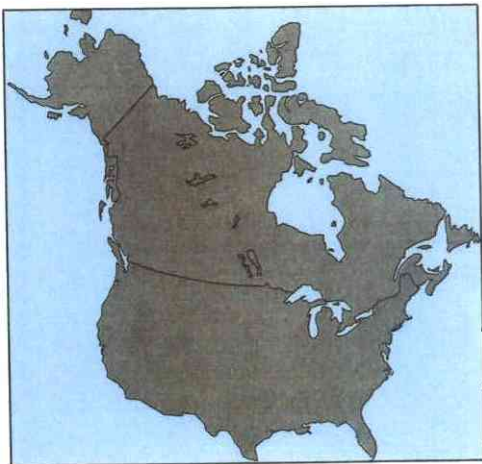
Map 8:

Wall and ceiling linings in escape routes with FRT wood*

Surface linings of fire retardant treated, FRT, wood



- ≥ 5 storeys
- 3-4 storeys
- ≤ 2 storeys (incl. 0)
- No information

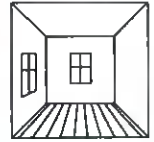
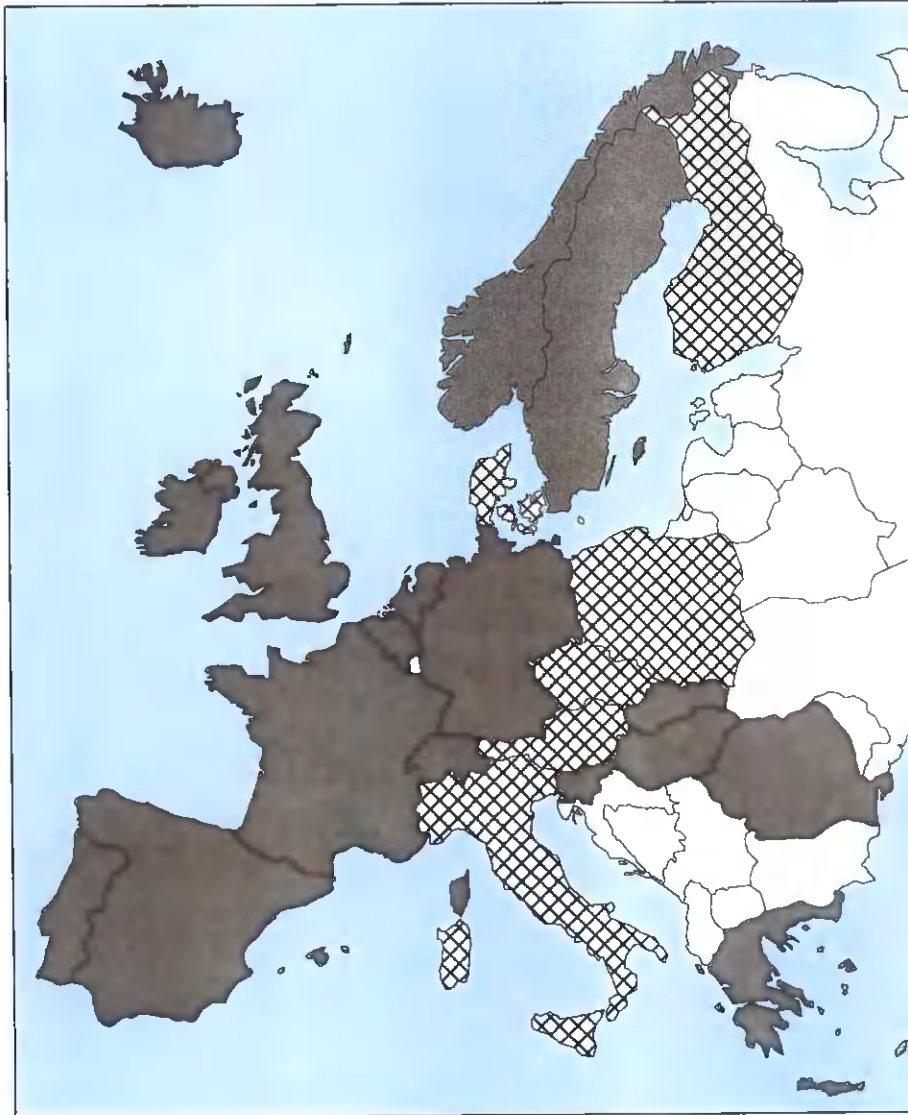






* Only if meeting required class

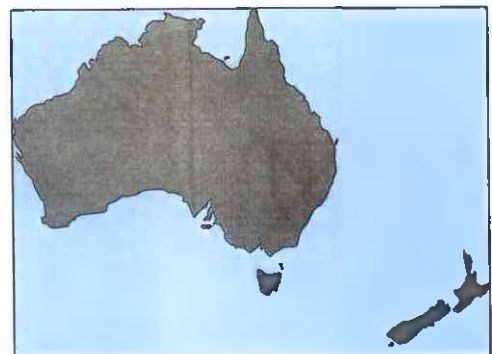
Map 9:

Floorings in flats without sprinklers

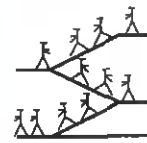
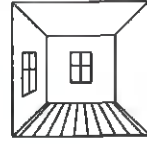
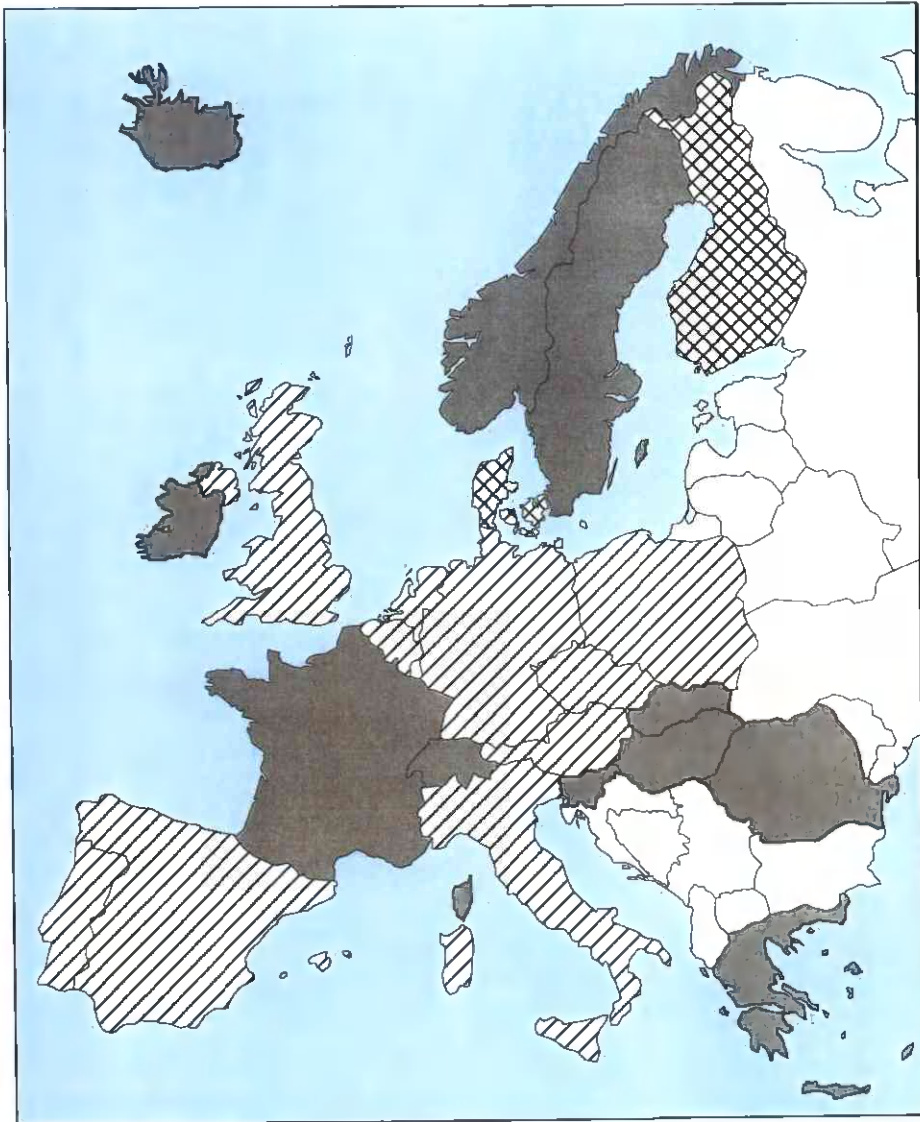
Wooden floorings







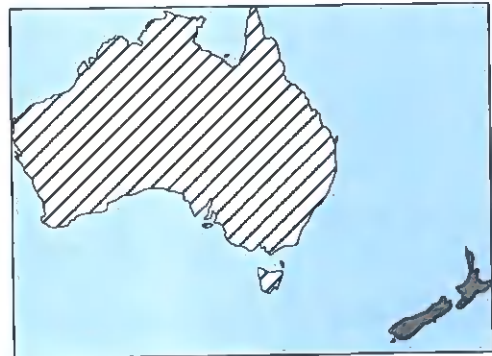
-  ≥ 5 storeys
-  3-4 storeys
-  ≤ 2 storeys (incl. 0)
-  No information



Map 10:
Floorings in escape routes without sprinklers
 Wooden floorings



-  ≥ 5 storeys
-  3-4 storeys
-  ≤ 2 storeys (incl. 0)
-  No information

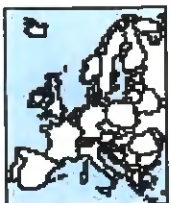


Regulations per country

The situation per country is illustrated in a series of pages, one per country. Each page contains


- a small map
- two sketches of buildings with maximum number of storeys in timber structure without and with sprinklers
- two tables with requirements for structural elements in timber and number of storeys with visible wood
- two sketches with possible use of visible wood and requirement levels on load-bearing structure in a 4-storey or higher unsprinkled building, if allowed. For countries allowing less than four storeys, the maximum number of storeys is illustrated instead.
- a note on special conditions is included for some countries

Example of page per country:




Switzerland

Maximum number of storeys in timber structure



Without sprinklers



With sprinklers

Structural elements in timber

Country	Storeys	Sprinklers	Structural elements in timber		Notes
			Timber	Steel	
AT	4	Yes	Yes	Yes	
BE	4	Yes	Yes	Yes	
DE	4	Yes	Yes	Yes	
DK	4	Yes	Yes	Yes	
ES	4	Yes	Yes	Yes	
FR	4	Yes	Yes	Yes	
IT	4	Yes	Yes	Yes	
NL	4	Yes	Yes	Yes	
NO	4	Yes	Yes	Yes	
PL	4	Yes	Yes	Yes	
PT	4	Yes	Yes	Yes	
SE	4	Yes	Yes	Yes	
SI	4	Yes	Yes	Yes	
UK	4	Yes	Yes	Yes	
US	4	Yes	Yes	Yes	

Visible wood on surfaces


Country	Storeys	Sprinklers	Visible wood on surfaces		Notes
			Timber	Steel	
AT	4	Yes	Yes	Yes	
BE	4	Yes	Yes	Yes	
DE	4	Yes	Yes	Yes	
DK	4	Yes	Yes	Yes	
ES	4	Yes	Yes	Yes	
FR	4	Yes	Yes	Yes	
IT	4	Yes	Yes	Yes	
NL	4	Yes	Yes	Yes	
NO	4	Yes	Yes	Yes	
PL	4	Yes	Yes	Yes	
PT	4	Yes	Yes	Yes	
SE	4	Yes	Yes	Yes	
SI	4	Yes	Yes	Yes	
UK	4	Yes	Yes	Yes	
US	4	Yes	Yes	Yes	

Special conditions in timber

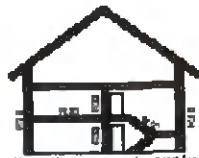
1. Visible wood surfaces

- Greater facade heights
- Greater wall and ceiling heights
- Greater floor spans

2. Local conditions under structure



Reaches to 4th - visible wood
of non-structural structure



Local conditions - requirements below

An overview of all national requirements surveyed is given in Table 1 Structural elements, and in Table 2 Visible wood on surfaces.

Table 1. Structural elements in timber, maximum number of storeys and fire resistance requirements in Residential buildings

Countries	Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o						Code changes		Comments		
	Unspr.	Spr.	Unspr.	Spr.	1-2		3-4		5-6		7-8	Stairs		Since 1995	For sprinklers
					load-bear.	sep.	load-bear.	sep.	load-bear.	sep.					
Austria	4*	4*			60	30	60	60	-	-	-	60	2000	No	* Forth storey > 1 m inclined from facade
Belgium	∞	∞	∞	∞	60	60	60	60	60	60	60	60	No	No	
Czech Rep	3	3	9	9	45*		60*		-	-	-	30	1999	No	* Underground floor excl. 30 for highest storey
Denmark	4	4			60	60	60*		-	-	-	-	1997	Yes	* Protection to prevent charring required
Finland	2	4	9	14	30/-*	30	-	-	-	-	90	-	No	No	* Depending on fire class of the building
France	15	15	50	50	15/30*	15/30*	30/60*	30/60*	90	90	90	60	No	Yes	* Vertically /horizontally
Germany	3/5*	3/5*			30		30**/90		-	-	-	60	No	Yes	* Future extension; ** 30 minutes for 3 storeys
Greece	∞	∞	∞	∞	30	30	30	30	60	60	60	-	No	No	Underground floor excluded
Hungary	2	2			30	30	-	90/45*	-	150/45**	-	-	No	No	* Vertically/horizontally; ** Only in 5 storeys in timber
Iceland	1	∞			-/30*						30	1998	Yes	Yes	* <200 m ² / <600 m ²
Ireland	∞	∞	∞	∞	30	60	60*	60*	60*	60*	60**	30	Yes	Yes	* 5 < height ≤ 20 m, **90 for 20<height ≤ 30 m
Italy	4	4			30	30	30	30	-	-	-	30	No	Yes	
Netherlands	∞*	∞*	∞*	∞*	30**		60**		90**	90**	90**	60	No	No	* in practise 5 (13 m), **+30 min for fire load > 500 kJ/m ²
Norway	∞	∞	∞	∞	15	30	60	60	*	*	*	30	1997	No	* Spec req. > 4 storeys (detailed doc needed)
Poland	2	2			?	?	-	-	-	-	-	-		No	
Portugal	2	2	9	9	30	-	-	-	-	-	-	-	No	No	
Romania	3	3			-	-	30	-	-	-	-	60	No	No	
Slovakia	2	3			45	-	-	-	-	-	-	-	No	No	
Slovenia	8	8	22*	22*		?	?	?	?	?	?	-	No	No	* Height of highest floor
Spain	∞	∞	∞	∞	60*		60	60	90	90	90	30	No	No	* 30 for one-family house
Sweden	∞	∞	∞	∞	30	30	60	60	90*	90*	90*	30	(1994)	No	* 60 minutes for horizontal elements
Switzerland	2*	2*			30**		-	-	-	-	-	-	(2003)	No	* 5 storeys in canton Aargau; ** no req for 1 storey
UK	6	6	18	18	30	15	60	60	60	60	90*	**	Yes	No	* not in Scotland; ** timber only if other escapes available
Australia	3*	3*			90	90/30	90	90/60	-	-	-	90	(1994)	No	* 4 storeys if ground level non comb garage
New Zealand	∞	∞	∞	∞	30	30	45	45	45	45	45	30	2000	No	
Canada	3	4			45/60*	45/60*	45/60*	45/60*	-	-	-	60		Yes	* Depends on area and height of building
USA	3/4*	4/5*			60	60	60	60	60	60	60	60		Yes	* Depends on building code
Japan	3	3	13	13	30/45		45/60*	45/60*	-	-	-	-	2000	No	* 4 storeys requirement: 60 min + 3 h rest

^o Requirements given only if timber structures allowed.

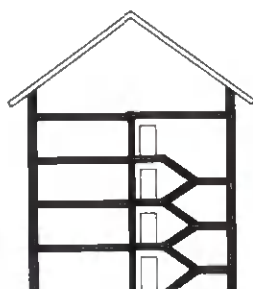
Table 2. Visible wood (on surfaces), maximum number of storeys in Residential buildings

Countries	Facades				Wall and ceiling linings				Floorings		Code changes		Comments		
	Wood, untr.		FRT wood		Flats		Escape routes		Flats	Esc. rout	since 1995	For sprink- lers			
	Unspr.	Spr.	Unspr	Spr.	Wood, untreated	FRT wood	Wood, untreated	Spr.	Unspr.	Unspr.	Wood	Unspr.			
Austria	2	2	4	4	4	4	2	2	4	4	2	2	No		
Belgium	1	1	1	1	∞*	∞*	0	0	∞	∞	0	0	No	* Walls only (0 storeys for ceilings)	
Czech Rep	3*	3*	3*	3*	3*	3*	0	0	0	3*	0	0	No	* 9 m height	
Denmark	1	2	4	4	0	4	0	0	4	4	4	4	1999	Yes	
Finland	2	4	2*/∞	4*/∞	2*/∞	4*/∞	0	0	4*/∞	4*/∞	4*/∞	4*/∞	1997	Yes	* In timber-frame buildings
France	4*	4*	-	-	∞	∞	0	0	0	∞	∞	∞	No	No	* higher if C+D rule applied, but not on ground floor
Germany	3	3	5	5	∞	∞	0	0	0	∞	0	0	No	No	
Greece	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	No	No	Only fire resistance requirements
Hungary	2	2	2	2	∞	∞	5	5	5	∞	5	5	No	No	
Iceland	1	1	∞	∞	1	∞	0	0	∞	∞	∞	∞	1998	Yes	
Ireland	8*	8*	12*	12*	4**	4**	0	0	∞	∞	∞	∞	Yes	No	* >1 m sep, **not on sep walls; *** not in fire fight stairways
Italy	4	4	4	4	4	4	0	0	4	4	2	2	No	No	Links between req. on Fire resist and Reac to fire
Netherlands	5	5	∞	∞	∞	∞	0	0	∞	∞	0	0	No	No	
Norway	∞*	∞*	∞	∞	∞**	∞**	0	0	∞	∞	∞	∞	1997	No	* Local decision; ** for compartments < 200 m ²
Poland	2	2	2	2	4/2*	4/2*	0	0	0	4	0	0	No	No	* Wall /ceiling linings
Portugal	0	0	0	0	∞	∞	0	0	0	∞	0	0	No	No	
Romania	2	2	3	3	∞	∞	∞	∞	∞	∞	∞	∞	No	No	
Slovakia	4	4	4	4	2	∞	0	0	0	∞	∞	∞	No	Yes	
Slovenia	8*	8*	8*	8*	∞	∞	8	8	8	8	8	8	No	No	* highest floor > 22 m and horizontal barriers req.
Spain	∞	∞	∞	∞	∞	∞	0	0	∞	∞	0*	0*	No	No	Mainly fire resistance requirements; *∞ for FRT wood
Sweden	2	2	2	2	8	8	0	0	∞	∞	∞	∞	(1994)	Yes	
Switzerland	2	2	2	2	8	8	0/1	0/1	0/1	∞	8	8	(2003)	No	
UK	6	6	18	18	2	2	0	0	∞	∞	0	0	Yes	No	
Australia	3/∞*	3/∞*	3/∞*	3/∞*	∞*	∞*	0	0	0	∞	0	0	(2004)	Later	* if load bearing and sep. elements non-comb
New Zealand	3	3			∞	∞	0	0	∞	∞	∞	∞	2000	Yes	
Canada	3	4	3	∞	∞	∞	0	0	∞	∞	7*	7*		Yes	* 18 m height
USA	3	3	3	3	∞	∞	0	0	∞	∞	0*	0*		No	* ∞ in some codes (east part of USA)
Japan	3	3	3	3	3	3	0	0	3	3	3	3	2000	No	

*∞ Only if meeting required class. In addition durability of improved class, especially at humid and exterior applications, will be required.

Austria

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o				Changes		
Unspr.	Spr.	Unspr.	Spr.	1-2 storeys		3-4 storeys		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	load-bear.	sep.	4 storey building		
4*	4*			60	30	60	60	60	2000	No

^o Requirements given only if timber structure allowed; * Forth storey > 1 m inclined from facade

Visible wood, storeys

Facades				Wall and ceiling linings						Floorings		Changes	
Wood, untr.		FRT wood ^o		Flats			Escape routes			Flats	Esc.rout	Since 1995	For sprinklers
Unspr.	Spr.	Unsp.	Spr.	Wood, untr	FRT wood ^o		Wood, untr	FRT wood ^o		Wood			
2	2	4	4	4	4	4	2	2	4	4	2	2000	No

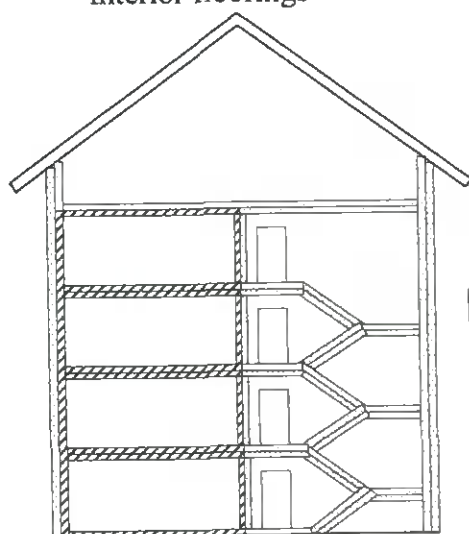
^o Only if meeting required class

NOTE: There are major differences between the federal states in Austria. The Vienna regulation is represented here. It is the most progressive one regarding the use of wood in buildings

Possible use in unsprinkled 4-storey buildings:

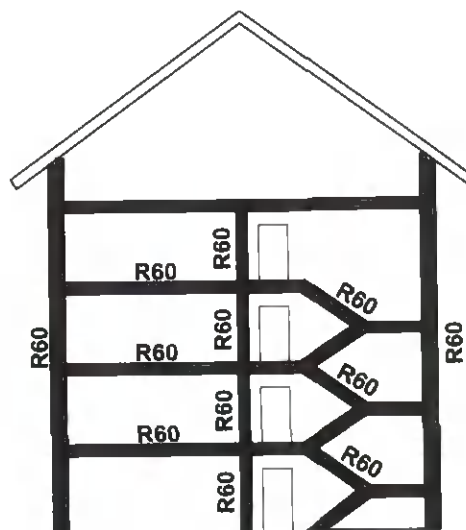
1. Visible wood surfaces

- Exterior facade claddings
- Interior wall and ceiling linings
- Interior floorings



Reaction to fire – visible wood

2. Load bearing timber structures

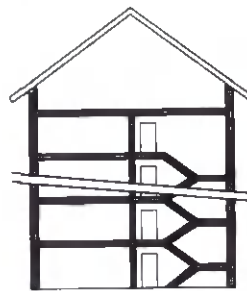


Fire resistance – requirement levels

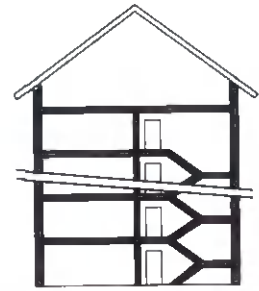


Belgium

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings °								Changes		
Unspr.	Spr.	Unspr.	Spr.	1-2		3-4		5-6		7-8		Stairs 4 storey building	Since 1995	For sprinklers
				load- bear.	sep.	load- bear.	sep.	load- bear.	sep.	load- bear.	sep.			
∞	∞	∞	∞	60	60	60	60	60	60	60	60	60	No	No

° Requirements given only if timber structure allowed

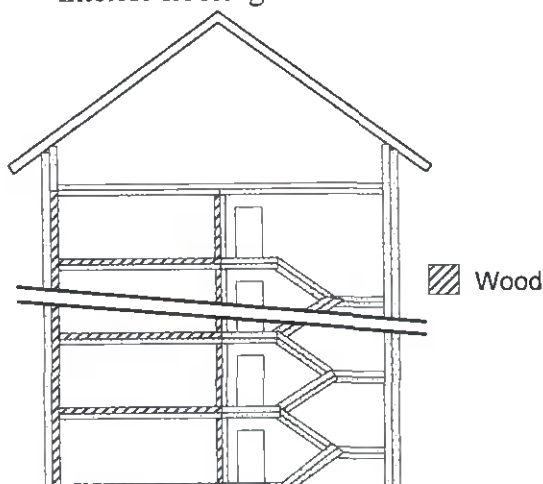
Visible wood, storeys

Facades				Wall and ceiling linings						Floorings		Changes	
Wood, untr.		FRT wood°		Flats		Escape routes				Flats	Esc.rout	Since 1995	For sprinklers
Unspr.	Spr.	Unsp.	Spr.	Unsp.	Spr.	Wood, untr	FRT wood°	Wood	Wood				
1	1	1	1	∞*	∞*	∞*	0	0	∞	∞	0	No	No

° Only if meeting required class; * Walls only (0 storeys for ceilings)

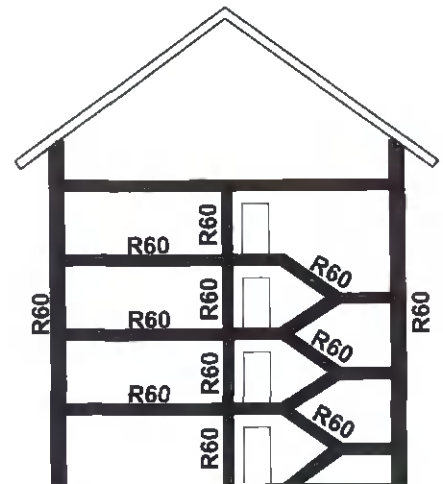
Possible use in unsprinkled buildings:

- Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings



Reaction to fire – visible wood

- Load bearing timber structures



Fire resistance – requirement levels

Czech Republic

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings °					Changes	
Unspr.	Spr.	Unspr.	Spr.	1-2		3-4		Stairs 4 storey building	Since 1995	For sprinklers
				load-bear.	sep.	load-bear.	sep.			
3	3	9	9	45*		60*		30	No	No

° Requirements given only if timber structure allowed; * Underground floor excluded, 30 minutes for highest storey

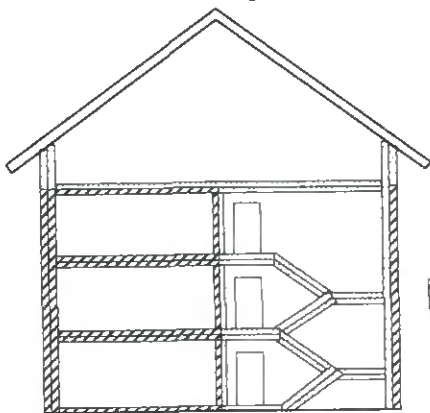
Visible wood, storeys

Facades				Wall and ceiling linings					Floorings		Changes			
Wood, untr.		FRT wood		Flats		Escape routes			Flats	Esc.rout	Since 1995	For sprinklers		
				Wood, untr	FRT wood	Wood, untr	FRT wood	Unspr.	Spr.	Unspr.			Unspr.	
Unspr.	Spr.	Unsp.	Spr.	Unsp.	Spr.	Unspr.	Spr.			Wood				
3*	3*	3*	3*	3*	3*	3*		0	0	0	3*	0	No	No

* 9 m height

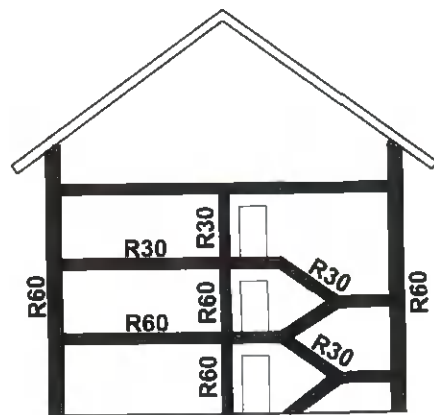
Possible use in unsprinkled 3-storey buildings:

- Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings
- Load bearing timber structures



Wood

Reaction to fire – visible wood

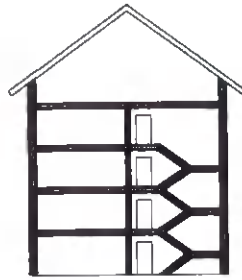


Fire resistance – requirement levels

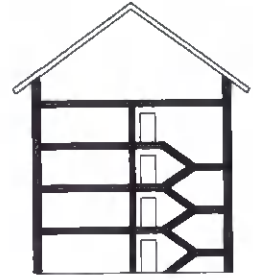


Denmark

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings °					Changes	
Unspr.	Spr.	Unspr.	Spr.	1-2		3-4		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	load-bear.	sep.	4 storey building		
4	4			60	60	60*	60*	30	1999	No

° Requirements given only if timber structure allowed; * Protection to prevent charring required

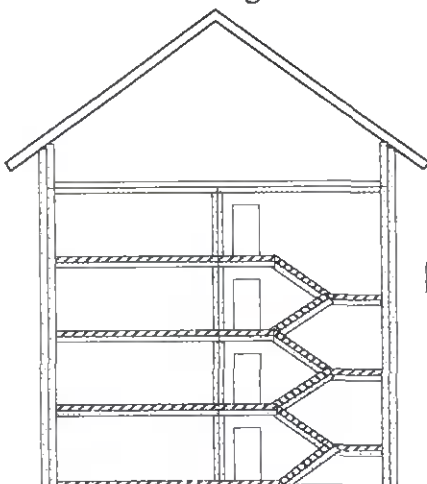
Visible wood, storeys

Facades				Wall and ceiling linings						Floorings		Changes	
Wood, untr.		FRT wood°		Flats		Escape routes		Esc. rout		Since 1995	For sprinklers		
				Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.			Wood	
1	2	4	4	0	0	4	0	0	4	4	4	1999	Yes

° Only if meeting required class

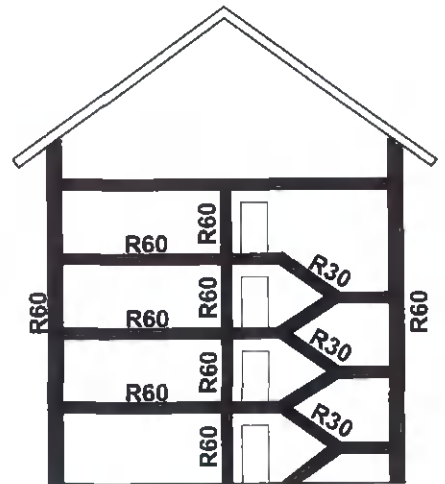
Possible use in unsprinkled 4-storey buildings:

- Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings
- Load bearing timber structures



Reaction to fire – visible wood

Wood



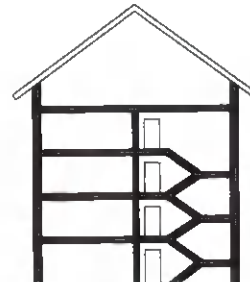
Fire resistance – requirement levels

Finland

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o			Changes	
Unspr.	Spr.	Unspr.	Spr.	1-2		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	4 storey building		
2	4	9	14	30/-*	30	-	1997	Yes

^o Requirements given only if timber structure allowed; * Depending on fire class of the building

Visible wood, storeys

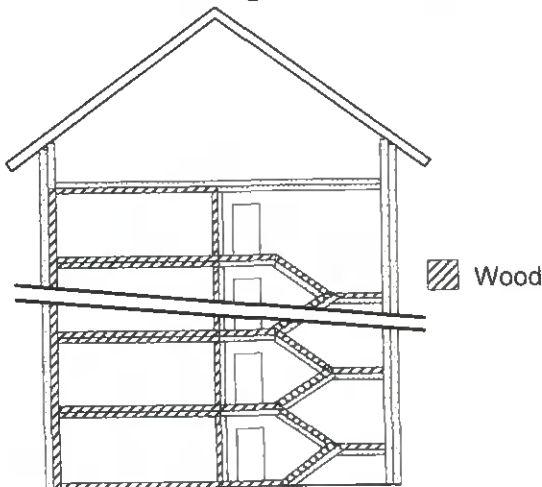
Facades		Wall and ceiling linings				Floorings		Changes		
		Flats		Escape routes		Flats	Esc.rout			
Wood, untr.	FRT wood ^o	Wood, untr	FRT wood ^o	Wood, untr	FRT wood ^o	Wood		Since 1995	For sprinklers	
Unspr.	Spr.	Unsp	Spr.	Unspr.	Spr.	Unspr.	Unspr.			
2	4	2*/∞	4*/∞	2*/∞	2*/∞	4*/∞	4*/∞	4*/∞	1997	Yes

^o Only if meeting required class; * In timber-frame buildings

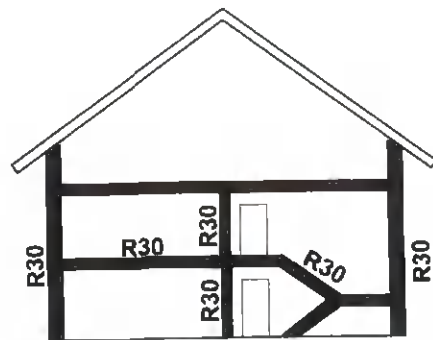
Possible use in unsprinkled buildings:

1. Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings

2. Load bearing timber structures



Reaction to fire – visible wood (if non-combustible structure)

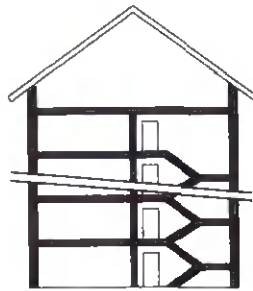


Fire resistance – requirement levels

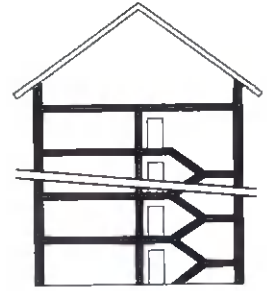


France

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings °								Changes		
Unspr.	Spr.	Unspr.	Spr.	1-2		3-4		5-6		7-8		Stairs 4 storey building	Since 1995	For sprinklers
				load- bear.	sep.	load- bear.	sep.	load- bear.	sep.	load- bear.	sep.			
15	15	50	50	15/30*	15/30*	30/60*	30/60*	90	90	90	90		No	No

° Requirements given only if timber structure allowed; * Vertically / Horizontally

Visible wood, storeys

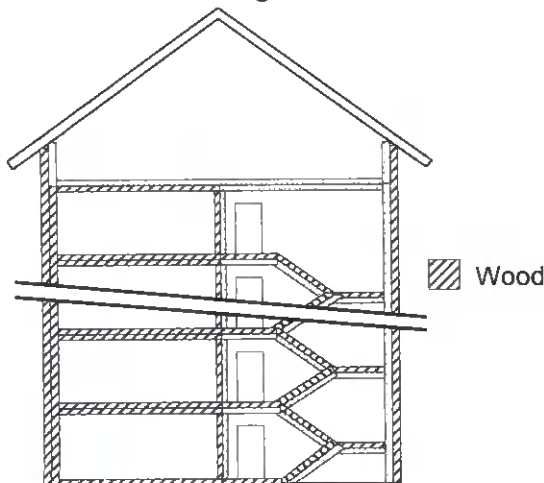
Facades				Wall and ceiling linings						Floorings		Changes	
Wood, untr.		FRT wood		Flats		Escape routes		Flats		Esc.rout		Since 1995	For sprinklers
				Wood, untr	FRT wood	Wood, untr	FRT wood	Wood	Esc.rout				
Unspr.	Spr.	Unsp.	Spr.	Unsp.	Spr.	Unsp.	Spr.	Unspr.	Unspr.	Unspr.	Unspr.		
4*	4*			∞	∞	∞	0	0	0	∞	∞	No	No

* higher if C+D rule applied, but not on ground floor

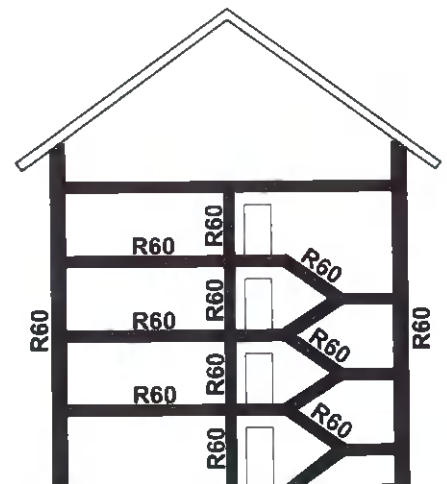
Possible use in unsprinkled buildings:

- Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings

- Load bearing timber structures



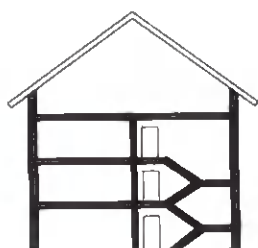
Reaction to fire – visible wood
(wooden facades only in 4 storeys)



Fire resistance – requirement levels

Germany

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o					Changes	
Unspr.	Spr.	Unspr.	Spr.	1-2		3-4		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	load-bear.	sep.	4 storey building		
3/5*	3/5*			30		30**/90		60	No	Yes

^o Requirements given only if timber structure allowed; *Future extension; ** 30 minutes for 3 storeys

Visible wood, storeys

Facades				Wall and ceiling linings						Floorings		Changes		
Wood, untr.		FRT wood ^o		Flats		Escape routes				Flats	Esc.rout	Since 1995	For sprinklers	
				Unspr.	Spr.	Wood, untr	FRT wood ^o	Wood, untr	FRT wood ^o	Wood	Esc.rout			
Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.	Unspr.	Unspr.			
3	3	5	5	∞	∞	∞		0	0	0	∞	0	No	No

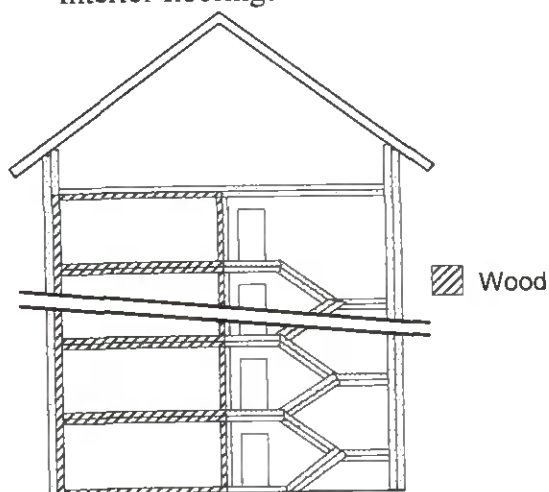
^o Only if meeting required class

NOTE: There are major differences between the federal states in Germany.
A new national building regulation is expected in the near future.

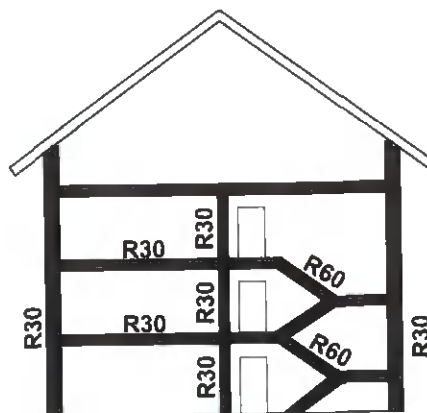
Possible use in unsprinkled buildings:

1. Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings

2. Load bearing timber structures



Reaction to fire – visible wood
(if non-combustible structure)

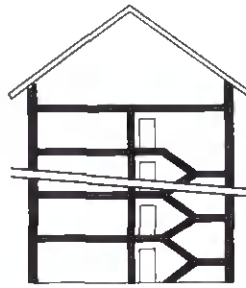


Fire resistance – requirement levels

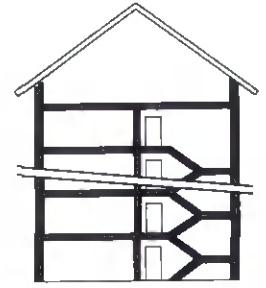


Greece

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings °								Changes		
Unspr.	Spr.	Unspr.	Spr.	1-2		3-4		5-6		7-8		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	load-bear.	sep.	load-bear.	sep.	load-bear.	sep.	4 storey building		
∞	∞	∞	∞	30		30		60		60			No	No

° Requirements given only if timber structure allowed; Underground floor excluded

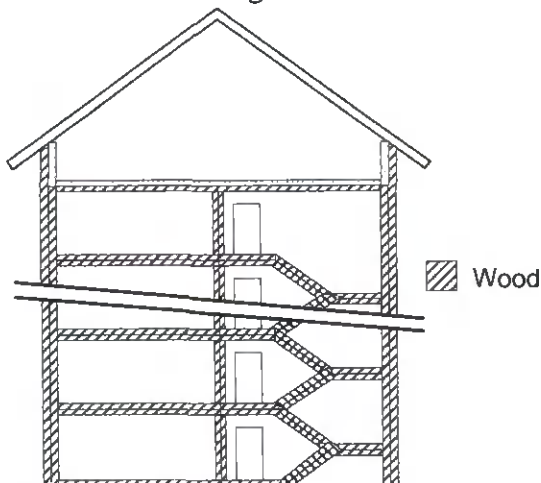
Visible wood, storeys

Facades				Wall and ceiling linings						Floorings		Changes	
Wood, untr.		FRT wood		Flats		Escape routes				Flats	Esc.rout	Since 1995	For sprinklers
Unspr.	Spr.	Unsp	Spr.	Wood, untr	FRT wood	Wood, untr	FRT wood	Wood	Unspr.	Unspr.			
∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	No	No

NOTE: There are only fire resistance requirements in Greece.

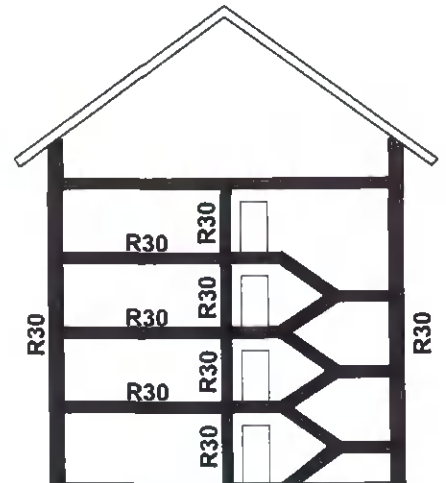
Possible use in unsprinkled buildings:

1. Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings



Reaction to fire – visible wood

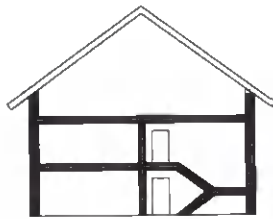
2. Load bearing timber structures



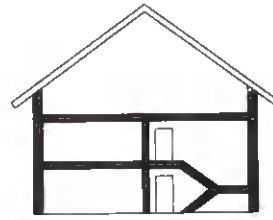
Fire resistance – requirement levels

Hungary

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings °						Changes		
Unspr.	Spr.	Unspr.	Spr.	1-2		3-4		5-6		Stairs 4 storey building	Since 1995	For sprinklers
				load-bear.	sep.	load-bear.	sep.	load-bear.	sep.			
2	2			30	30	-	90/45*	-	150/45**	-	No	No

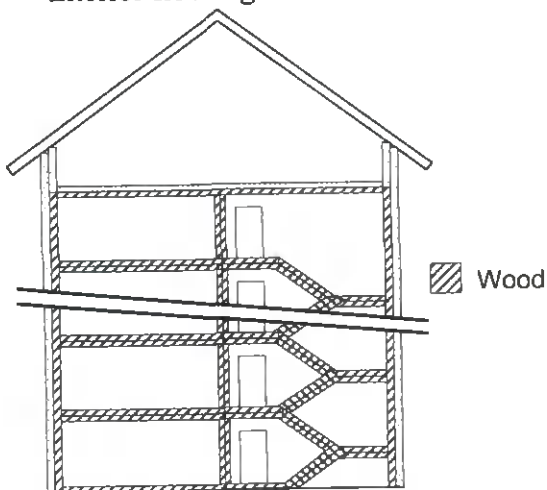
° Requirements given only if timber structure allowed; * Vertically/Horizontally; ** Only 5 storeys in timber

Visible wood, storeys

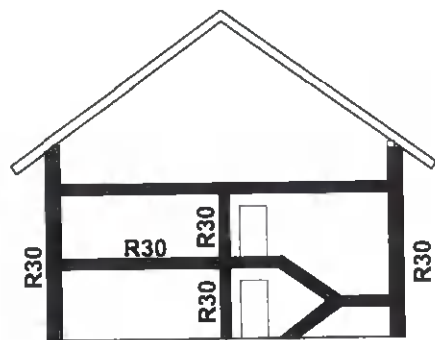
Facades				Wall and ceiling linings						Floorings		Changes	
Wood, untr.		FRT wood		Flats		Escape routes		Flats	Esc.rout	Wood		Since 1995	For sprinklers
				Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.				
2	2	2	2	∞	∞	∞	5	5	5	∞	5	No	No

Possible use in unsprinkled buildings:

- Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings
- Load bearing timber structures



Reaction to fire – visible wood (if non-combustible structure)

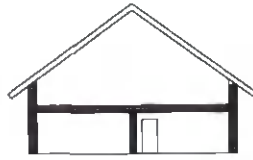


Fire resistance – requirement levels

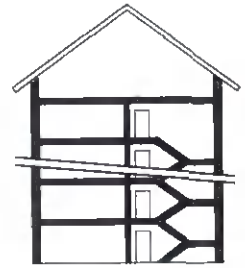


Iceland

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings °			Changes	
Unspr.	Spr.	Unspr.	Spr.	1-2		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	4 storey building		
1	∞			-/30*		30	1998	Yes

° Requirements given only if timber structure allowed; * < 200 m² / < 600 m²

Visible wood, storeys

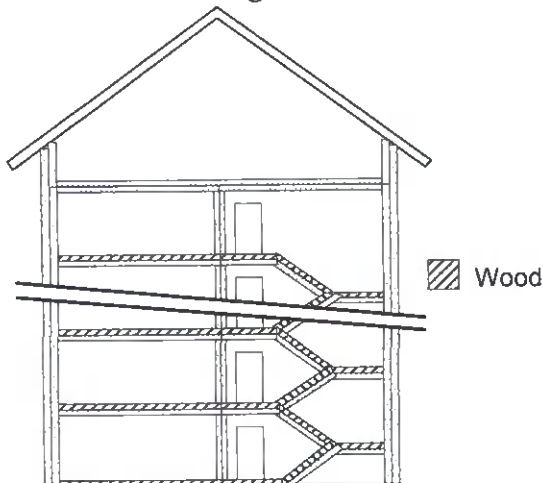
Facades				Wall and ceiling linings						Floorings		Changes	
Wood, untr.		FRT wood°		Flats		Escape routes		Flats	Esc.rout	Since 1995	For sprinklers		
Unspr.	Spr.	Unsp	Spr.	Wood, untr	FRT wood°	Wood, untr	FRT wood°	Wood					
1	1	∞	∞	1	∞	∞	0	0	∞	∞	∞	1998	Yes

° Only if meeting required class

Possible use in unsprinkled buildings:

- Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings

- Load bearing timber structures



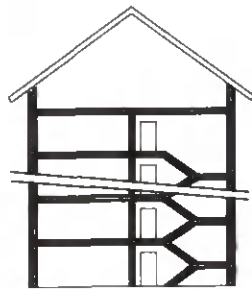
Reaction to fire – visible wood (if non-combustible structure)



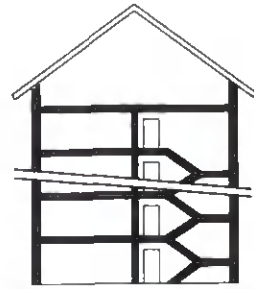
Fire resistance – requirement levels

Ireland

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers



Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o								Changes		
Unspr.	Spr.	Unspr.	Spr.	1-2 storeys		3-4 storeys		5-6 storeys		7-8 storeys		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	load-bear.	sep.	load-bear.	sep.	load-bear.	sep.	4 storey building		
∞	∞	∞	∞	30	60	60*	60*	60*	60*	60**	60**	30	Yes	Yes

^o Requirements given if timber structure allowed; * 5 < height ≤ 20 m; ** 90 minutes for 20 < height ≤ 30 m

Visible wood, storeys

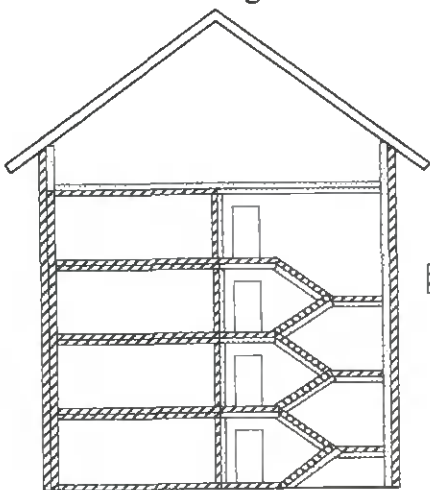
Facades				Wall and ceiling linings						Floorings		Changes	
Wood, untr.		FRT wood ^o		Flats		Escape routes		Flats	Esc.rout	Since 1995	For sprinklers		
				Wood, untr	FRT wood ^o	Wood, untr	FRT wood ^o	Wood					
Unspr.	Spr.	Unsp	Spr.	Unsp	Spr.	Unspr.	Spr.	Unspr.	Unspr.				
8*	8*	12**	12**	4***	4***	∞	0	0	∞	∞	∞****	Yes	No

^o Only if meeting required class; * > 1 m to boundary and ≤ 20 m in height; ** > 1 m to boundary and ≤ 30 m height; *** not on separating walls; **** not in fire fighting stairways

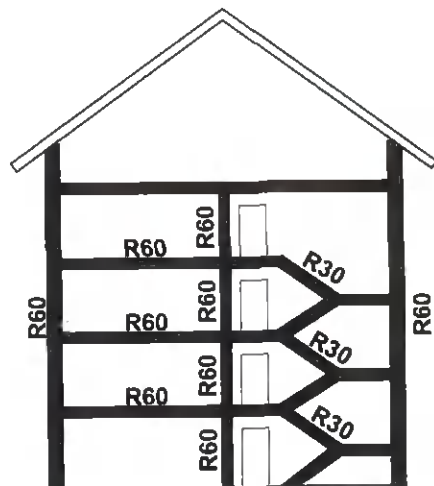
NOTE: The regulations in Ireland are very complicated and the situation may change for specific individual cases.

Possible use in unsprinkled 4-storey buildings:

- Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings
- Load bearing timber structures



Reaction to fire – visible wood

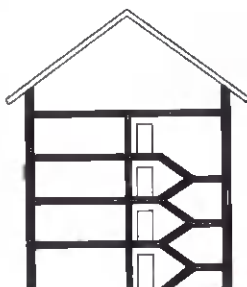


Fire resistance – requirement levels

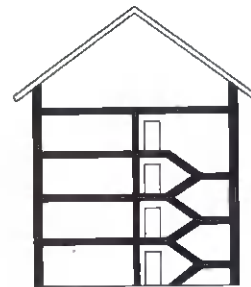


Italy

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings °					Changes	
Unspr.	Spr.	Unspr.	Spr.	1-2		3-4		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	load-bear.	sep.	4 storey building		
4	4			30		30		30	No	Yes

° Requirements given only if timber structure allowed;

Visible wood, storeys

Facades				Wall and ceiling linings						Floorings		Changes	
		FRT wood°		Flats		Escape routes		Flats	Esc.rout			Since 1995	For sprinklers
Wood, untr.	Unspr.	Spr.	Unsp	Spr.	Wood, untr	FRT wood°	Wood, untr	FRT wood°	Wood				
Unspr.	Spr.	Unsp	Spr.	Unsp	Spr.	Unspr.	Spr.	Unspr.	Spr.	Unspr.	Unspr.		
4	4	4	4	4	4	4	0	0	4	4	2	No	No

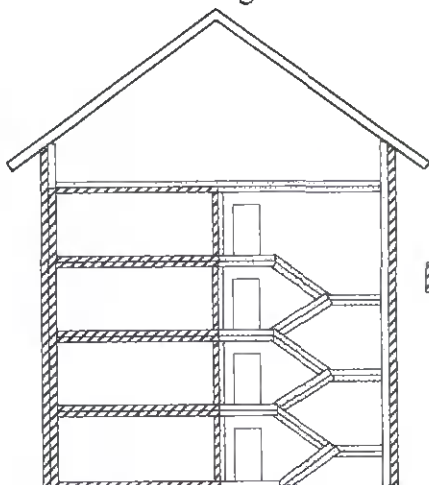
° Only if meeting required class;

NOTE: There are links between requirements on Fire resistance and Reaction to fire in Italy. The fire requirements are also linked to seismic regions.

Possible use in unsprinkled 4-storey buildings:

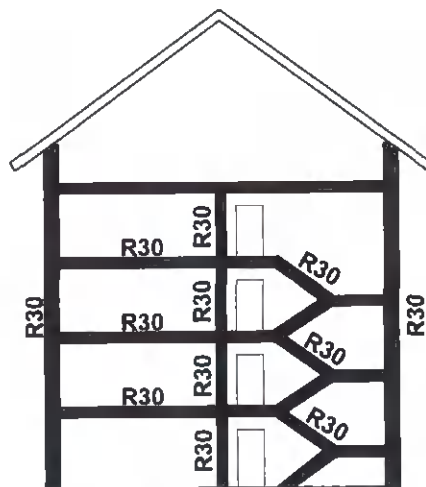
1. Visible wood surfaces

- Exterior facade claddings
- Interior wall and ceiling linings
- Interior floorings



Reaction to fire – visible wood

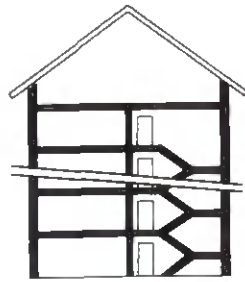
2. Load bearing timber structures



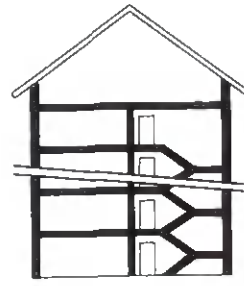
Fire resistance – requirement levels

Netherlands

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o								Changes		
Unspr.	Spr.	Unspr.	Spr.	1-2		3-4		5-6		7-8		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	load-bear.	sep.	load-bear.	sep.	load-bear.	sep.	4 storey building		
∞*	∞*	∞*	∞*	30**		60**		90**		90**		60	No	No

^o Requirements given only if timber structure allowed; * in practise 5 storeys (13 m); ** + 30 minutes for fire load > 500 kJ/m²

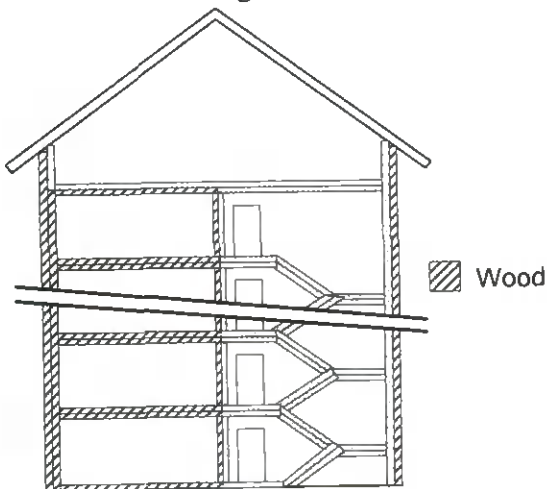
Visible wood, storeys

Facades				Wall and ceiling linings				Floorings		Changes		
Wood, untr.		FRT wood ^o		Flats		Escape routes		Flats	Esc.rout	Since 1995	For sprinklers	
				Unspr.	Spr.	Wood, untr	FRT wood ^o	Wood				
Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.	Unspr.	Unspr.			
5	5	∞	∞	∞	∞	∞	0	0	∞	0	No	No

^o Only if meeting required class

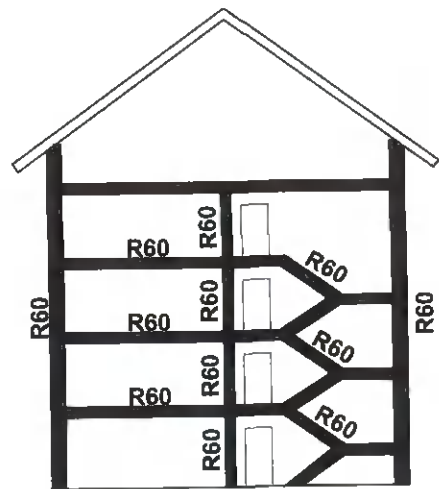
Possible use in unsprinkled buildings:

1. Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings



Reaction to fire – visible wood (wooden façade only in 5 storeys)

2. Load bearing timber structures

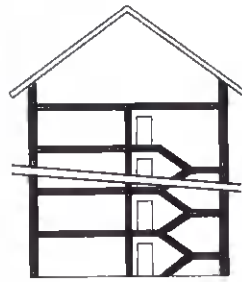


Fire resistance – requirement levels

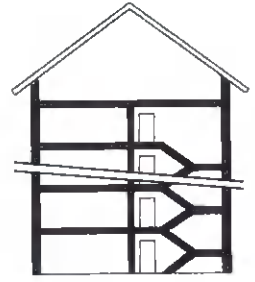


Norway

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings °								Changes		
Unspr.	Spr.	Unspr.	Spr.	1-2		3-4		5-6		7-8		Stairs 4 storey building	Since 1995	For sprinklers
				load-bear.	sep.	load-bear.	sep.	load-bear.	sep.	load-bear.	sep.			
∞	∞	∞	∞	15	30	60	60	*	*	*	*	30	1997	No

° Requirements given only if timber structure allowed; * Special requirements > 4 storeys (detailed documentation needed)

Visible wood, storeys

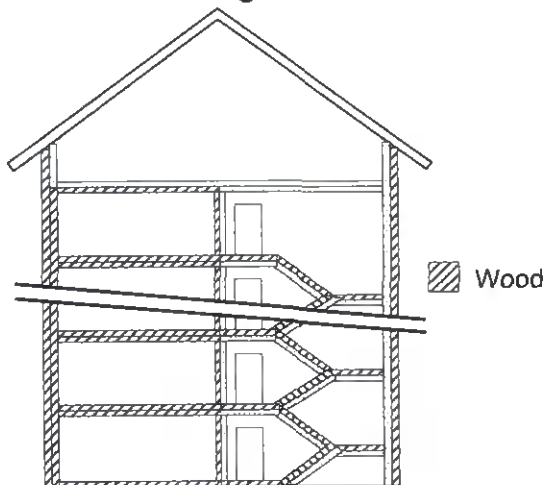
Facades				Wall and ceiling linings						Floorings		Changes	
Wood, untr.		FRT wood°		Flats		Escape routes		Flats	Esc.rout	Wood		Since 1995	For sprinklers
				Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.				
∞*	∞*	∞	∞	∞**	∞**	∞**	0	0	∞	∞	∞	1997	No

° Only if meeting required class; * Local decision; ** For compartments < 200 m²

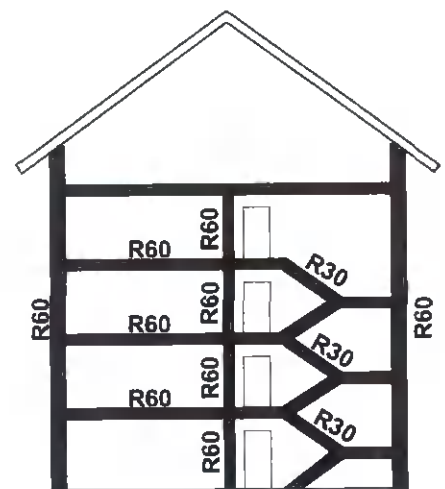
Possible use in unsprinkled buildings:

- Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings

- Load bearing timber structures



Reaction to fire – visible wood



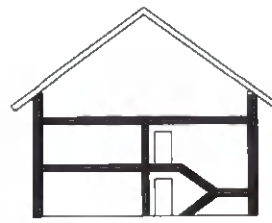
Fire resistance – requirement levels

Poland

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o			Changes	
Unspr.	Spr.	Unspr.	Spr.	1-2		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	4 storey building		
2	2			?	?			No

^o Requirements given only if timber structure allowed

Visible wood, storeys

Facades				Wall and ceiling linings						Floorings		Changes	
				Flats			Escape routes			Flats	Esc.rout	Since 1995	For sprinklers
Wood, untr.	FRT wood	Wood, untr.		FRT wood		Wood, untr.		FRT wood		Wood			
Unspr.	Spr.	Unsp	Spr.	Unsp	Spr.	Unspr.	Spr.	Unspr.	Spr.	Unspr.	Unspr.		
2	2	2	2	4/2*	4/2*	4/2*	0	0	0	4	0		No

* Wall / ceiling linings

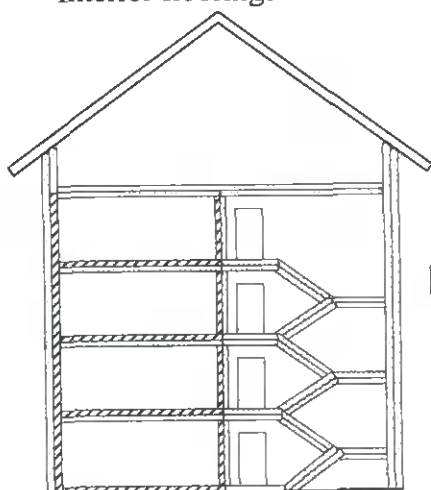
NOTE: There is limited information from Poland.

Possible use in unsprinkled buildings:

1. Visible wood surfaces

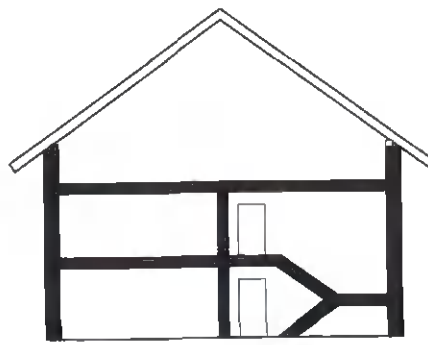
- Exterior facade claddings
- Interior wall and ceiling linings
- Interior floorings

2. Load bearing timber structures



▨ Wood

Reaction to fire – visible wood (if non-combustible structure)



Fire resistance – requirement levels

Portugal

Maximum number of storeys in timber structures



Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o			Changes	
Unspr.	Spr.	Unspr.	Spr.	1-2		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	4 storey building		
2	2	9	9	30	-	-	No	No

^o Requirements given only if timber structure allowed

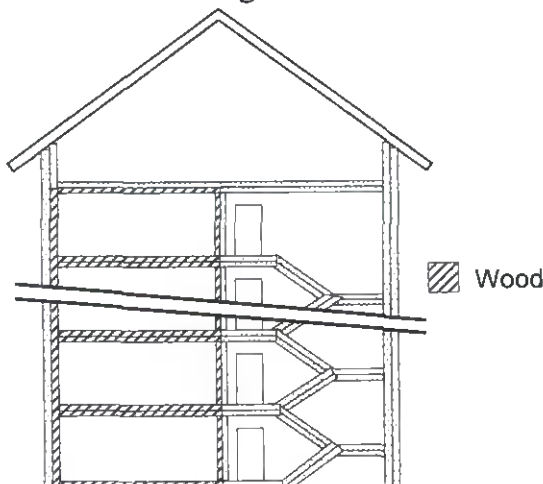
Visible wood, storeys

Facades				Wall and ceiling linings						Floorings		Changes	
Wood, untr.		FRT wood		Flats		Escape routes		Flats	Esc.rout	Since 1995	For sprinklers		
Unspr.	Spr.	Unsp.	Spr.	Unsp.	Spr.	Unsp.	Spr.	Wood					
0	0	0	0	∞	∞	∞	0	0	0	∞	0	No	No

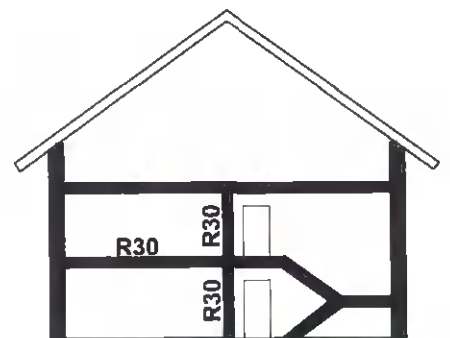
Possible use in unsprinkled buildings:

- Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings

- Load bearing timber structures



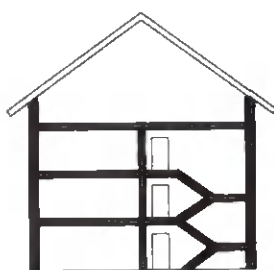
Reaction to fire – visible wood (if non-combustible structure)



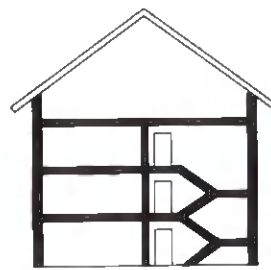
Fire resistance – requirement levels

Romania

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o				Changes		
Unspr.	Spr.	Unspr.	Spr.	1-2		3-4		Since 1995	For sprinklers	
				load-bear.	sep.	load-bear.	sep.			4 storey building
3	3			-		30		60	No	No

^o Requirements given only if timber structure allowed

Visible wood, storeys

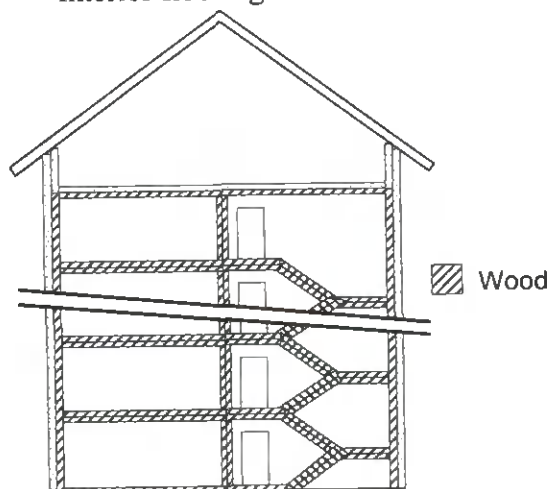
Facades				Wall and ceiling linings						Floorings		Changes	
Wood, untr.		FRT wood ^o		Flats		Escape routes				Flats	Esc.rout	Since 1995	For sprinklers
				Unsp	Spr.	Wood, untr	FRT wood ^o	Wood, untr	FRT wood ^o	Unspr.	Spr.		
2	2	3	3	∞	∞	∞	∞	∞	∞	∞	∞	No	No

^o Only if meeting required class

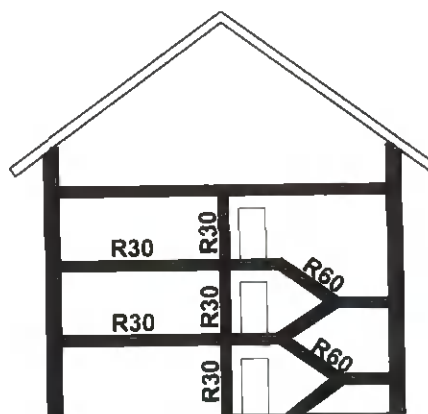
Possible use in unsprinkled buildings:

- Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings

- Load bearing timber structures



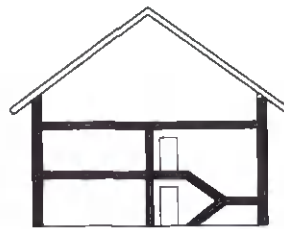
Reaction to fire – visible wood (if non-combustible structure)



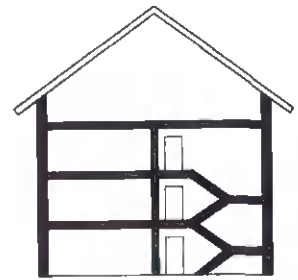
Fire resistance – requirement levels

Slovakia

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o			Changes	
Unspr.	Spr.	Unspr.	Spr.	1-2		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	4 storey building		
2	3			45			No	No

^o Requirements given only if timber structure allowed

Visible wood, storeys

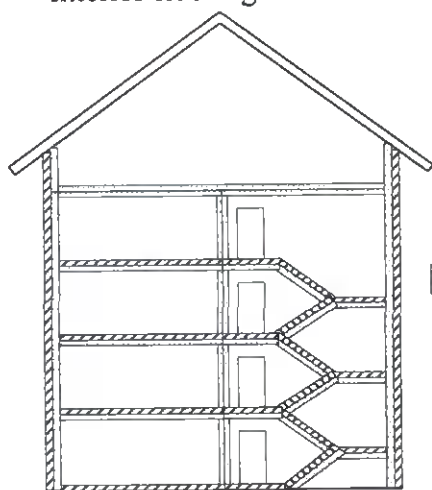
Facades				Wall and ceiling linings						Floorings		Changes	
				Flats				Escape routes		Flats	Esc.rout	Since 1995	For sprinklers
Wood, untr.	FRT wood ^o	Wood, untr.	FRT wood ^o	Wood, untr.	FRT wood ^o	Wood, untr.	FRT wood ^o	Unspr.	Spr.	Unspr.	Unspr.		
Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.	Unspr.	Unspr.	No	Yes
4	4	4	4	2	∞	∞		0	0	0	∞	∞	

^o Only if meeting required class

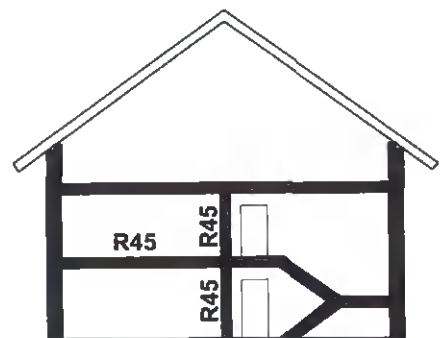
Possible use in unsprinkled buildings:

- Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings

- Load bearing timber structures



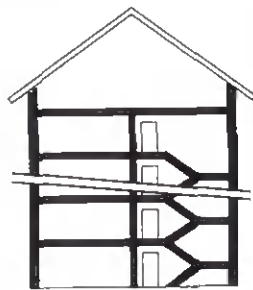
Reaction to fire – visible wood (if non-combustible structure)



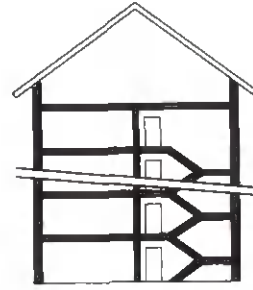
Fire resistance – requirement levels

Slovenia

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o								Changes		
Unspr.	Spr.	Unspr.	Spr.	1-2		3-4		5-6		7-8		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	load-bear.	sep.	load-bear.	sep.	load-bear.	sep.	4 storey building		
8	8	22*	22*	?	?	?	?	?	?	?	?	?	No	No

^o Requirements given only if timber structure allowed; * Height of highest floor

Visible wood, storeys

Facades				Wall and ceiling linings						Floorings		Changes	
Wood, untr.		FRT wood		Flats		Escape routes		Flats	Esc.rout	Since 1995	For sprinklers		
				Wood, untr	FRT wood	Wood, untr	FRT wood	Wood					
Unspr.	Spr.	Unsp	Spr.	Unsp	Spr.	Unspr.	Spr.	Unspr.	Unspr.				
8*	8*	8*	8*	∞	∞	∞	8	8	8	8	8	No	No

* highest floor > 22 m and horizontal barriers required

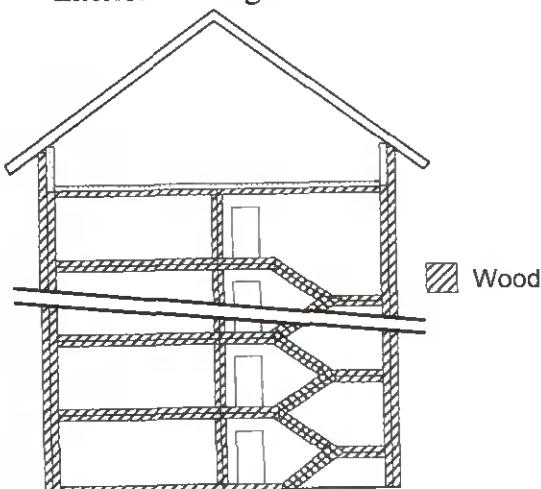
NOTE: Fire resistance requirements from Slovenia are lacking. Multi-storey timber structures are allowed in principle, but rare.

Possible use in unsprinkled buildings:

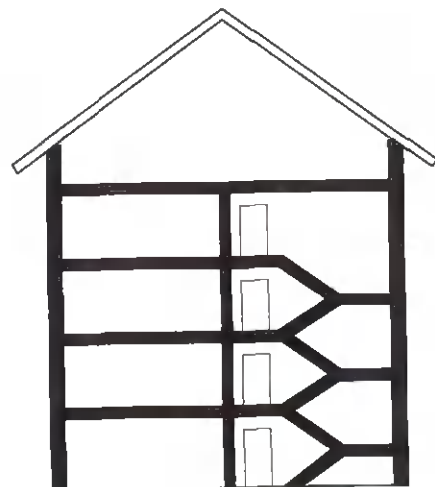
1. Visible wood surfaces

- Exterior facade claddings
- Interior wall and ceiling linings
- Interior floorings

2. Load bearing timber structures



Reaction to fire – visible wood (wooden facades up to 8 storeys)

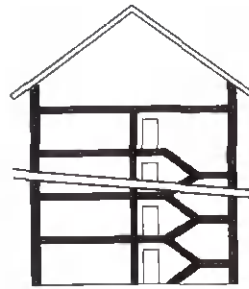


Fire resistance – requirement levels

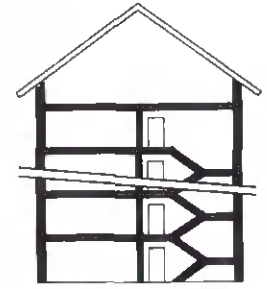


Spain

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o								Changes		
Unspr.	Spr.	Unspr.	Spr.	1-2		3-4		5-6		7-8		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	load-bear.	sep.	load-bear.	sep.	load-bear.	sep.	4 storey building		
∞	∞	∞	∞	60*		60		90		90		30	No	No

^o Requirements given only if timber structure allowed; * 30 minutes for one-family houses

Visible wood, storeys

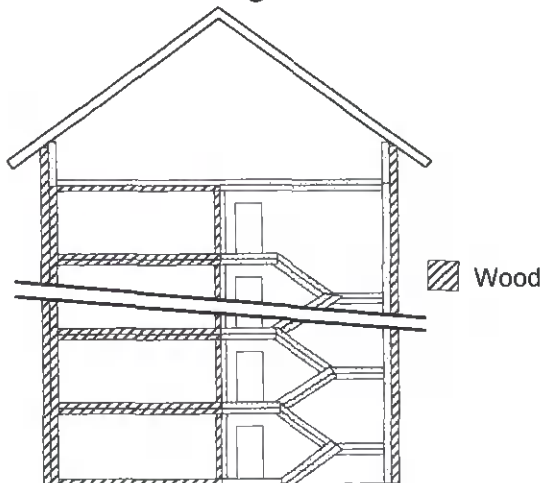
Facades				Wall and ceiling linings						Floorings		Changes		
Wood, untr.		FRT wood ^o		Flats		Escape routes				Flats	Esc.rout	Since 1995	For sprinklers	
				Unspr.	Spr.	Wood, untr	FRT wood ^o	Wood, untr	FRT wood ^o	Wood				
Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.	Unspr.	Unspr.			
∞	∞	∞	∞	∞	∞			0	0	∞	∞	0*	No	No

^o Only if meeting required class; * ∞ for FRT wood

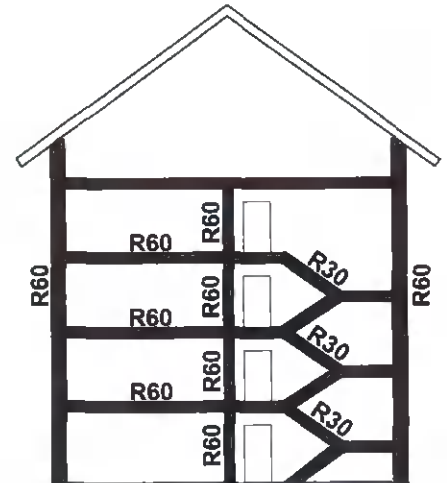
NOTE: There are mainly fire resistance requirements in Spain.

Possible use in unsprinkled buildings:

- Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings
- Load bearing timber structures



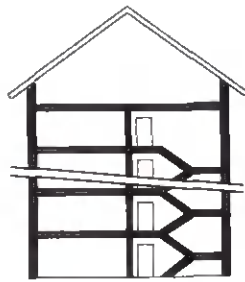
Reaction to fire – visible wood



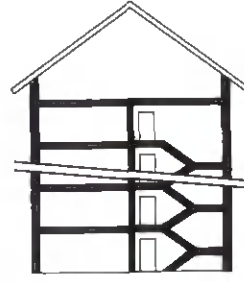
Fire resistance – requirement levels

Sweden

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers



Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o								Changes		
Unspr.	Spr.	Unspr.	Spr.	1-2		3-4		5-6		7-8		Stairs 4 storey building	Since 1995 (1994)	For sprinklers No
				load- bear.	sep.	load- bear.	sep.	load- bear.	sep.	load- bear.	sep.			
∞	∞	∞	∞	30	30	60	60	90*	90*	90*	90*	30		

^o Requirements given only if timber structure allowed; * 60 minutes for horizontal elements

Visible wood, storeys

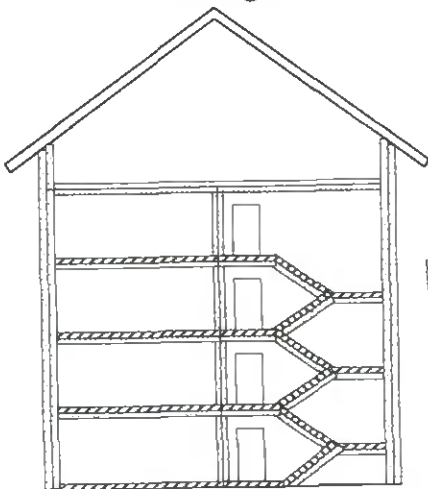
Facades				Wall and ceiling linings						Floorings		Changes	
Wood, untr.		FRT wood ^o		Flats		Escape routes		Flats	Esc.rout	Wood		Since 1995 (1994)	For sprinklers Yes
				Unspr	Spr.	Wood, untr	FRT wood ^o	Unspr.	Spr.				
2	∞	∞	∞	2	8	∞	0	0	∞	∞	∞		

^o Only if meeting required class

Possible use in unsprinkled 4-storey buildings:

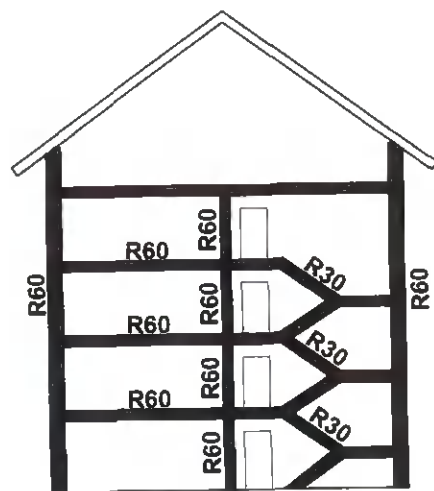
1. Visible wood surfaces

- Exterior facade claddings
- Interior wall and ceiling linings
- Interior floorings



Reaction to fire – visible wood

2. Load bearing timber structures



Fire resistance – requirement levels

Switzerland

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o			Changes	
Unspr.	Spr.	Unspr.	Spr.	1-2 storeys		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	4 storey building		
2*	2*			30**			(2003)	No

^o Requirements if timber structure allowed; * 5 storeys in canton Aagan; ** No requirements for 1 storey

Visible wood, storeys

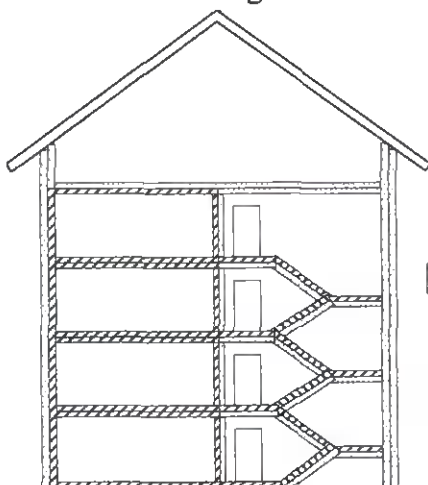
Facades				Wall and ceiling linings						Floorings		Changes	
		FRT wood ^o		Flats			Escape routes			Flats	Esc.rout	Since 1995	For sprinklers
Unspr.	Spr.	Unsp	Spr.	Unsp	Spr.	FRT wood ^o	Wood, untr	FRT wood ^o	Wood	Unspr.	Unspr.		
2	2	2	2	8	8	8	0/1	0/1	0/1	∞	8	(2003)	No

^o Only if meeting required class

NOTE: There are major differences between the cantons in Switzerland.
A new national building regulation is expected in 2003.

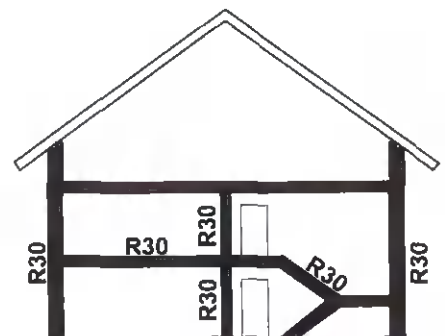
Possible use in unsprinkled buildings:

1. Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings
2. Load bearing timber structures



Wood

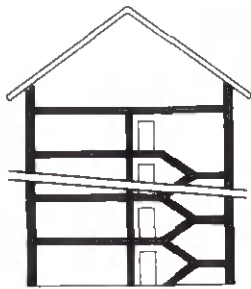
Reaction to fire – visible wood (if non-combustible structure)



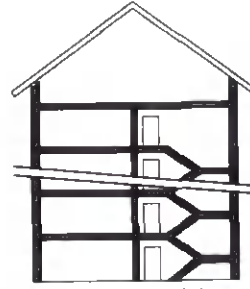
Fire resistance – requirement levels

UK

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers



Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o								Changes		
Unspr.	Spr.	Unspr.	Spr.	1-2 storeys		3-4 storeys		5-6 storeys		7-8 storeys		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	load-bear.	sep.	load-bear.	sep.	load-bear.	sep.	4 storey building		
6	6	18	18	30	15	60	60	60	60	90*	90*	**	Yes	No

^o Requirements given if timber structure allowed; * Not in Scotland; ** Timber only if other escape routes available

Visible wood, storeys

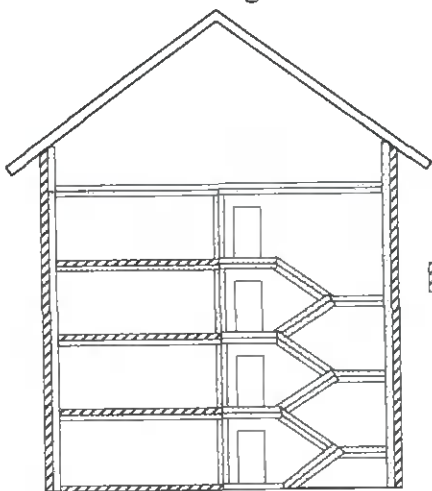
Facades				Wall and ceiling linings						Floorings		Changes	
				Flats		Escape routes		Flats	Esc.rout			Since 1995	For sprinklers
Wood, untr.	FRT wood ^o	Wood, untr	FRT wood ^o	Wood, untr	FRT wood ^o	Wood, untr	FRT wood ^o	Wood					
Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.	Unspr.	Unspr.	Since 1995	For sprinklers		
6	6	18	18	2	2	∞	0	0	∞	0	Yes	No	

^o Only if meeting required class

NOTE: There are some differences between England, Scotland, Wales and Northern Ireland.

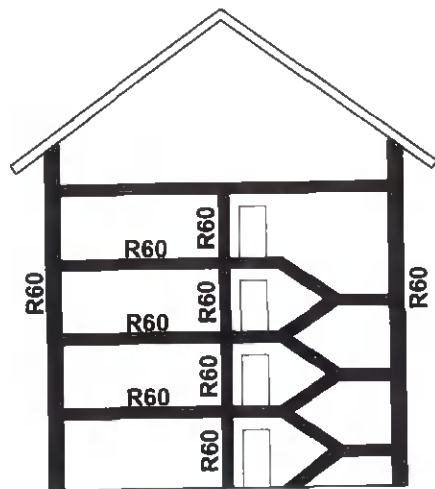
Possible use in unsprinkled 4-storey buildings:

1. Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings
2. Load bearing timber structures

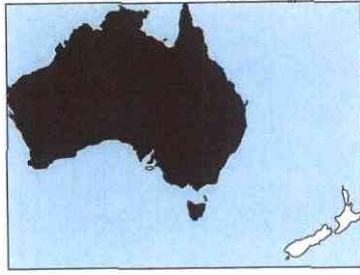


Reaction to fire – visible wood

Wood

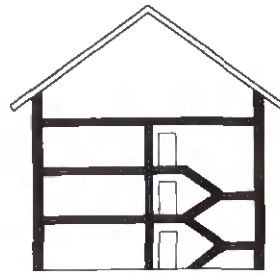


Fire resistance – requirement levels

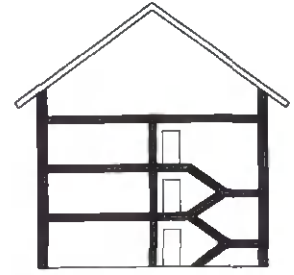


Australia

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storesys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o						Changes	
Unspr.	Spr.	Unspr.	Spr.	1-2 storeys		3-4 storeys		Stairs 4 storey building	Since 1995 (1994)	For sprinklers No	
				load-bear.	sep.	load-bear.	sep.				
3*	3*			90	90/30	90	90/60	90			

^o Requirements given only if timber structure allowed; * 4 storeys if ground level is non-combustible garage

Visible wood, storeys

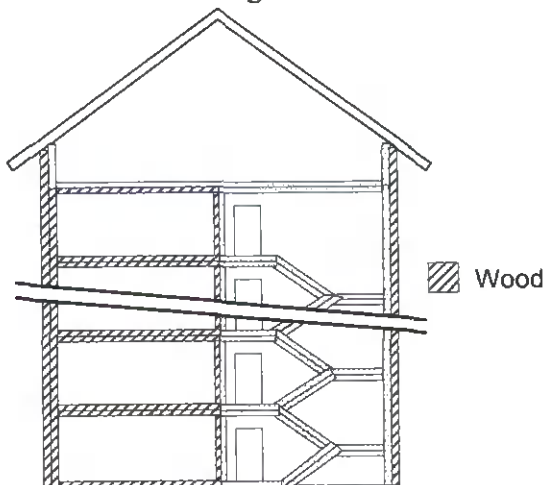
Facades				Wall and ceiling linings						Floorings		Changes	
Wood, untr.		FRT wood		Flats			Escape routes			Flats	Esc.rout	Since 1995 (2004)	For sprinklers Later
Unspr.	Spr.	Unsp	Spr.	Unsp	Spr.	FRT wood	Wood, untr	FRT wood	Unspr.	Unspr.			
3/∞*	3/∞*	3/∞*	3/∞*	∞*	∞*	∞*	0	0	0	∞	0		

* If load bearing and separating elements non-combustible

NOTE: New sprinkler dependent regulations are expected in 2004 in Australia.

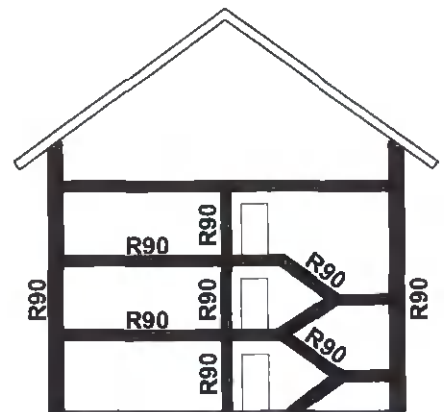
Possible use in unsprinkled buildings:

2. Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings



Reaction to fire – visible wood
(if non-combustible structure)

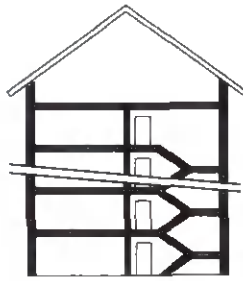
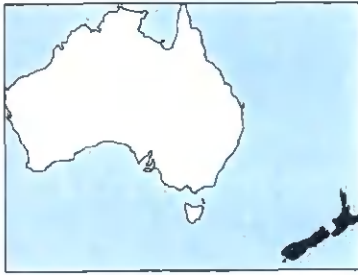
2. Load bearing timber structures



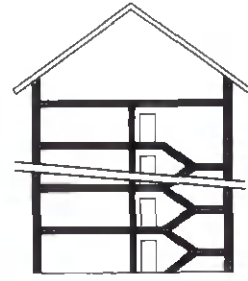
Fire resistance – requirement levels

New Zealand

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o								Changes		
Unspr.	Spr.	Unspr.	Spr.	1-2 storeys		3-4 storeys		5-6 storeys		7-8 storeys		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	load-bear.	sep.	load-bear.	sep.	load-bear.	sep.	4 storey building		
∞	∞	∞	∞	30		45		45		45		30	2000	No

^o Requirements given only if timber structure allowed

Visible wood, storeys

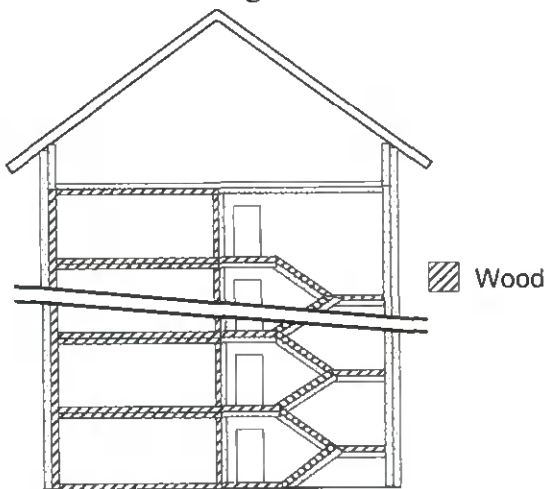
Facades				Wall and ceiling linings						Floorings		Changes			
Wood, untr.		FRT wood ^o		Flats		Escape routes		Flats		Esc.rout		Since 1995	For sprinklers		
				Unsp	Spr.	Wood, untr	FRT wood ^o	Wood		Unspr.	Unspr.				
Unspr.	Spr.	Unsp	Spr.	Unsp	Spr.	Unspr.	Spr.	Unspr.	Unspr.						
3	3			∞	∞	∞		0	0	∞		∞	∞	2000	Yes

^o Only if meeting required class

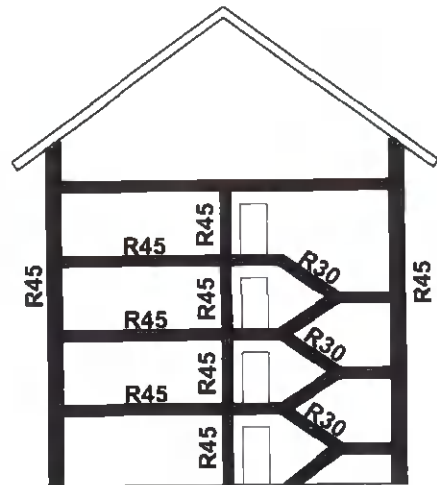
NOTE: Performance based fire regulations were introduced in New Zealand in 2000.

Possible use in unsprinkled buildings:

1. Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings
2. Load bearing timber structures

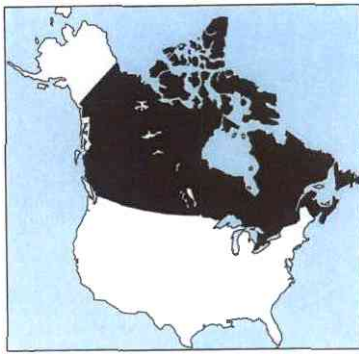


Reaction to fire – visible wood



Fire resistance – requirement levels

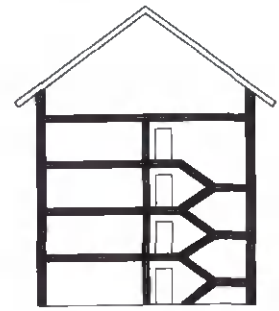
Canada



Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings [°]						Changes	
Unspr.	Spr.	Unspr.	Spr.	1-2 storeys		3-4 storeys		Stairs	Since 1995	For sprinklers	
				load-bear.	sep.	load-bear.	sep.	4 storey building			
3	4			45/60*	45/60*	45/60*	45/60*	60		Yes	

[°] Requirements given only if timber structure allowed; * Depends on area and height of building

Visible wood, storeys

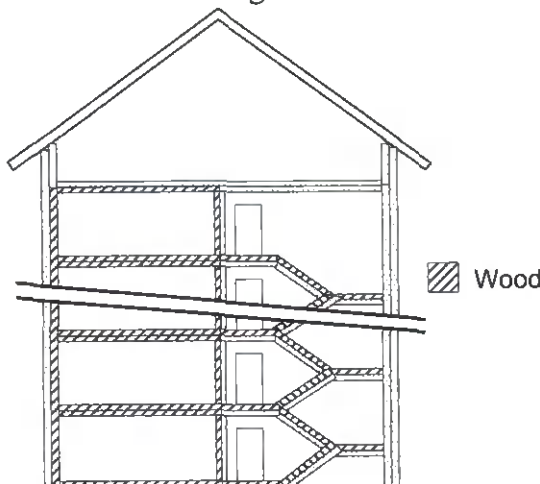
Facades				Wall and ceiling linings						Floorings		Changes	
		FRT wood [°]		Flats		Escape routes		Flats	Esc.rout	Since 1995	For sprinklers		
Wood, untr.	Unspr.	Spr.	Unsp	Spr.	Wood, untr	FRT wood [°]	Wood						
3	4	3	∞	∞	∞	∞	0	0	∞	∞	7*	Yes	

[°] Only if meeting required class; * 18 m height

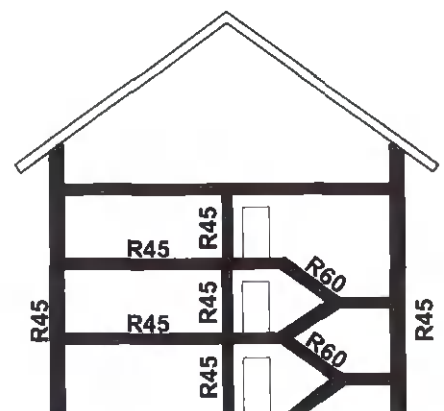
Possible use in unsprinkled buildings:

1. Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings

2. Load bearing timber structures



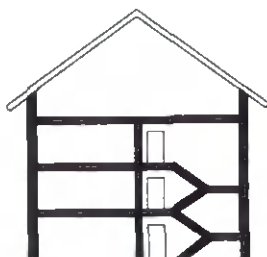
Reaction to fire – visible wood (if non-combustible structure)



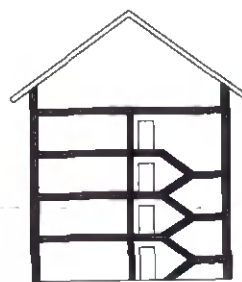
Fire resistance – requirement levels

USA

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o						Changes		
Unspr.	Spr.	Unspr.	Spr.	1-2 storeys		3-4 storeys		5-6 storeys		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	load-bear.	sep.	load-bear.	sep.	4 storey building		
3/4*	4/5*			60		60		60		60		Yes

^o Requirements given only if timber structure allowed; * Depends on building code

Visible wood, storeys

Facades				Wall and ceiling linings						Floorings		Changes	
Wood, untr.		FRT wood ^o		Flats		Escape routes				Flats	Esc.rout	Since 1995	For sprinklers
				Unspr.	Spr.	Wood, untr	FRT wood ^o	Wood, untr	FRT wood ^o	Wood	Esc.rout		
Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.	Unspr.	Spr.	Unspr.	Unspr.		
3	3	3	3	∞	∞	∞	0	0*	∞	∞	0*		No

^o Only if meeting required class; * ∞ in some codes (mainly in the east part of USA)

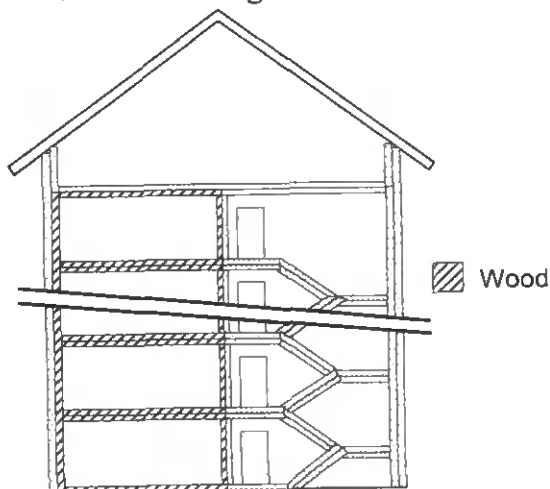
NOTE: There are different building codes in USA, three main model codes (NBC, SBC and UBC) and since 2000 also a unified "International Building Code", IBC.

Possible use in unsprinkled buildings:

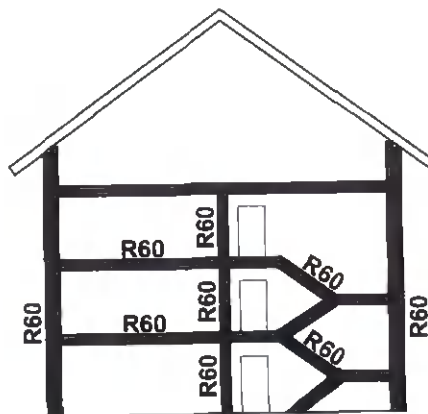
1. Visible wood surfaces

- Exterior facade claddings
- Interior wall and ceiling linings
- Interior floorings

2. Load bearing timber structures



Reaction to fire – visible wood (if non-combustible structure)



Fire resistance – requirement levels

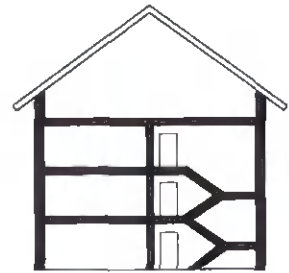


Japan

Maximum number of storeys in timber structures



Without sprinklers



With sprinklers

Structural elements in timber

Storeys		Height, m		Fire resistance requirements, minutes, Unsprinkled buildings ^o					Changes	
Unspr.	Spr.	Unspr.	Spr.	1-2 storeys		3-4 storeys		Stairs	Since 1995	For sprinklers
				load-bear.	sep.	load-bear.	sep.	4 storey building		
3	3	13	13	30/45		45/60*		-	2000	No

^o Requirements given only if timber structure allowed; * 4 storeys requirement: 60 minutes fire exposure + 3 h rest before quenching and finalizing the fire resistance test

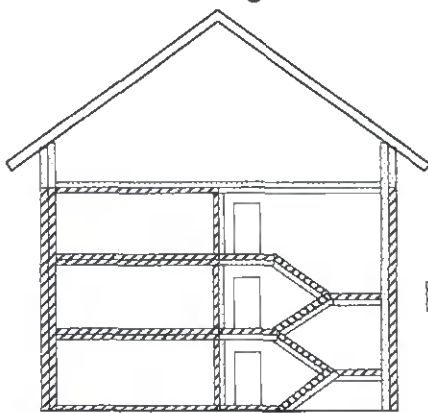
Visible wood, storeys

Facades				Wall and ceiling linings						Floorings		Changes	
Wood, untr.		FRT wood ^o		Flats		Escape routes		Flats	Esc.rout	Since 1995	For sprinklers		
Unspr.	Spr.	Unsp	Spr.	Wood, untr	FRT wood ^o	Wood, untr	FRT wood ^o	Wood					
Unspr.	Spr.	Unsp	Spr.	Unsp	Spr.	Unspr.	Spr.	Unspr.	Unspr.				
3	3	3	3	3	3	0	0	3	3	3	3	2000	No

^o Only if meeting required class

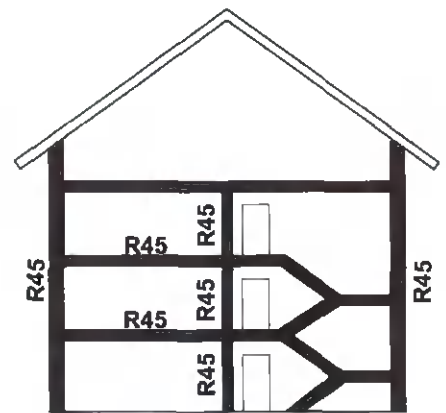
Possible use in unsprinkled buildings:

1. Visible wood surfaces
 - Exterior facade claddings
 - Interior wall and ceiling linings
 - Interior floorings



Reaction to fire – visible wood

2. Load bearing timber structures



Fire resistance – requirement levels

New design possibilities

There are several new possibilities for a more advanced fire design of timber buildings. European guidelines and models for load bearing and non-load bearing structures are available or underway /2/. Present national guidelines are often very conservative /3/.

New technologies for fire safety engineering and performance based design /4/ will provide further tools for extended use of timber in buildings. One example is the extended use of active fire protection e.g. residential sprinklers and for application of risk assessment methods /5/. A Nordic guide for fire safety design of timber buildings was published in 1999 and an extended version in 2002 /6/.

Conclusions

At least twelve European countries allow four storeys or more in timber structure and nine countries allow seven storeys or more. However, in some of these countries timber structures are very rare. On the other hand, at least nine European countries do not allow timber structures of more than one to three storeys.

Most countries have restrictions on the use of wooden facade claddings. Some countries have no restrictions, but, on the other hand also very limited experience of using wooden facades due to building traditions.

Several countries allow wooden panelling in flats, but usually not in escape routes. Wooden floorings are permitted in flats in most countries and in some countries also in escape routes.

Installation of active fire protection systems, e.g. residential sprinklers, may allow for higher buildings with timber structure or further use of visible wood in some countries. However, these systems are still quite unknown in most countries.

Outside Europe, unlimited number of storeys in timber structure is allowed only in New Zealand, where performance based requirements were introduced in 2000. Wooden facades are usually not allowed in more than three storeys. Visible wood may be used without limits in flats in three countries, but not in escape routes.

The building regulations have been changed in some countries since 1995, e.g. in Denmark, Finland, Ireland, Italy and Norway. Switzerland has announced a change to take place in 2003. Changes are soon also expected in Germany and Australia.

Main conclusions are

- There are major differences between the countries included in this survey for the use of wood products in buildings due to national fire regulations
- Technical design solutions are available only in some countries
- There is a need for exchange of experience
- Further development and application of new technologies for fire safety engineering and performance based design will facilitate extended and fire safe use of timber in buildings

References

1. Benefeu, The potential benefits of fire safety engineering in the European union, EC contract EDT/01/503480, 2002
2. prEN 1995-1-2 Eurocode 5 – Design of timber structures Part 1-2: General rules – Structural fire design, Final draft February 2002
3. Östman B, Rydholm D: Fire resistance of timber structures, National guidelines in European and some other countries, Trätekt publication 0212045, 2002
4. ISO TR 13387 Parts 1-8, Fire safety engineering, 1999
5. Karlsson B: Fire Risk Index Method – Multistorey Apartment Buildings, FRIM-MAB Version 2.0, Trätekt report 0212053, 2002 (www.brand.lth.se/frim-mab)
6. Östman, König, Mikkola, Stenstad, Carlsson, Karlsson: Fire Safe Timber Buildings, Nordic Design Guide version 2 (in Swedish). Trätekt publication 0210034, 2002

Acknowledgement

The contribution of national data from colleagues in different international networks e.g. ISO, CEN and COST Action E5 Timber frame building systems is kindly acknowledged. Without their help and input it would have been impossible to present this survey.

Main contributors are:

Europe:

Austria	Wolfgang Winter, Andres Gutierrez
Belgium	Stéphan Wolfferts, Johan Parthoens
Czech Republic	Petr Kuklik, Eva Jindrichová
Denmark	Hilmer Riberholt, Charlotte Micheelsen
Finland	Tuuli Oksanen
France	Jean-Marie Gaillard
Germany	Jörn Frenzel, Max Merk, Lars Wikholm, Stefan Winter
Greece	John Kakaras
Hungary	Tamás Bánky
Iceland	Gudmundur Gunnarsson, Björn Karlsson
Ireland	Bill Robinson
Italy	Ario Ceccotti, Michele Ruffino
Netherlands	Arie Mooiman
Norway	Vidar Stenstad
Poland	Jadwiga Fangrat
Portugal	José Amorim Faria
Romania	Adriana Luchian
Slovakia	Ondrej Grexa, Henrich Libke
Slovenia	Mateja Bajde
Spain	Francisco Arriaga
Sweden	Anders Johansson
Switzerland	Markus Meili, Josef Kolb
UK	Tom Lennon, Brian Haynes

Other countries:

Australia	Andrew Dunn, Micael Lundqvist
Canada	Jim Mehaffey
Japan	Saburou Uesugi
New Zealand	Hans Gerlich
USA	Kuma Sumathipala

The financial support from the Swedish Wood Association (Svenskt Trä) and the Swedish Agency of Innovation Systems (VINNOVA) are kindly acknowledged.

Detta digitala dokument
skapades med anslag från
**Stiftelsen Nils och Dorthi
Troëdssons forskningsfond**

Träte

INSTITUTET FÖR TRÄTEKNISK FORSKNING

Box 5609, 114 86 STOCKHOLM
Besöksadress: Drottning Kristinas väg 67
Telefon: 08-762 18 00
Telefax: 08-762 18 01

Vidéum Science Park, 351 96 VÄXJÖ
Besöksadress: Lückligs plats 1
Telefon: 0470-59 97 00
Telefax: 0470-59 97 01

Skeria 2, 931 77 SKELLEF
Besöksadress: Laboratorgrän
Telefon: 0910-28 56 00
Telefax: 0910-28 56 01