Next generation Eurocode 5 – Design of timber structures, Part 1-2: Structural fire design

Eurocode 5 Seminar, Finland, 30.5.2023
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Based on the presentation prepared by CEN TC250 SC5 WG4 & PT4 Chair
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Disclaimer

The data and information in the following slides represent an excerpt from the revision work on prEN 1995-1-2 as of November 2022.

This information shall not be used for the design of timber structures.

European Commission

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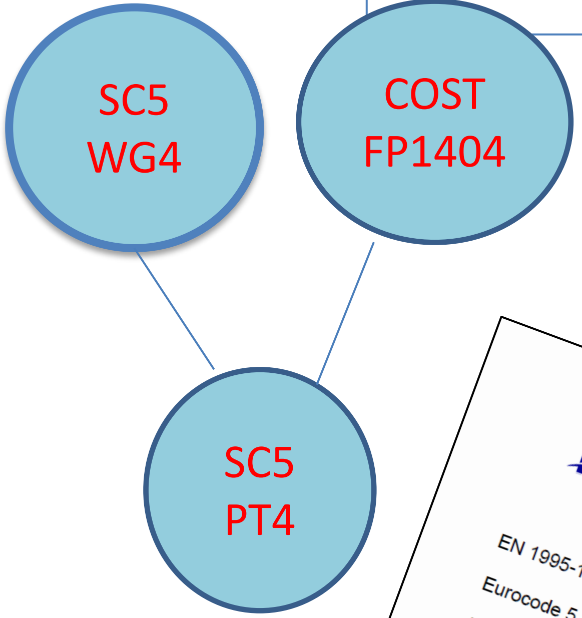
CEN TC250 SC5 PT4

Project Team for drafting the fire part of Eurocode 5



Members PT

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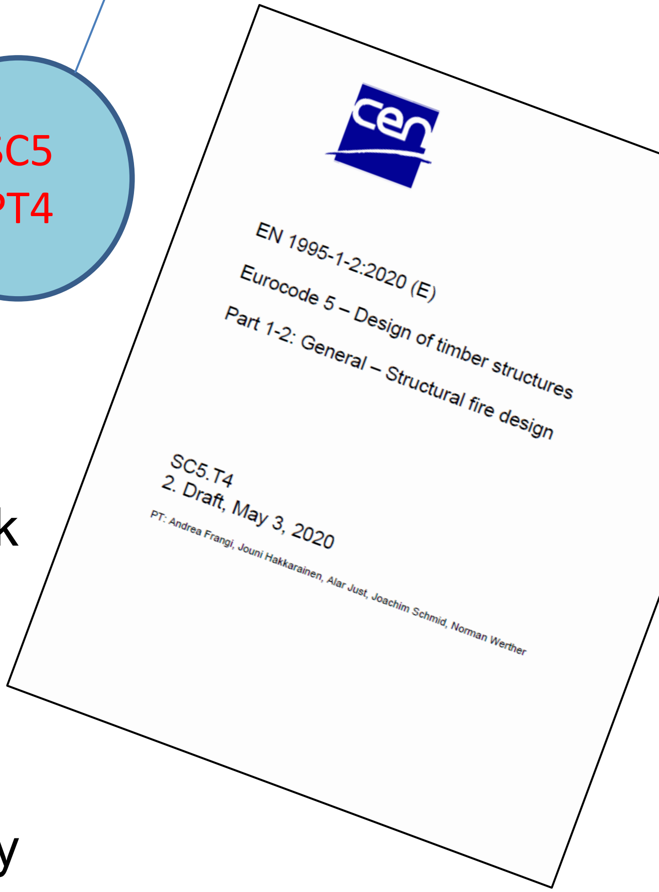
Tasks

June 2018	Start of the work
April 2019	1st draft
April 2020	2nd draft
October 2020	3rd draft
April 2021	Final draft
September 21	Informal Enquiry
September 22	Formal Enquiry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EN 1995-1-2:2020 (E)

Eurocode 5 – Design of timber structures

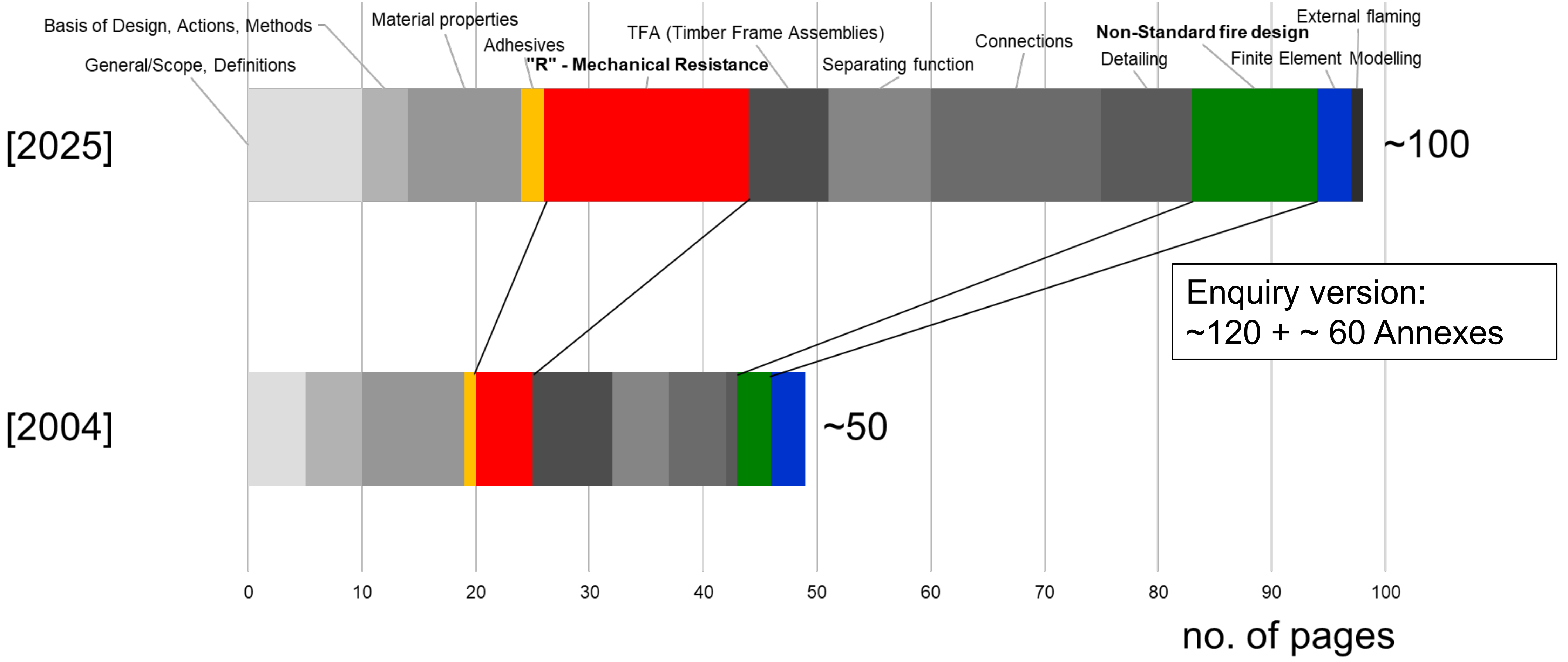
Part 1-2: General – Structural fire design

SC5.T4

2. Draft, May 3, 2020

PT: Andrea Frangi, Jouni Hakkarainen, Alar Just, Joachim Schmid, Norman Werther

CEN TC250 SC5 PT4



Principles Eurocodes Revision

- Current State-Of-the-Art
- Ease of Use
- Avoiding parallel design methods
- Similar style between different Eurocodes

It is an evolution not a revolution!

EN 1995-1-2:2025

1. Scope
2. Normative references
3. Terms, definitions and symbols
4. Basis of design
5. Material properties
6. Tabulated design data
7. Simplified design methods
8. Advanced design methods
9. Connections
10. Detailing

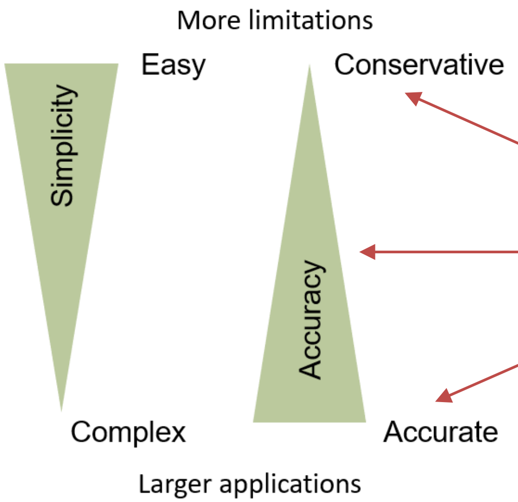
Annexes

Common part for all EN 199x-1-2

Start of charring, failure time of protection, charring rate

Specific rules
Zero-strength layer

Requirements for detailing



4.5 Design values of material properties

EN 1995-1-2:2025

$$X_{d,fi} = k_{\Theta} \cdot k_{fi} \cdot X_k / \gamma_{M,fi}$$

k_{fi}

Solid timber	1,25
Glued-laminated timber, cross-laminated timber	1,15
Wood-based panels	1,15
LVL	1,10
Connections with laterally loaded fasteners with side members of wood and wood-based panels	1,15
Connections with laterally loaded fasteners with side members of steel	1,05
Connections with axially loaded fasteners	1,05

EN 1995-1-2:2004

$$f_{d,fi} = k_{mod,fi} \frac{f_{20}}{\gamma_{M,fi}}$$

$$f_{20} = k_{fi} f_k$$

	k_{fi}
Solid timber	1,25
Glued-laminated timber	1,15
Wood-based panels	1,15
LVL	1,1
Connections with fasteners in shear with side members of wood and wood-based panels	1,15
Connections with fasteners in shear with side members of steel	1,05
Connections with axially loaded fasteners	1,05

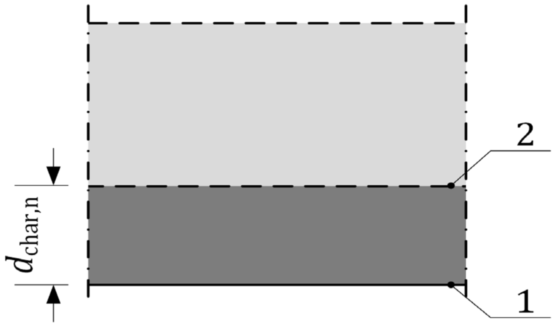
5.4 Charring

5.4.2 The European charring model

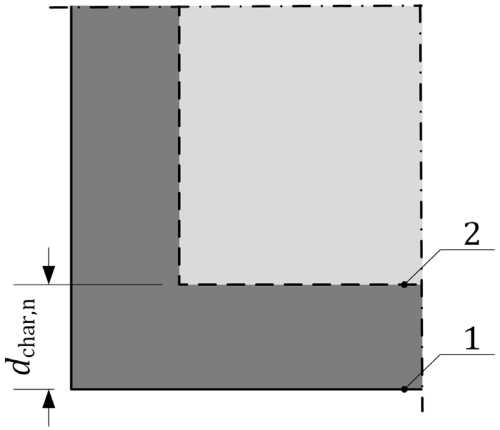
(1) <REC> The European charring model should be applied to **standard fire exposure.**

(2) <REQ> If the timber member undergoes charring in different charring phases the European charring model shall be individually applied for the **individual charring phases** and combined in series.

Notional charring depth



a) One-dimensional charring



b) Two-dimensional charring.

Key: 1 Fire exposed side
2 Residual cross-section

$$d_{char,n} = \beta_n \cdot t$$

$d_{char,n}$ notional charring depth **within one charring phase** in mm;

β_n notional design charring rate **within one charring phase** in mm/min;

t time for the charring phase considered, in min.

Notional design charring rate

$$\beta_n = \prod_{k_i} k_i \cdot \beta_0$$

Table 5.1 – Modification factors for charring

Modification factor	Designation	Reference
k_{gd}	grain direction factor	5.4.2.2 (4)
k_g	gap factor	5.4.2.2 (6)
k_h	thickness factor	5.4.2.2 (8)
k_n	conversion factor	5.4.2.2 (5), 7.2.2 (2)
$k_{s,n,1}$	combined section and conversion factor for the fire exposed side	5.4.2.2 (7); 7.2.4 (12)
$k_{s,n,2}$	combined section and conversion factor for the lateral side	5.4.2.2 (7); 7.2.4 (12)
k_ρ	density factor	5.4.2.2 (9)
k_2	protection factor for Phase 2	5.4.2.2 (10)-(12)
k_3	post-protection factor for Phase 3	5.4.2.2 (13)
$k_{3,1}$	post-protection factor for the fire exposed side for Phase 3	7.2.4 Table 7.6
$k_{3,2}$	post-protection factor for lateral side for Phase 3	7.2.4 Table 7.6
k_4	consolidation factor for Phase 4	5.4.2.2 (14)

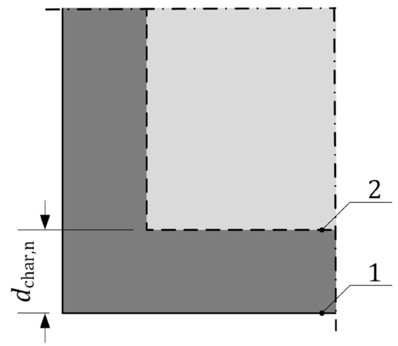
Basic design charring rates

	β_0 [mm/min]
a) Timber member made of softwood[(1)] [(3)] [(4)]	0,65
b) Timber member made of hardwood[(1)]	
Beech[(5)]	0.70
Beech[(5)] LVL	0,65
Ash[(6)]	0,60
Oak[(7)]	0,50
c) Panel[(2)]	
Solid wood panelling and cladding, solid wood panel with only one layer	0,65
LVL panel[(3)]	0,65
Particleboard, fibreboard	0,72
OSB, solid wood panel with multiple layers	0,9
Plywood	1,0

- Annex C – a method for the evaluation of the basic design charring rate
- NDP for other species/densities allowed

Initially unprotected sides of timber members

$$\beta_n = \beta_0 \cdot k_{gd} \cdot k_g \cdot k_h \cdot k_n \cdot k_\rho$$



b) Two-dimensional charring.

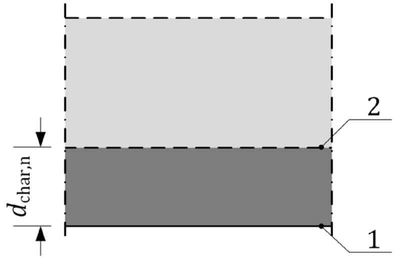
Key: 1 Fire exposed side
2 Residual cross-section

Linear members

$$\beta_n = \beta_0 \cdot k_n$$

Solid timber $\beta_n = 0,65 \cdot 1,23 = 0,8$ mm/min

Glulam $\beta_n = 0,65 \cdot 1,08 = 0,7$ mm/min



a) One-dimensional charring

Plane members (solid timber, glulam, LVL, CLT)

$$\beta_n = \beta_0 \cdot k_g$$

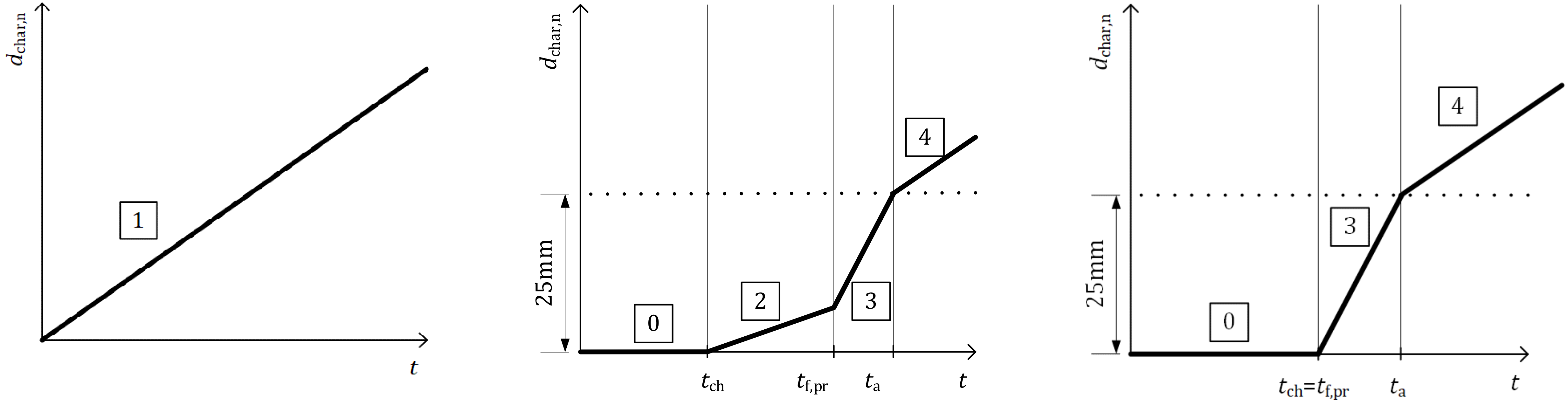
- Gaps ≤ 2 mm $\beta_n = 0,65 \cdot 1 = 0,65$ mm/min
- Gaps 2..5 mm $\beta_n = 0,65 \cdot 1,2 = 0,78$ mm/min

Charring phases

- **Normal charring phase (Phase 1)**
  for initially unprotected sides of timber members

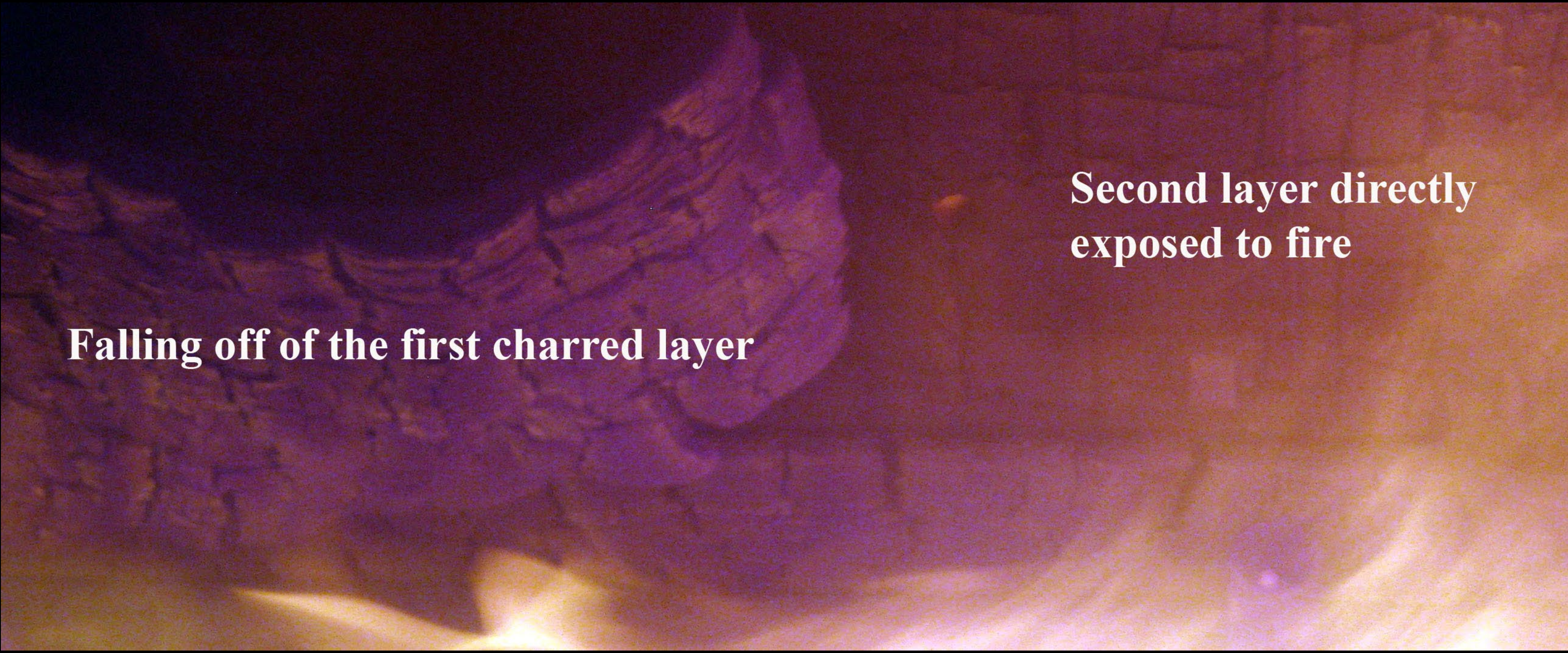
  for initially protected sides of timber members
- **Encapsulated phase (Phase 0)**
  is the phase when no charring of the timber member occurs behind the fire protection system.
- **Protected charring phase (Phase 2)** is the phase when charring occurs behind the fire protection while the system is still in place.
- **Post-protected charring phase (Phase 3)** is the phase after the failure of the fire protection before a fully developed char layer has been formed.
- **Consolidated charring phase (Phase 4)**
  is the phase with fully developed char layer.

Charring phases (bond line integrity is maintained)

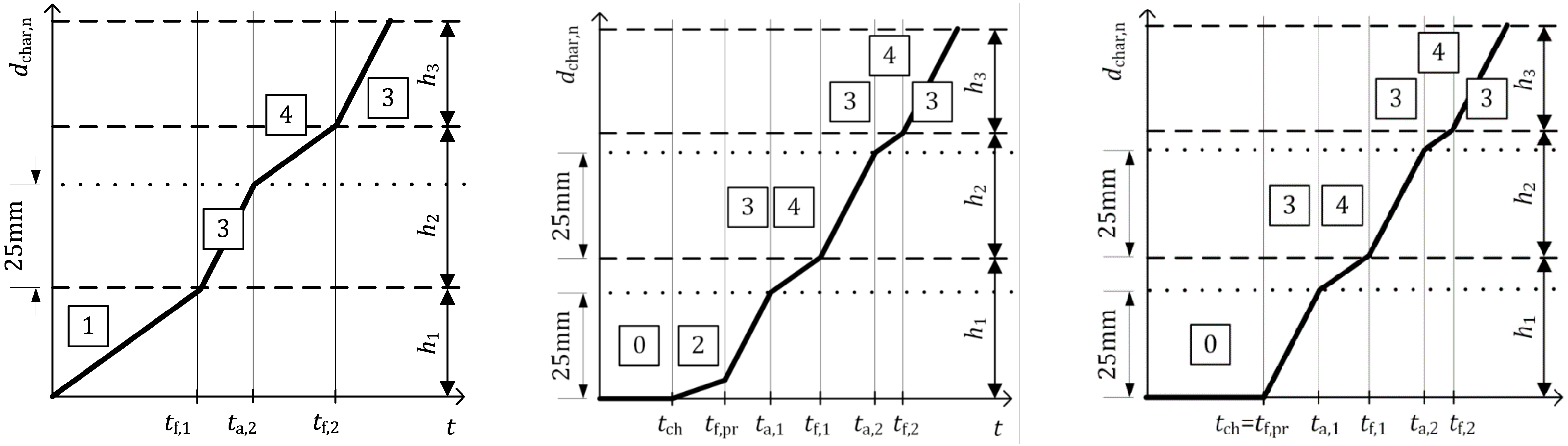


- Normal charring phase (Phase 1)

- Encapsulated phase (Phase 0)
- Protected charring phase (Phase 2)
- Post-protected charring phase (Phase 3)
- Consolidated charring phase (Phase 4)


Second layer directly
exposed to fire
Falling off of the first charred layer

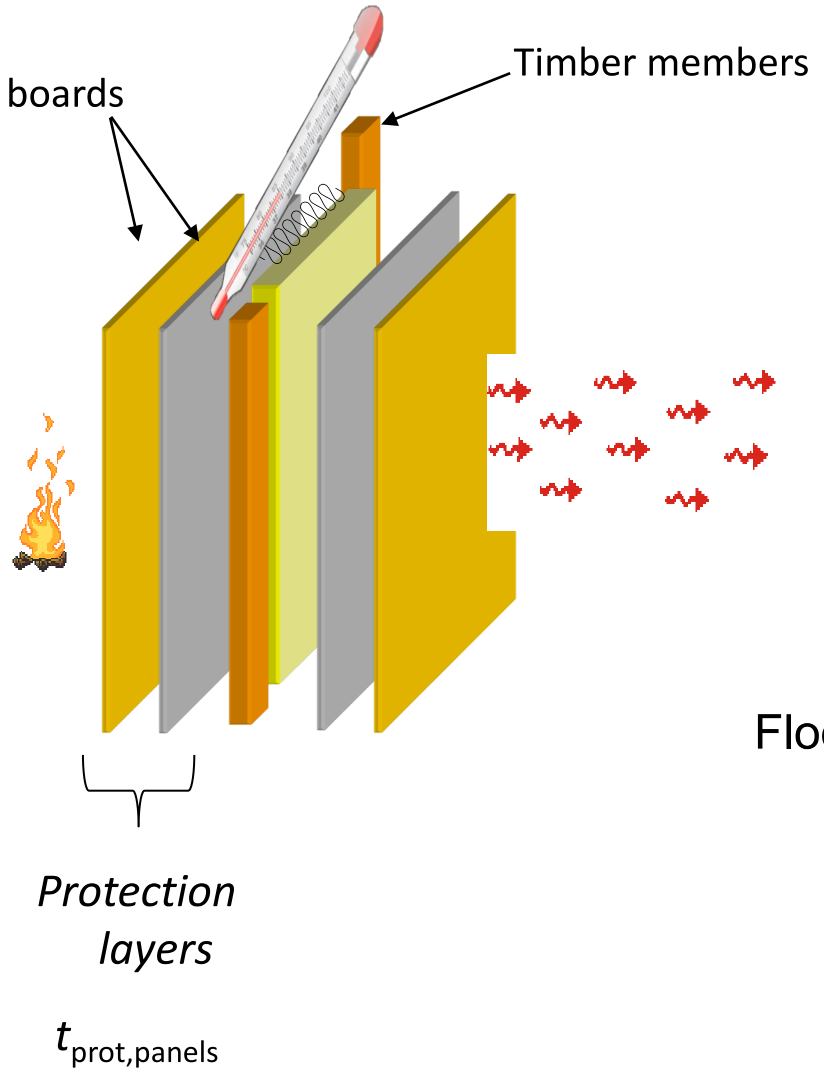
Charring phases (bond line integrity is not maintained)



- Normal charring phase (Phase 1)
- Post-protected charring phase (Phase 3)
- Consolidated charring phase (Phase 4)

- Encapsulated phase (Phase 0)
- Protected charring phase (Phase 2)
- Post-protected charring phase (Phase 3)
- Consolidated charring phase (Phase 4)

Start time of charring



Sum of protection times (270˚C):

$$t_{ch} = \Sigma\, t_{prot,\ panels}$$

Separating Function Method

Floors:

$$t_{ch} = \min \begin{cases} \sum t_{prot} \\ t_{f,pr} \end{cases}$$

Failure times

Table 5.4 – Failure time of panels <u>due to mechanical degradation</u>

$$t_{f,pr} = \min \begin{cases} t_{f,\mathrm{degr}} \\ t_{f,anch} \end{cases}$$

Generic values based on 20% fractile analysis

Panels		Vertical		Horizontal	
		t_f **[min]**	h_p **[mm]**	t_f **[min]**	h_p **[mm]**
Gypsum plasterboards	Type F, one layer	$t_f = 4,6 \cdot h_p - 25$ (5.10)	$9 \leq h_p \leq 18$	$t_f = 1,3 \cdot h_p + 9$ (5.11)	$9 \leq h_p \leq 18$
Gypsum plasterboards	Type F, two layers or Type F + A(*)	$t_f = 4,4 \cdot h_p - 50$ (5.12)	$25 \leq h_p \leq 36$	$t_f = 1,5 \cdot h_p + 15$ (5.13)	$25 \leq h_p \leq 36$
Gypsum plasterboards	Type A, one layer	$t_f = 2,1 \cdot h_p - 6$ (5.14)	$9 \leq h_p \leq 18$	$t_f = 2,1 \cdot h_p - 9$ (5.15)	$9 \leq h_p \leq 18$
Gypsum plasterboards	Type A, two layers	$t_f = 1,8 \cdot h_p - 4$ (5.16)	$25 \leq h_p \leq 36$	$t_f = 1,7 \cdot h_p - 13$ (5.17)	$25 \leq h_p \leq 36$
Gypsum fibreboards, one layer		$t_f = 3,8 \cdot h_p - 21$ (5.18)	$9 \leq h_p \leq 18$	$t_f = 1,3 \cdot h_p + 7$ (5.19)	$9 \leq h_p \leq 18$
Gypsum fibreboards, two layers		$t_f = 3,7 \cdot h_p - 42$ (5.20)	$25 \leq h_p \leq 36$	$t_f = 1,3 \cdot h_p + 14$ (5.21)	$25 \leq h_p \leq 36$

where:

h_p is the is the thickness of the single panel or the total thickness of multiple panels of the same material, in mm

(*) Type F directly exposed to fire.

6. Tabulated design data

6.1 General

6.2 Time limits for charring phases

6.3 Initially protected timber members

6.4 Plane timber members made of cross-laminated timber

Tabulated design data

t_{ch} & $t_{f,pr}$

Table 6.2 – Start time of charring t_{ch} and failure time of the fire protection systems $t_{f,pr}$ on horizontal timber frame assemblies or plane timber members exposed to fire from below

Panels	Thickness of the fire protection system h_p [mm] [a]		Layers backed by insulation [b]		Layers backed by panel	
	layer 1 h_1	layer 2 h_2	Start of charring t_{ch} [min]	Failure time $t_{f,pr}$ [min]	Start of charring t_{ch} [min	Failure time $t_{f,pr}$ [min]
Gypsum plaster board type A	12,5	-	17	17	20	20
	15	-	22	22	27	27
	18	-	29	29	34	34
	12,5	12,5	28	29	35	35
	15	15	36	39	45	45
	18	18	47	48	58	58
Gypsum plaster board type F	12,5	-	17	25	24	30
	15	-	22	28	30	34
	18	-	28	32	37	39
	12,5	12,5	39	52	49	63
	15	15	50	60	60	72
	18	18	63	69	75	83
Gypsum plaster board type F+A (type F is layer 1)	12,5	12,5	39	52	49	63
	15	12,5	45	56	55	67
Gypsum fibre board	12,5	-	17	23	24	28
	15	-	22	26	30	32
	18	-	29	30	36	36
	12,5	12,5	39	46	49	55
	15	15	50	53	60	63
	18	18	61	61	73	73

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Tabulated design data CLT

6.4 Plane timber members made of cross-laminated timber

(1) <RCM> The rules given in 6.4 should be applied to plane timber members made of cross-laminated timber with layers orthogonally oriented when the bond line integrity is maintained or the charring depth does not exceed the first bond line.

(2) <RCM> The notional charring depth $d_{char,n}$ should be calculated according to 7.2.3.

(3) <RCM> The values of the effective zero-strength layer depth $d_{0,ef}$ should be deducted according to Figure 6.2
- for floors from layer(s) with grain parallel to the span direction (i = 1, 3, 5)
- for walls from vertical layer(s) (i = 1, 3, 5)

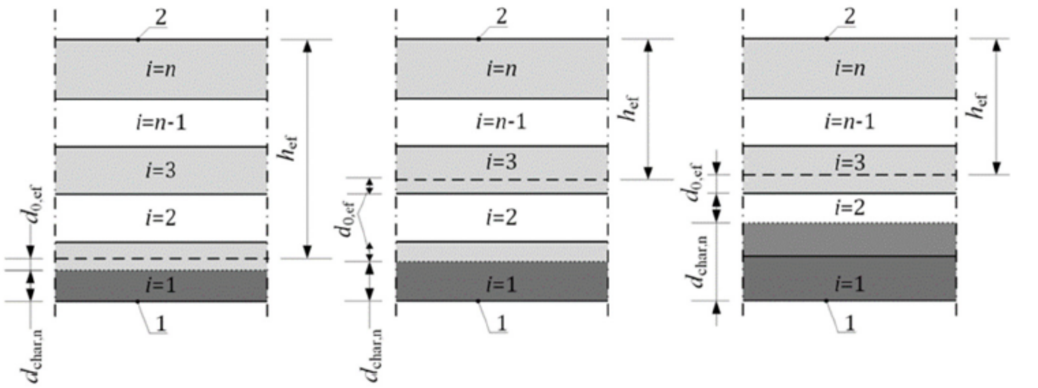


Figure 6.2 – Examples of deduction of the effective zero-strength layer depth $d_{0,ef}$

(4) <RCM> The values of the effective zero-strength layer depth $d_{0,ef}$ should be taken from Table 6.5 to Table 6.8.

Table 6.5 — Values of the depth of the effective cross-section h_{ef} in mm for initially unprotected floors made of CLT with bond line integrity maintained

# of layers	Layup [mm]	Total thickness [mm]	h_{ef} [mm]		
			30 min	60 min	90 min
3	20-20-20	60	18	9	-
3	40-40-40	120	94	38	38
5	20-20-20-20-20	100	58	49	18
5	40-20-20-20-40	140	114	78	70
5	40-20-40-20-40	160	134	98	90
5	40-30-40-30-40	180	154	108	108
5	40-40-40-40-40	200	174	118	118

Table 6.6 — Values of the depth of the effective cross-section h_{ef} in mm for initially protected floors made of CLT with bond line integrity maintained

# of layers	Layup [mm]	Total thickness [mm]	h_{ef} [mm]		
			30 min with $t_{ch} \geq 20$ min	60 min with $t_{ch} \geq 30$ min	90 min with $t_{ch} \geq 60$ min
3	20-20-20	60	18	16	16
3	40-40-40	120	95	38	38
5	20-20-20-20-20	100	58	56	56
5	40-20-20-20-40	140	115	78	78
5	40-20-40-20-40	160	135	98	98
5	40-30-40-30-40	180	155	108	108
5	40-40-40-40-40	200	175	118	118

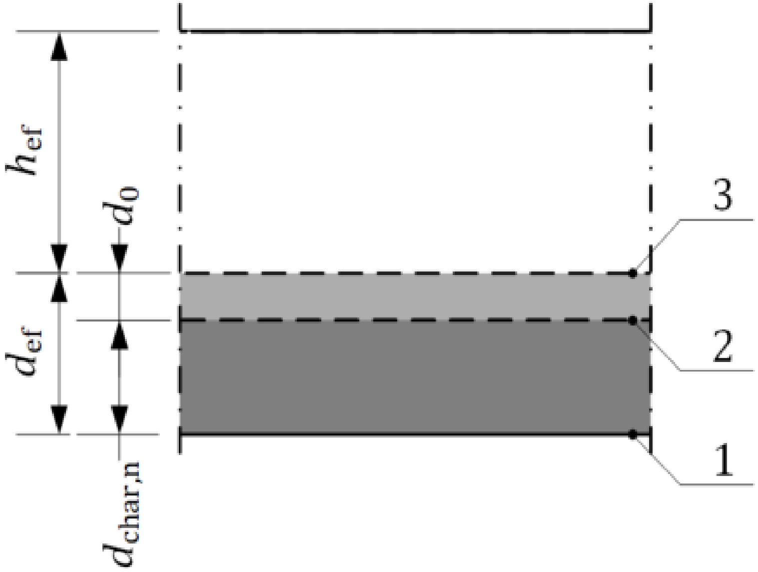
7. Simplified design methods

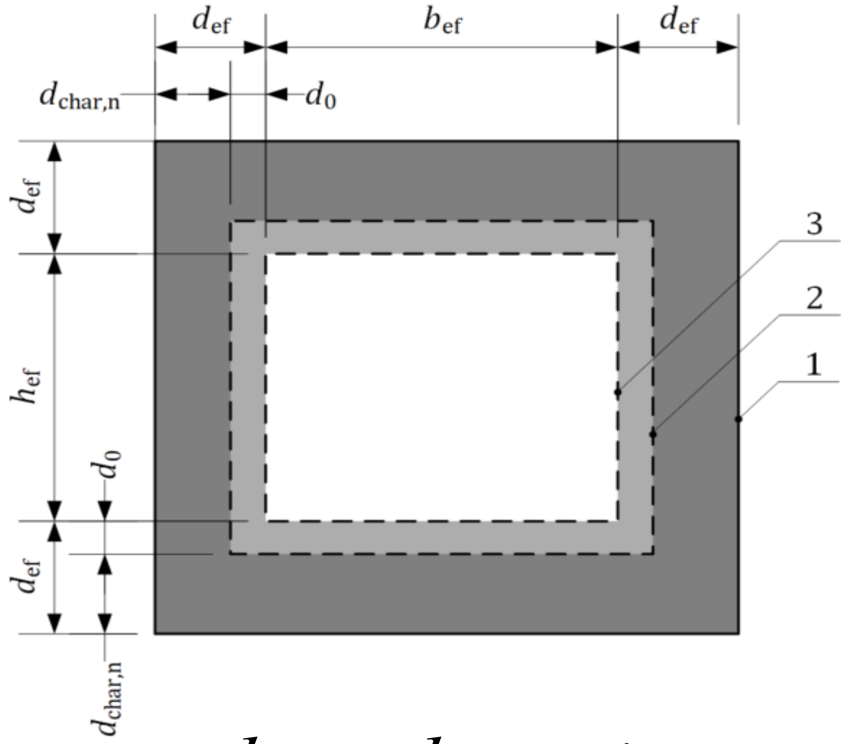
7.1 General

7.2 Effective cross section method

7.3 Separating function method

Effective cross-section





1 Fire exposed side
2 Residual cross-section
3 Effective cross-section

d_0	is the zero-strength layer depth
$d_{char,n}$	is the notional charring depth
d_{ef}	is the effective charring depth
k_{side}	is the number of respective sides exposed to fire

$$d_{ef} = d_{char,n} + d_0$$

$$b_{ef} = b - k_{side} \cdot d_{ef}$$

$$h_{ef} = h - k_{side} \cdot d_{ef}$$

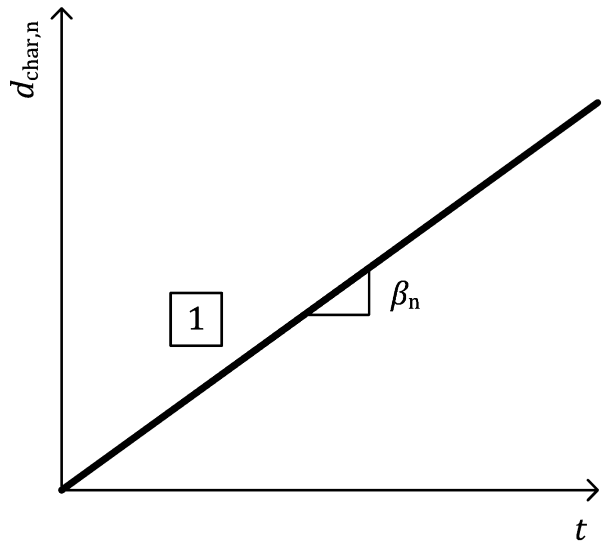
7.2.2 Design of linear timber members

Phase 1 $\beta_n = k_n \cdot \beta_0$

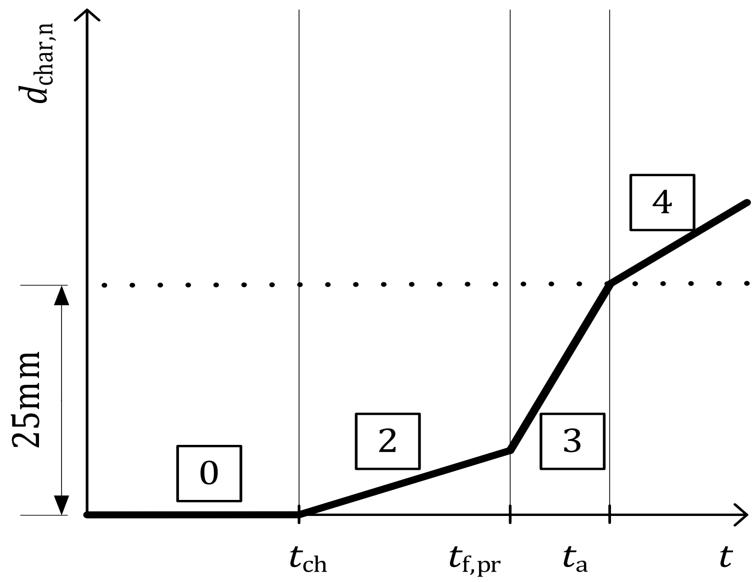
Phase 2 $\beta_n = k_2 \cdot k_n \cdot \beta_0$

Phase 3 $\beta_n = k_3 \cdot k_n \cdot \beta_0$

Phase 4 $\beta_n = k_n \cdot \beta_0$

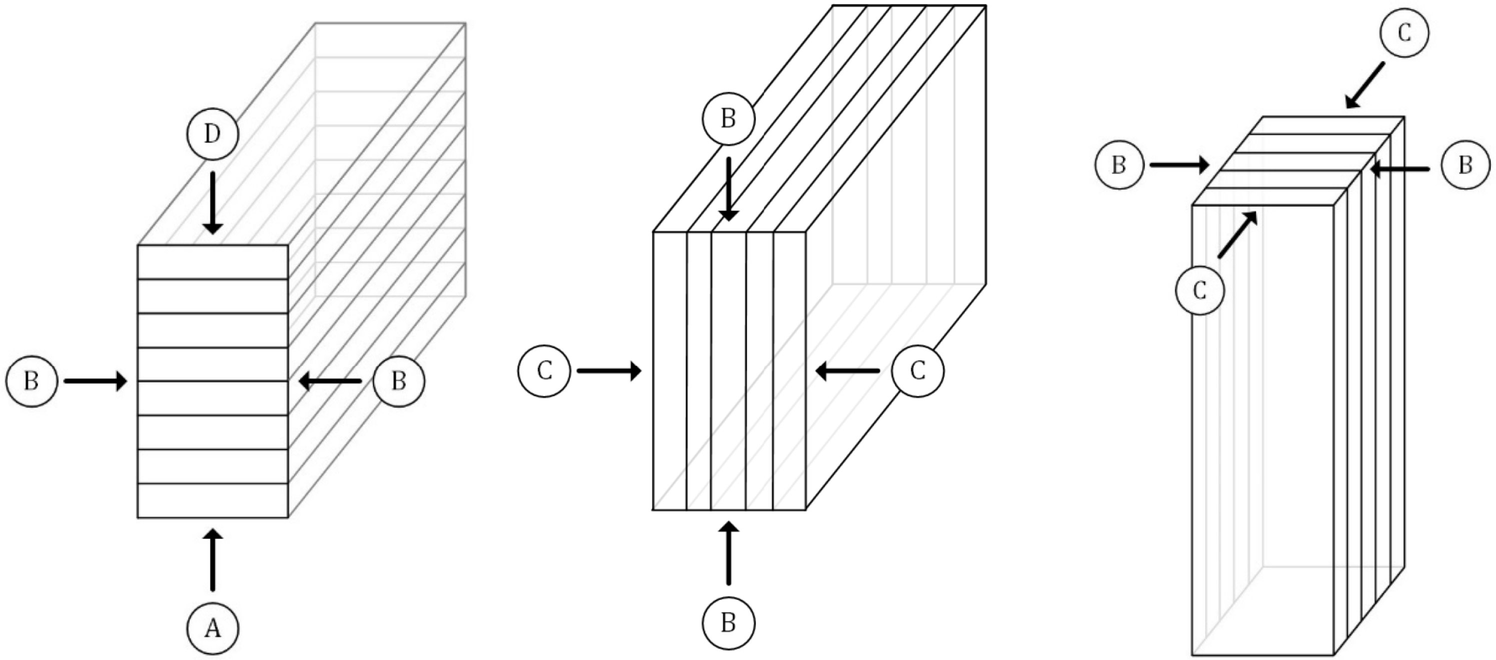


Initially **unprotected** sides of timber members



Initially **protected** sides of timber members

7.2.2 Design of linear timber members



a) Horizontal member b) Vertical member

Figure 7.4 – Definition of the charring direction for linear timber members

Table 7.2 – Post-protection factor k_3 for linear timber members made of GLT, CLT and GLVL

Charring direction	**Layer**	
	first layer	other layers
A	2	2
B	2	not applicable
C	2	1,3
D	2	not applicable

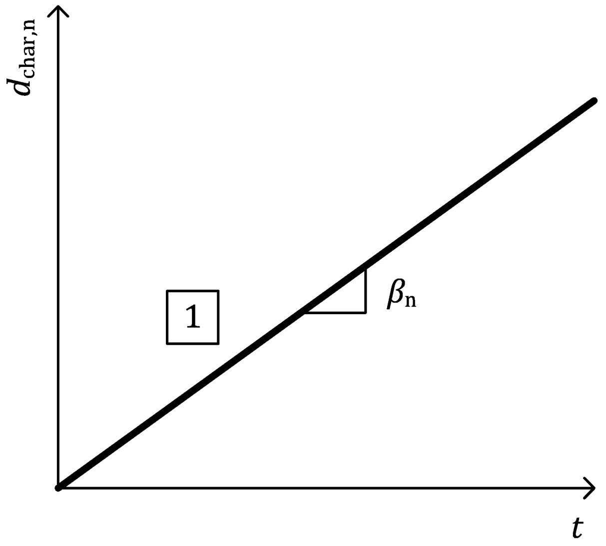
Caused by:

- first layer: Fall-off of protection system
- other layers: Fall-off of charred layer

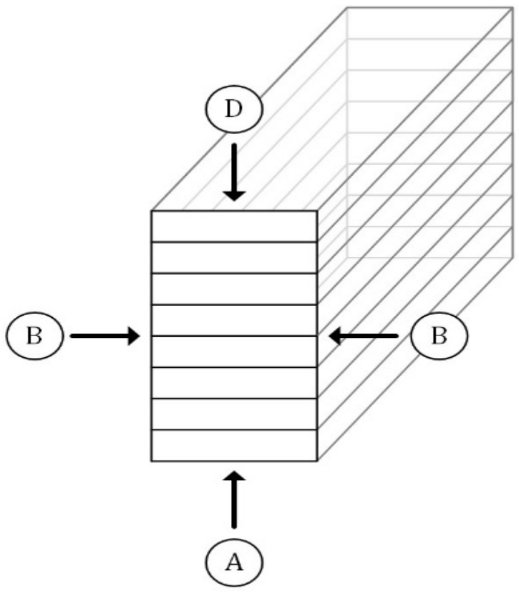
7.2.2 Design of linear timber members

Initially **unprotected** sides of timber members; Bond line integrity **not** maintained

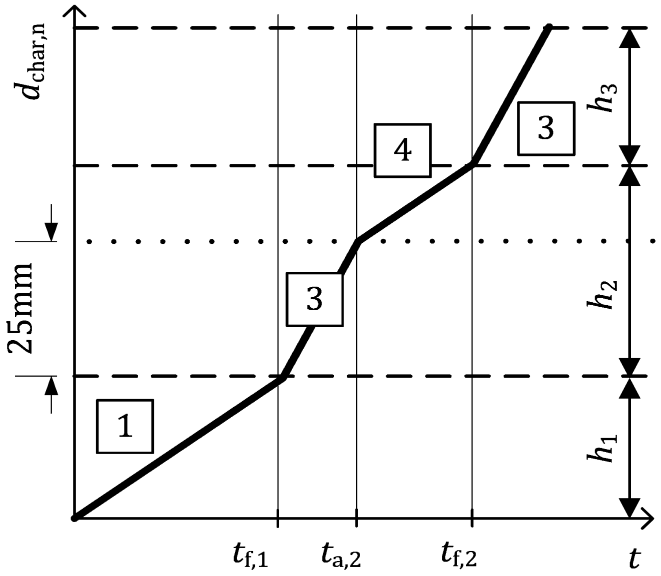
Charring in direction B and D



Phase 1 β_n = 0,7 mm/min



Charring in direction A



Phase 1 β_n = 0,7 mm/min

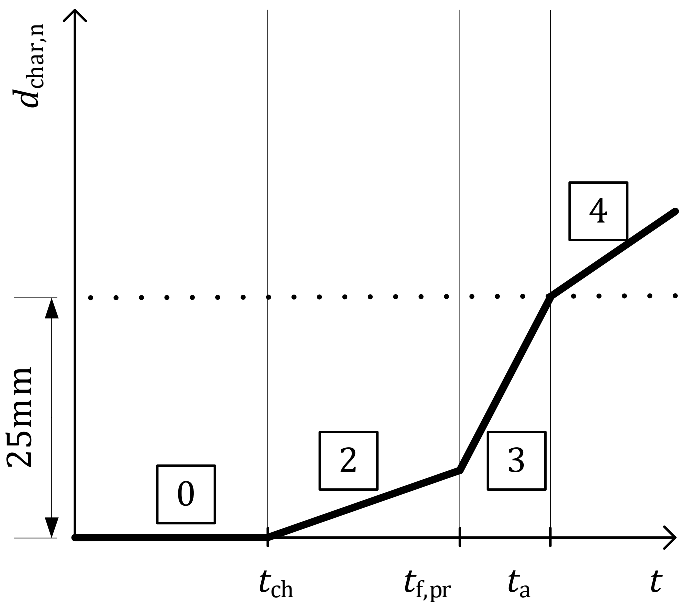
Phase 3 β_n = 2,0*0,7 = 1,4 mm/min

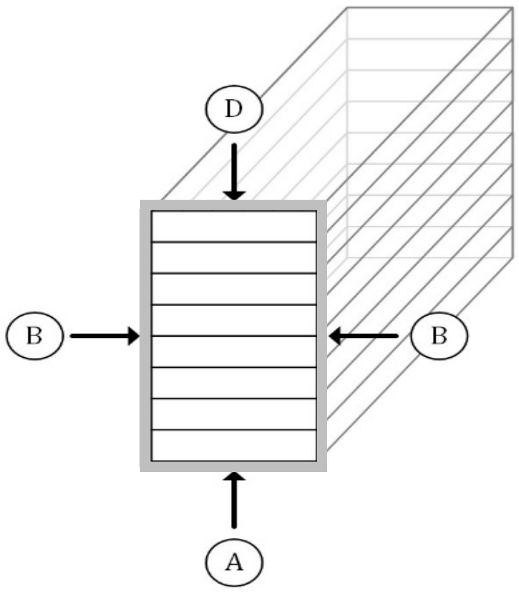
Phase 4 β_n = 0,7 mm/min

7.2.2 Design of linear timber members

Initially **protected** sides of timber members; Bond line integrity **not** maintained

Charring in direction B and D

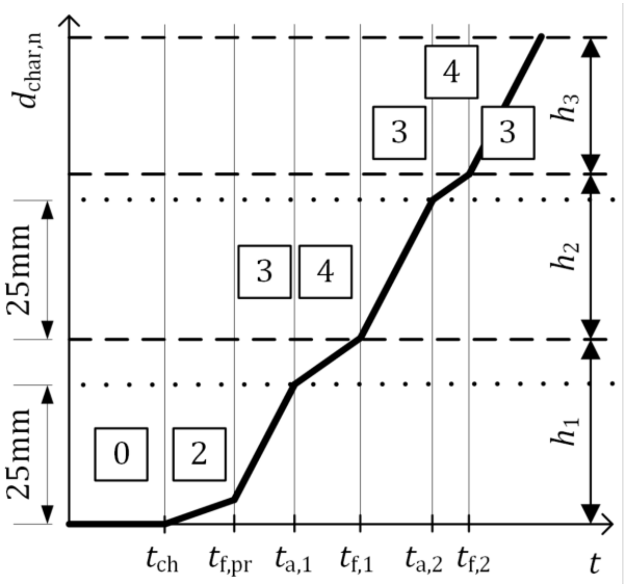




Phase 3 β_n = 2,0*0,7 = 1,4 mm/min

Phase 4 β_n = 0,7 mm/min

Charring in direction A



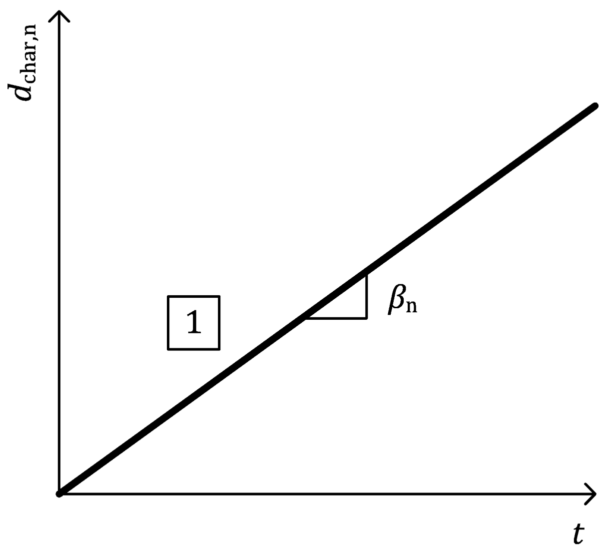
Phase 3 β_n = 2,0*0,7 = 1,4 mm/min

Phase 4 β_n = 0,7 mm/min

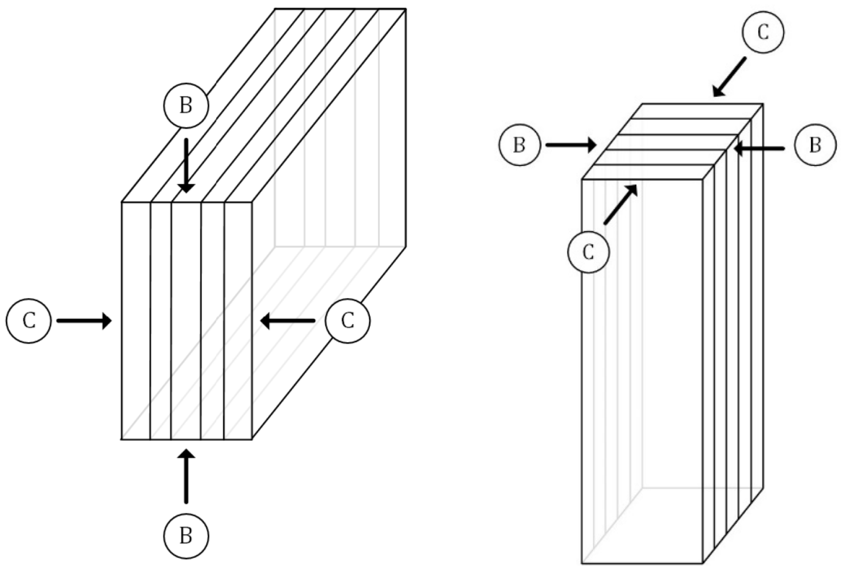
7.2.2 Design of linear timber members

Initially **unprotected** sides of timber members; Bond line integrity **not** maintained

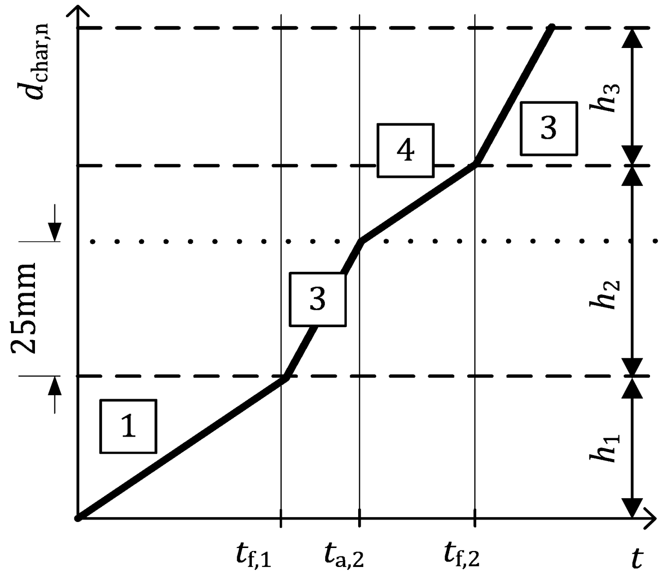
Charring in direction B



Phase 1 β_n = 0,7 mm/min



Charring in direction C



Phase 1 β_n = 0,7 mm/min

Phase 3 β_n = 1,3*0,7 = 0,91 mm/min

Phase 4 β_n = 0,7 mm/min

7.2.2 Design of linear timber members

Zero-strength layer depth d_0

(7) <RCM> Unless rules are given in this standard, the value of zero-strength layer depth d_0 for the design of linear timber members should be assumed as follows:

$$d_0 = 14\ mm$$

(8) <PER> For linear timber members subjected predominantly to tension or bending the value of zero-strength layer depth d_0 for the design of linear timber members may be assumed as follows:

$$d_0 = 10\ mm$$

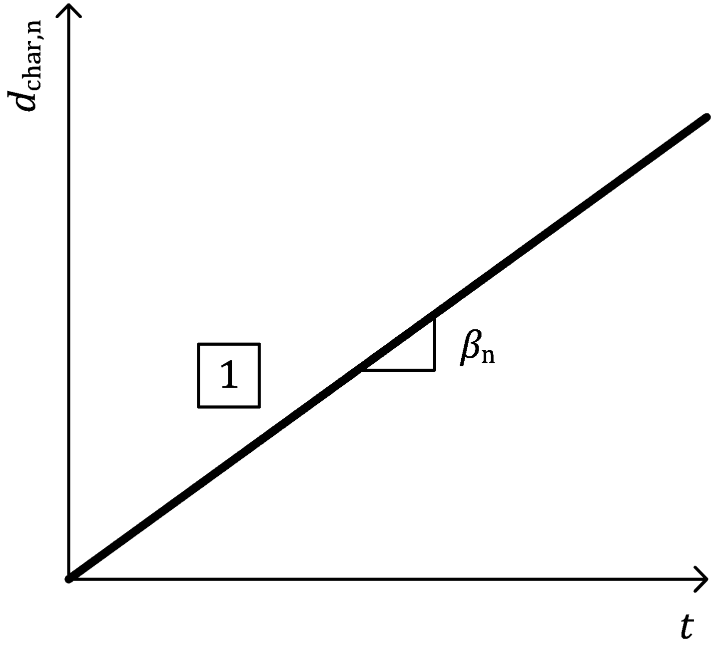
EN 1995-1-2:2004

d_0=7 mm

7.2.3 Design of plane timber members

Bond line integrity maintained

Phase 1 $\beta_n = k_g \cdot \beta_0$

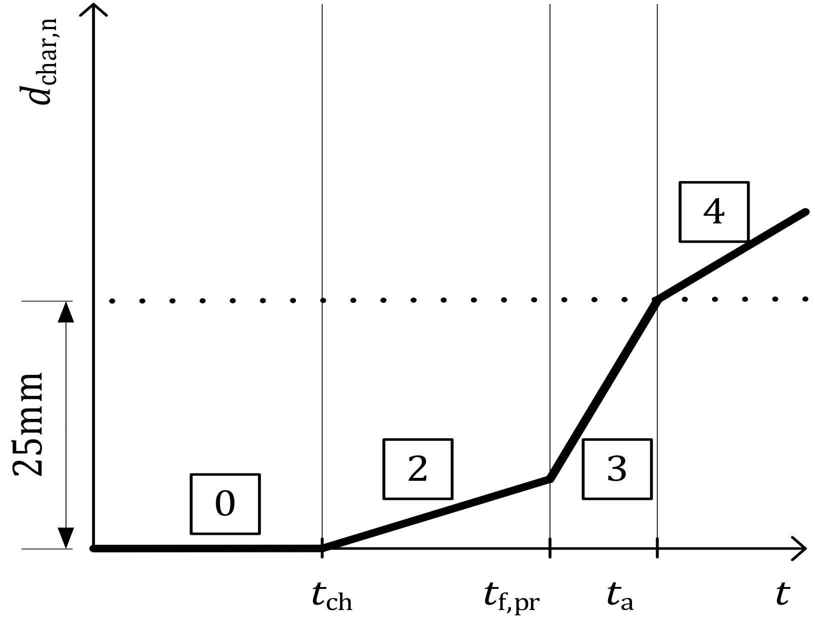


Initially **unprotected** sides of timber members

Phase 2 $\beta_n = k_2 \cdot k_g \cdot \beta_0$

Phase 3 $\beta_n = k_3 \cdot k_g \cdot \beta_0$

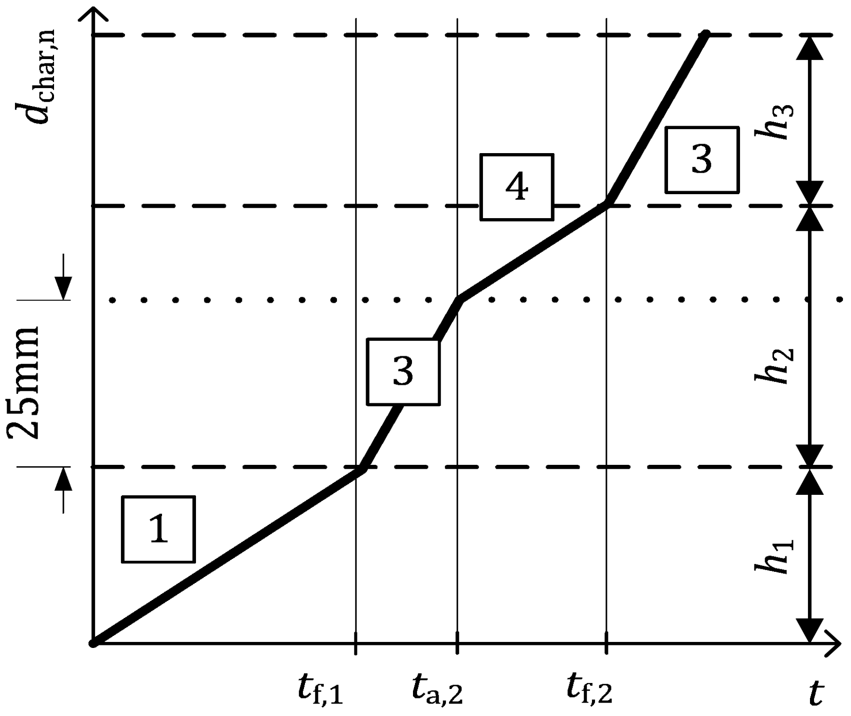
Phase 4 $\beta_n = k_g \cdot \beta_0$



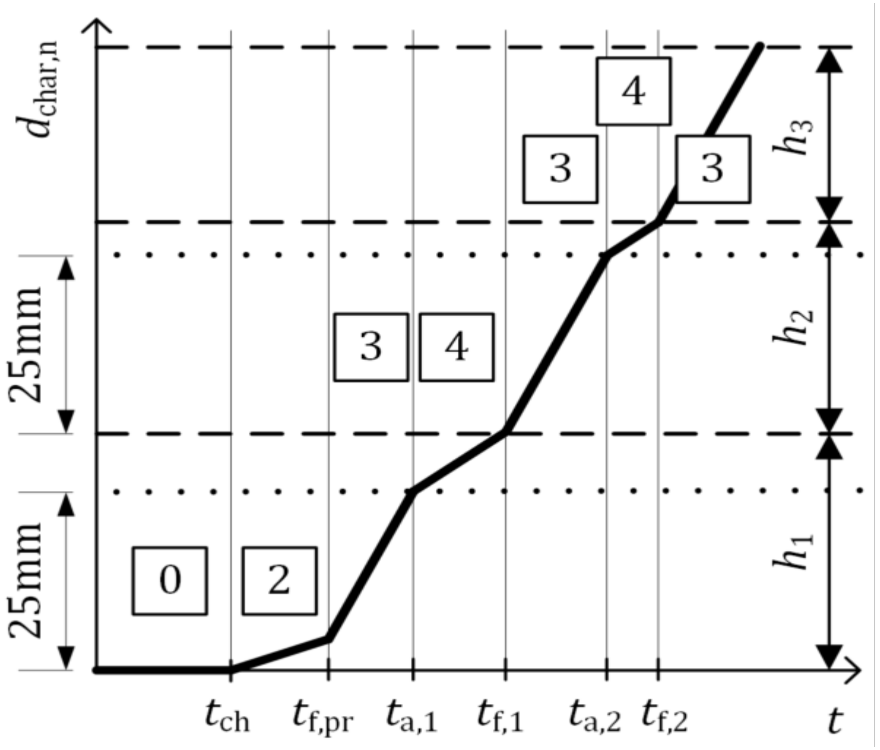
Initially **protected** sides of timber members

7.2.3 Design of plane timber members

*Bond line integrity **not** maintained*



Initially **unprotected** sides of timber members



Initially **protected** sides of timber members

Evaluation of bond line integrity according to Annex B

7.2.3 Design of plane timber members

(2) <RCM> The gap factor k_g for gaps within the members should be assumed as follows:

$k_g = 1$	for gaps ≤ 2 mm	One-dimensional charring
$k_g = 1,2$	for gaps > 2 mm and ≤ 5 mm	One dimensional charring
$k_g = 1,2$	for gaps > 5 mm	Two-dimensional charring in analogy to Figure 10.5

Table 7.3 – Post-protection factor k_3 for plane timber members made of CLT and GLVL

Horizontal	**Vertical**	
	first layer	other layers
2	2	1,3

Fall-off of protection system (first layer)

Fall-off of charred layer (other layers)

7.2.3 Design of plane timber members made of solid wood, glulam and LVL

Zero-strength layer depth d_0

Fire exposure on	**Floors**	**Walls**
Tension side	$d_0 = 8 + \frac{h}{55}$ (7.14)	Not relevant
Compression side	$d_0 = 9 + \frac{h}{20}$ (7.15)	
where h is depth of the initial cross-section of the plane timber member in mm		

7.2.3 Design of plane timber members made of cross-laminated timber

Zero-strength layer depth d_0

Fire exposure on	Floors	
	Initially unprotected	Initially protected
Tension side for first layer	7[a]	12[a]
Tension side for other layers	12[a b]	
Compression side for first layer	10[c]	16[c]
Compression side for other layers	16[c d]	

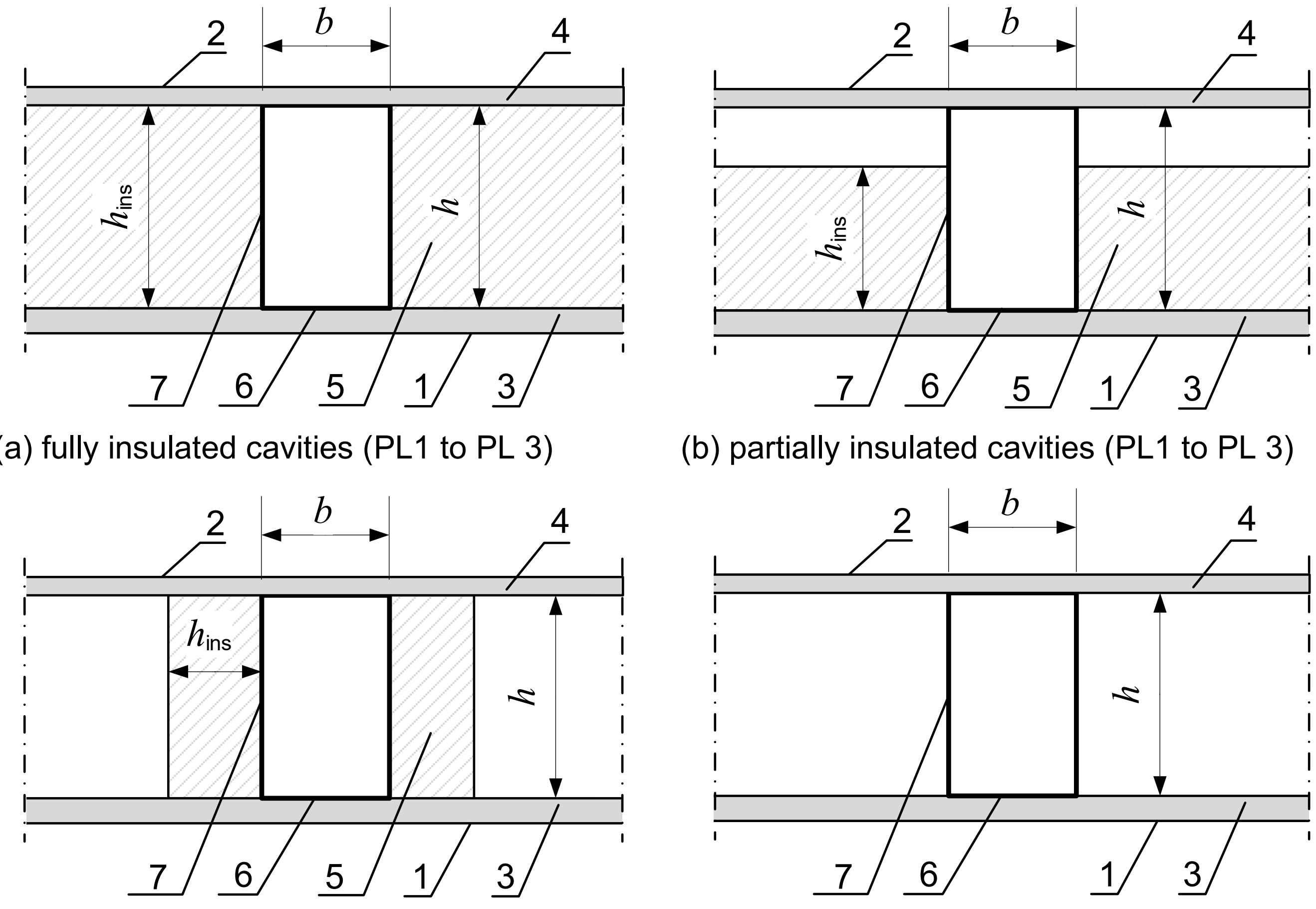
[a] When d_{ef} is within a layer with grain perpendicular to the span direction, d_{ef} should be increased in order to reduce the following layer with grain parallel to the span direction at least by 2 mm.

[b] When d_{ef} is within a layer with grain parallel to the span direction, d_{ef} should at least as large to reduce this layer by 2 mm.

[c] When d_{ef} is within a layer with grain perpendicular to the span direction, d_{ef} should be increased in order to reduce the following layer with grain parallel to the span direction at least by 4 mm.

[d] When d_{ef} is within a layer with grain parallel to the span direction, d_{ef} should at least as large to reduce this layer by 4 mm.

7.2.4 Design of timber frame assemblies



(a) fully insulated cavities (PL1 to PL 3)

(b) partially insulated cavities (PL1 to PL 3)

(c) side protection of timber member with cavity insulation PL1

(d) void cavities

Key:

1 Fire exposed side of the timber frame assembly
2 Unexposed side of the timber frame assembly
3 Fire protection system, cladding on the fire exposed side
4 Cladding on the unexposed side
5 Cavity insulation
6 Fire exposed side of the timber member
7 Lateral side of the timber member
b Width of the initial cross-section of the timber member
h Height of the initial cross-section of the timber member
h_{ins} Thickness of the cavity insulation

7.2.4 Design of timber frame assemblies

Protection level PL for typical insulation materials

Protection level PL	Insulation material	Density
PL 1	Stone wool	≥ 26 kg/m³
PL 2	Glass wool	≥ 14 kg/m³
	Wood fibre	≥ 50 kg/m³
	Cellulose fibre	≥ 50 kg/m³
PL 3	XPS	-
	EPS	-
	PUR	-
	PIR	-
	Not assessed insulation materials	-

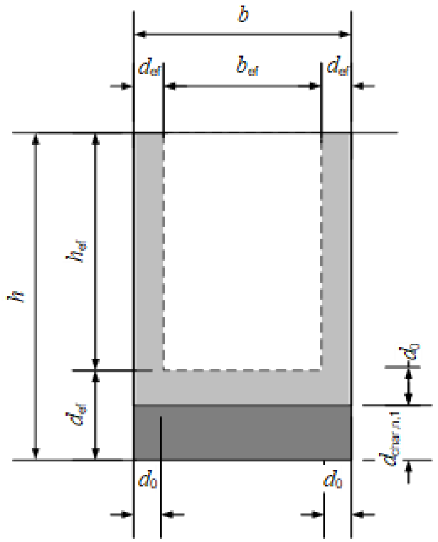
Protection level PL can be assessed according to Annex D.

EN 1995-1-2:2004

Stone wool
Glass wool (until t_f)

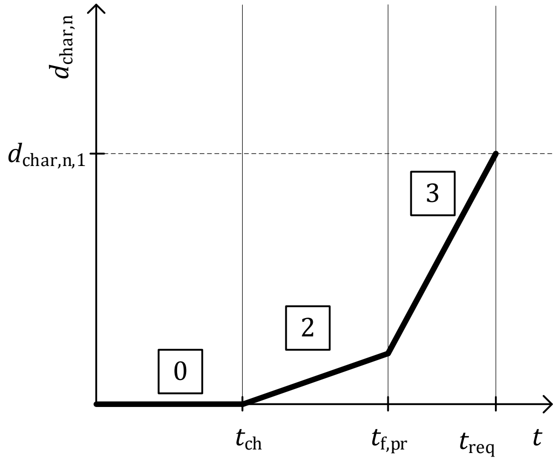
7.2.4 Design of timber frame assemblies

PL1



Maximum values for d_0

Bending member with the fire exposed side in tension:	$d_0 = 10 + \frac{b}{50} + \frac{h}{100}$
Bending member with the fire exposed side in compression	$d_0 = 6 + \frac{b}{50} + \frac{h}{50}$
Out-of-plane buckling of compression member	$d_0 = 7 + \frac{b}{50} + \frac{h}{25}$
In-plane buckling of compression member	$d_0 = 6 + \frac{b}{14} + \frac{h}{100}$



Zero strength layer changes between the limits:

d_0 =0 at time t=0
d_0 is maximum at time t_{peak}
d_0 =0 when $d_{char,n,1}$=h

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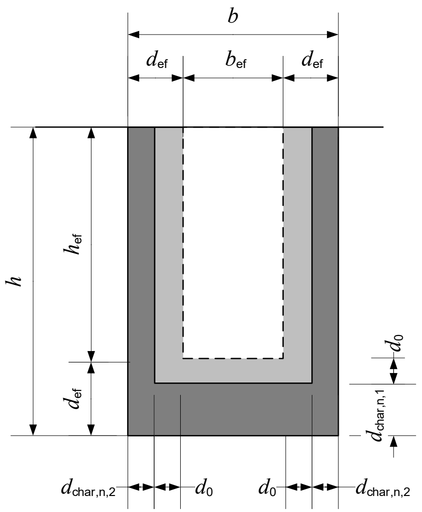
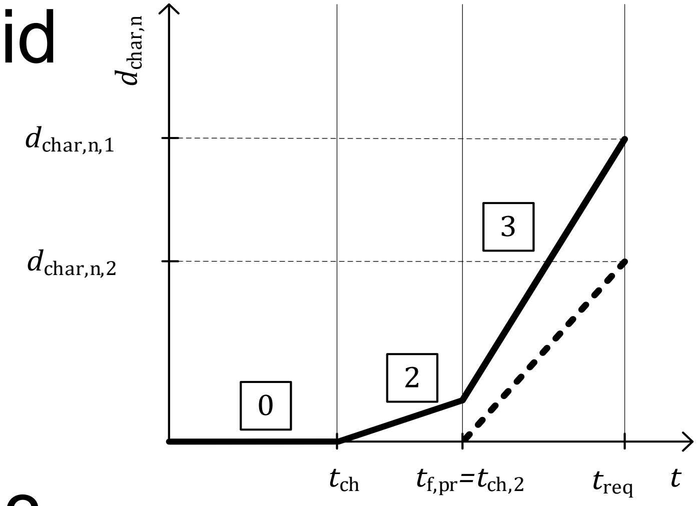
Reduced Properties Method

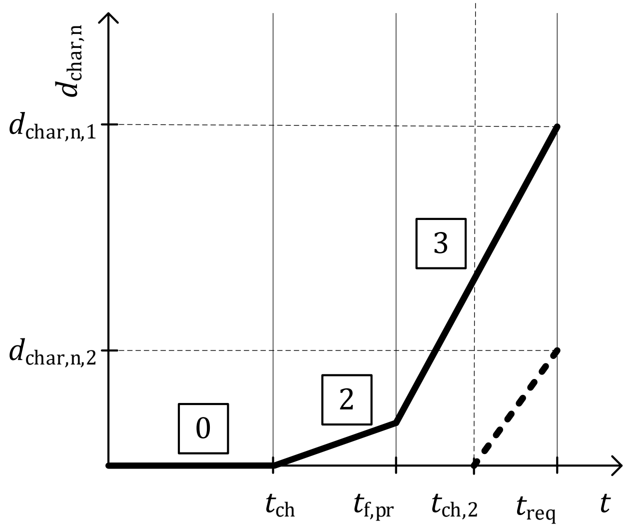
7.2.4 Design of timber frame assemblies



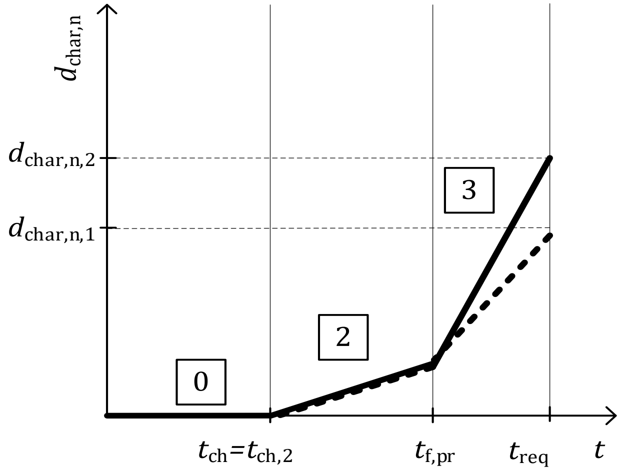
void



PL2



PL3



Start time of charring on the lateral side

$$t_{ch,2} = t_{f,pr} + \frac{2}{3} \cdot \frac{h}{v_{rec}}$$

For the fire exposed side

Phase 2 $\beta_n = k_2 \cdot k_{s,n,1} \cdot \beta_0$

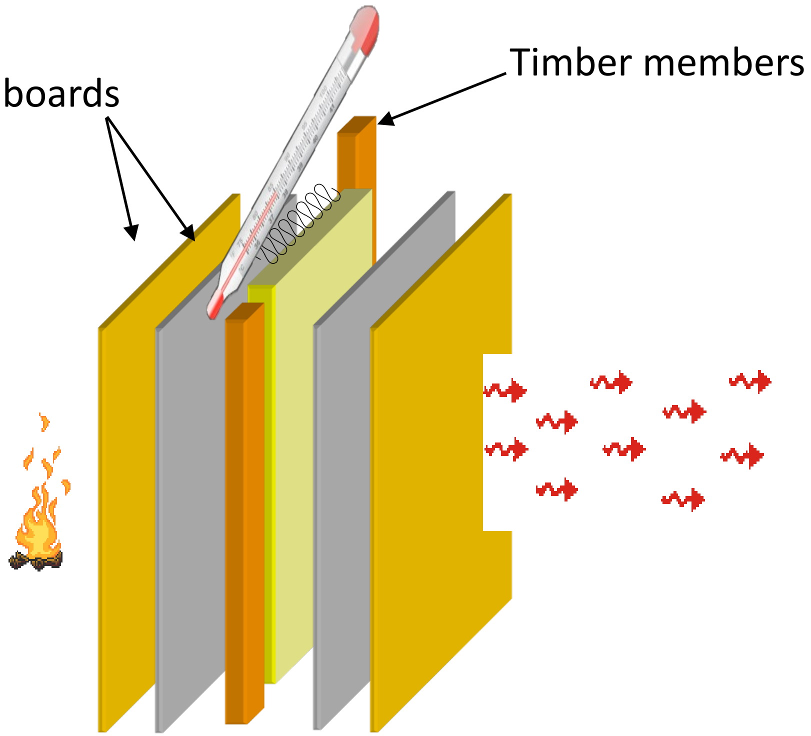
Phase 3 $\beta_n = k_{3,1} \cdot k_{s,n,1} \cdot \beta_0$

For the lateral side

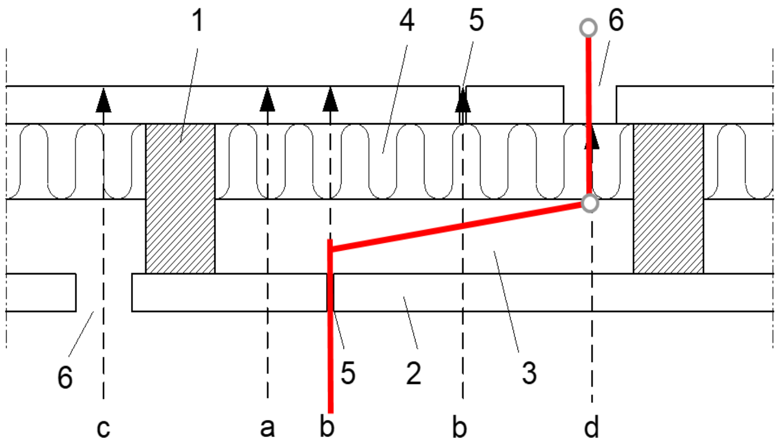
Phase 3 $\beta_n = k_{3,2} \cdot k_{s,n,2} \cdot \beta_0$

Phase 4 $\beta_n = k_{s,n,2} \cdot \beta_0$

7.3 Separating function method



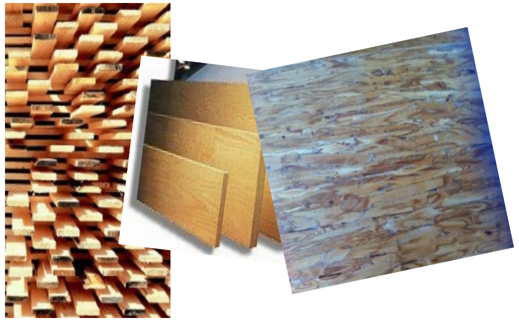
$$t_{ins} = \sum_{i=1}^{i=n-1} t_{prot,i} + t_{ins,n}$$



Schleifer, V (2009) Zum Verhalten von raumabschliessenden mehrschichtigen Holzbauteilen im Brandfall. Diss. ETH Zürich.
Mit Ergänzungen/Verbesserungen von K. Maeger (TalTech) und M. Rauch (TUM)

Generic materials included

Gypsum plasterboards, Type A, F, H		EN 520
Gypsum fibre boards		EN 15283-2
Timber, glulam, CLT	$\rho \geq 290$ kg/m^3	
LVL	$\rho \geq 480$ kg/m^3	
OSB	$\rho \geq 550$ kg/m^3	EN 300
Particle boards	$\rho \geq 500$ kg/m^3	EN 312
Fibre boards	$\rho \geq 500$ kg/m^3	EN 622
Mineral wool	EN 13162	



ADDED

Cellulose and wood fibre insulations

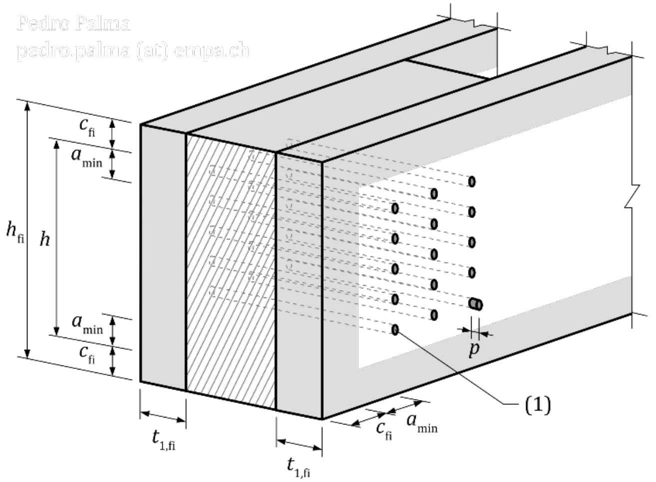
Clay plaster, lime plaster, screed

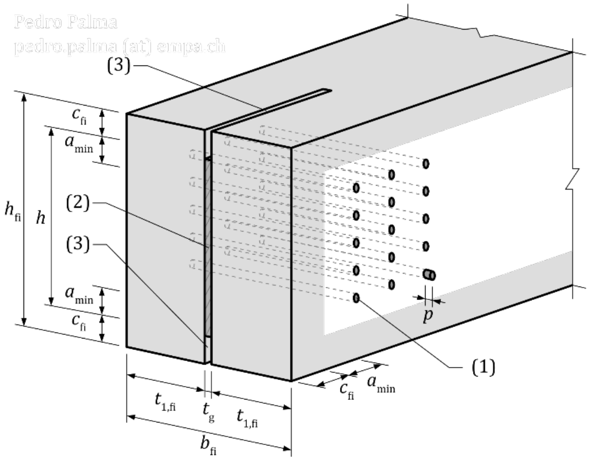
9 Connections

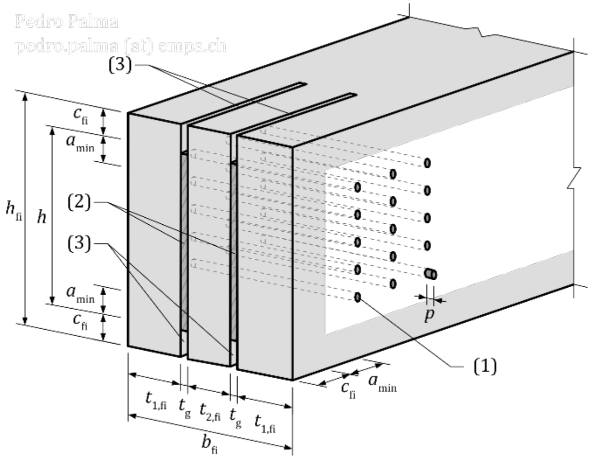
Methods extended to fire resistance **up to 120 min**.

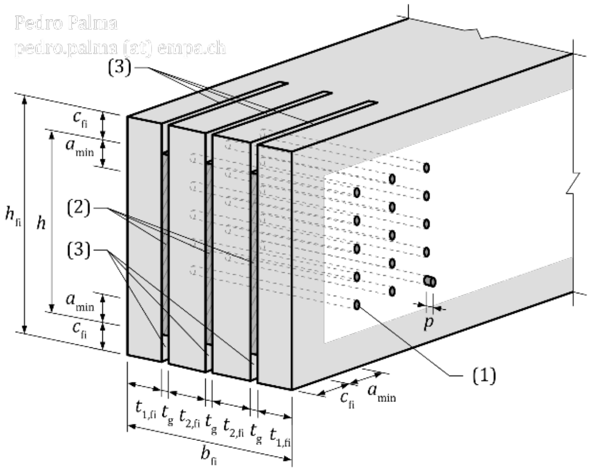
Connections with timber side members

- minimum fire resistance of initially unprotected timber-to-timber and steel-to-timber connections
- geometric requirements for a specific fire resistance up to 120 min









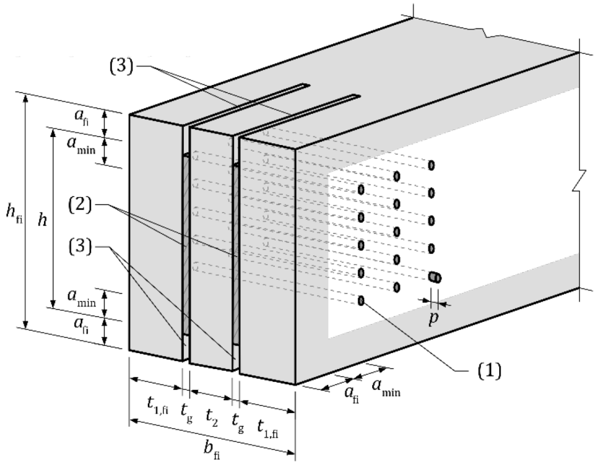
9 Connections

Geometric requirements for a specific fire resistance up to 120 min

Table 10.4 – Geometric requirements for a specific fire resistance time of steel-to-timber connections with dowels[a)] and two slotted-in steel plates, in mm

Fire resistance time, t_{fi}	$t_{1,fi}$			a_{fi}
	$\eta_{fi} \leq 0{,}1$	$\eta_{fi} \leq 0{,}2$	$\eta_{fi} \leq 0{,}3$	
30 min	≥ 30	≥ 45	≥ 50	≥ 15
60 min	≥ 60	≥ 75	≥ 80	≥ 50
90 min	≥ 90	≥ 100	≥ 110	≥ 90
120 min	≥ 120	≥ 135	≥ 140	≥ 130

a) The table may be used even if 2 dowels are replaced by 2 bolts (or screws)



9 Connections

Methods extended to fire resistance **up to 120 min**.

- Exponential reduction method

Nails and screws

$$R_{k,fi} = R_k \cdot e^{-k \cdot t_{req}}$$

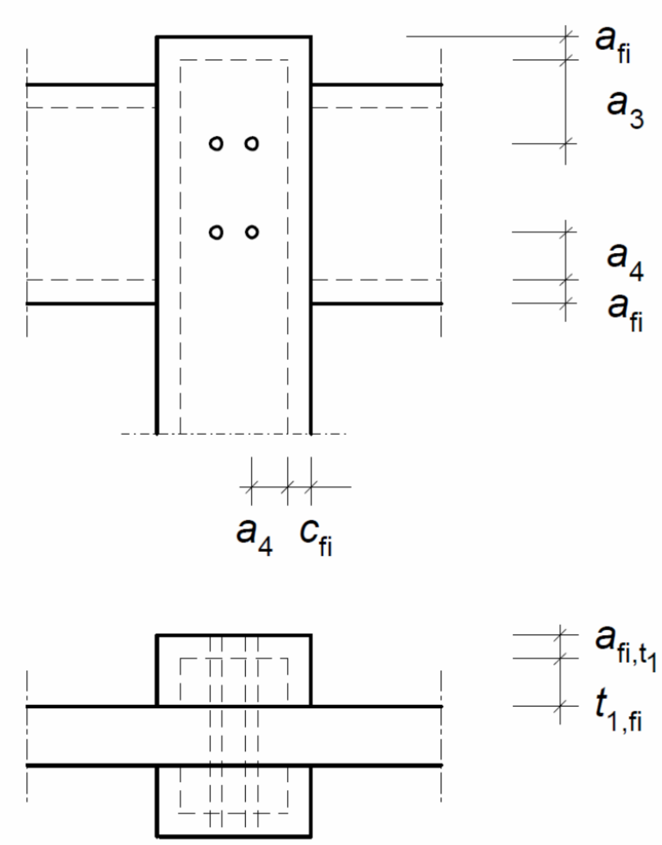
Dowels and dowels

$$R_{k,fi} = R_k \cdot e^{\left(-c_1 \cdot t_{req} + c_2 \cdot t_{1,fi} + c_3\right)}$$

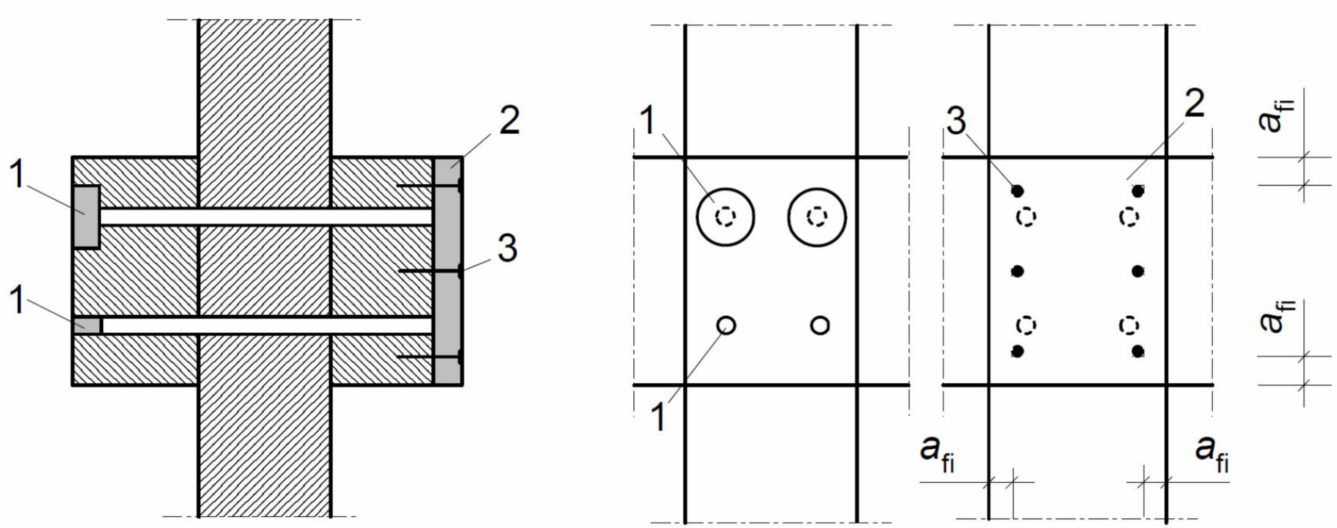
$R_{k,fi}$ – characteristic load-carrying capacity at normal temperature
R_k – characteristic load-carrying capacity at the required fire resistance time
c_1, c_2 -k – coefficient depending on type of fastener and connection
t_{req} – required fire resistance time

9 Connections

- Increased dimensions



- Protected connections



10 Detailing

Rules for

- dimensions and spacings
- fixing and connections of panels, gaps of joints
- fixing of cavity insulation
- joints in and between elements
- penetrations and openings

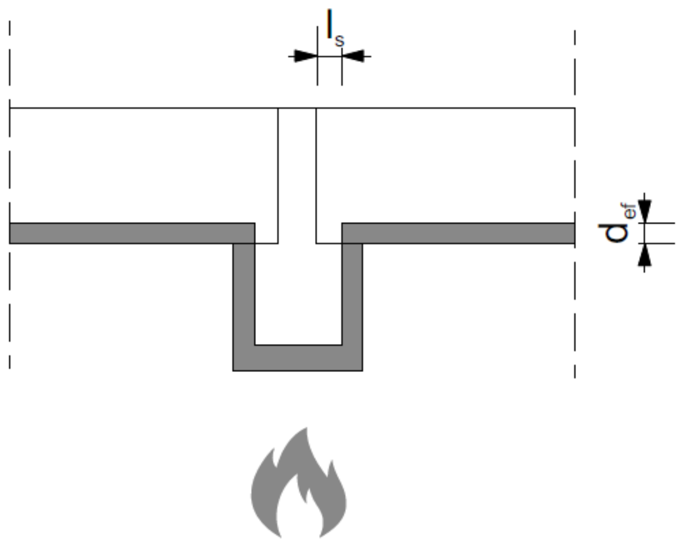
2nd Draft -> 7 pages

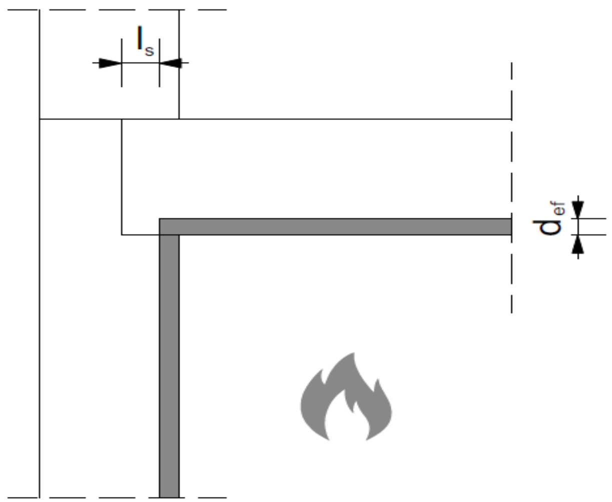
EN 1995-1-2:2004

Very few general rules (2 pages)
No rules for joints between the elements, penetrations

10 Detailing

The fire resistance of the relevant bracing, the bearing area and the supporting structural elements shall be verified.





10.2.2 Fixing and joints of panels

Table 9.1 – Perimeter spacing between fasteners for the fire exposed layer of wood-based panels, wood panelling, gypsum plasterboards and gypsum fibreboards[a]

Staples		Nails		Screws	
Wall	Ceiling	Wall	Ceiling	Wall	Ceiling
Maximum spacing of fasteners for wood-based panels and wood panelling					
150	150	150	150	250	250
Maximum spacing of fasteners for gypsum plasterboards					
80	80	120	120	250	170
Maximum spacing of fasteners for gypsum fibreboards					
200	150	200	150	250	200

[a] Internal spacing may be increased to twice the values given in the table, but not more than 300 mm

Annexes (normative or informative)

Annex A Design of timber structures exposed to physically based design fires

Annex B Evaluation of the bond line integrity in fire

Annex C Determination of the basic design charring rate

Annex D Assessment of Protection Level (PL) of the cavity insulation

Annex E External flaming

Annex F Assessment of the failure time of fire protection systems

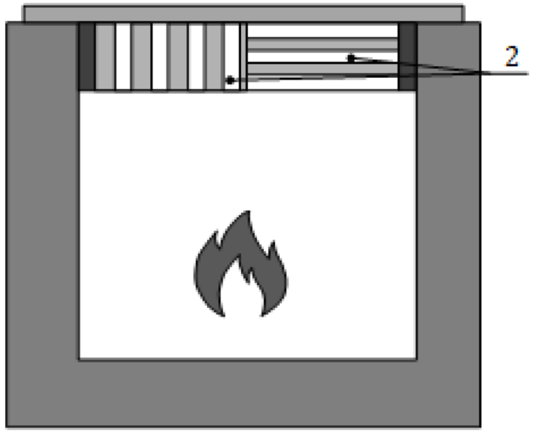
Annex G Implementation rules for Separating Function Method

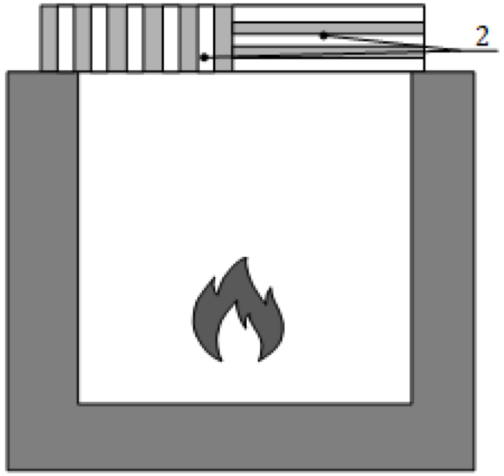
Annex I Design model for timber frame assemblies with I-shaped timber member

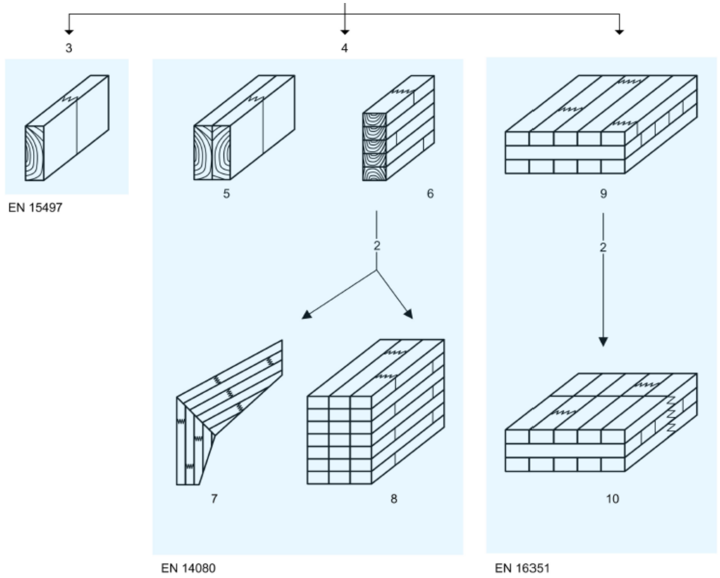
Annex M Material properties

Annex T Determination of temperature in timber members

Annex B Assessment of the bond line integrity in fire (normative)







Key

1 boards
2 is a component for
structural finger jointed timber
glued laminated products
glued solid timber
6 glued laminated timber (glulam)
7 glulam with large finger joints
8 block glued glulam
9 cross laminated timber (X-Lam)
10 cross laminated timber (X-Lam) with large finger joints

Table B.1 – Assessment of the bond line integrity in fire

Bond line integrity maintained	$\beta_{mean,specimen} \leq 1,05 \cdot \beta_{mean,reference}$
Bond line integrity not maintained	$\beta_{mean,specimen} > 1,05 \cdot \beta_{mean,reference}$

EN 1995-1-2:2025 vs EN 1995-1-2:2004

- The European charring model
  - Notional design charring rate
  - Failure time of the fire protection system
  - ….
- Effective cross-section method
  - New rules for CLT
  - New rules for TCC
  - Revised rules for Timber Frame Assemblies
  - ….
- Revised rules for connections
  - Extension up to 120 min
  - ….
- Revised rules for detailing
- Design of timber structures exposed to physically based design fires