Fire safe timber buildings - Nordic design guidelines

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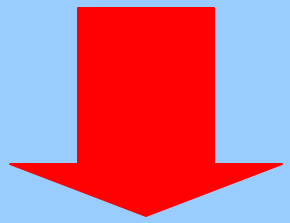
Performance criteria



Multi-storey timber buildings

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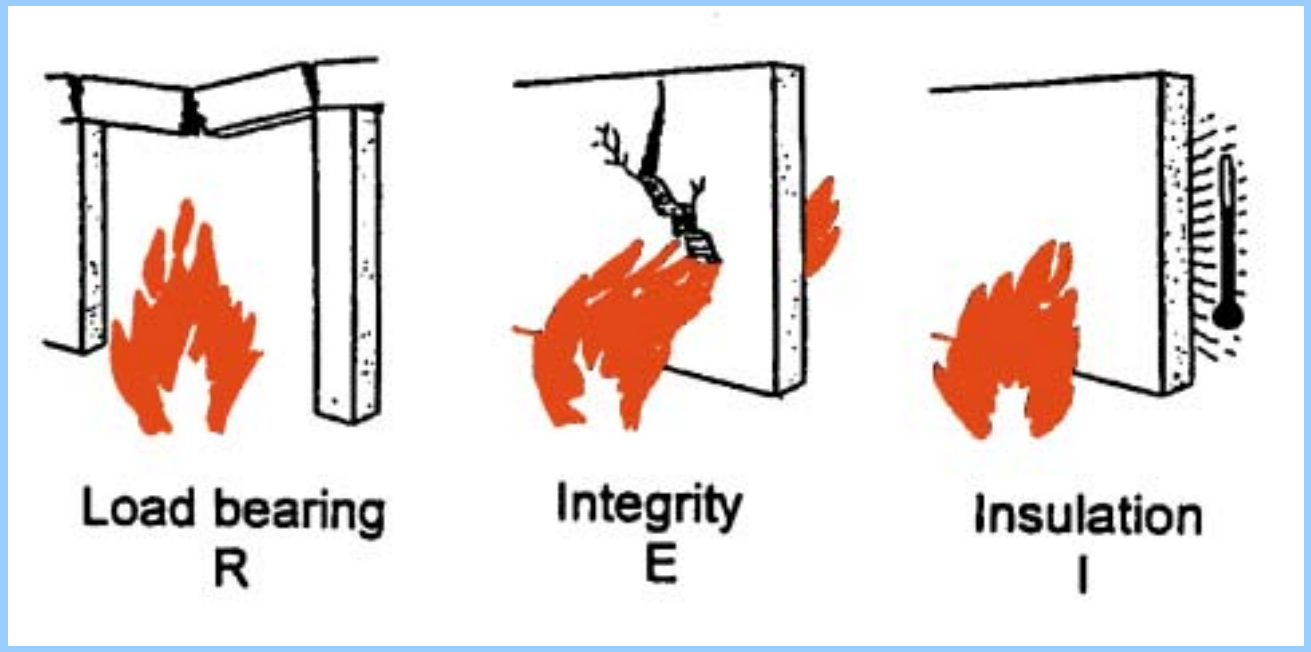
Performance criteria:



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~~Non combustibility requirements~~

Performance criteria
(R, E, I)

e.g. REI 60, EI30 etc

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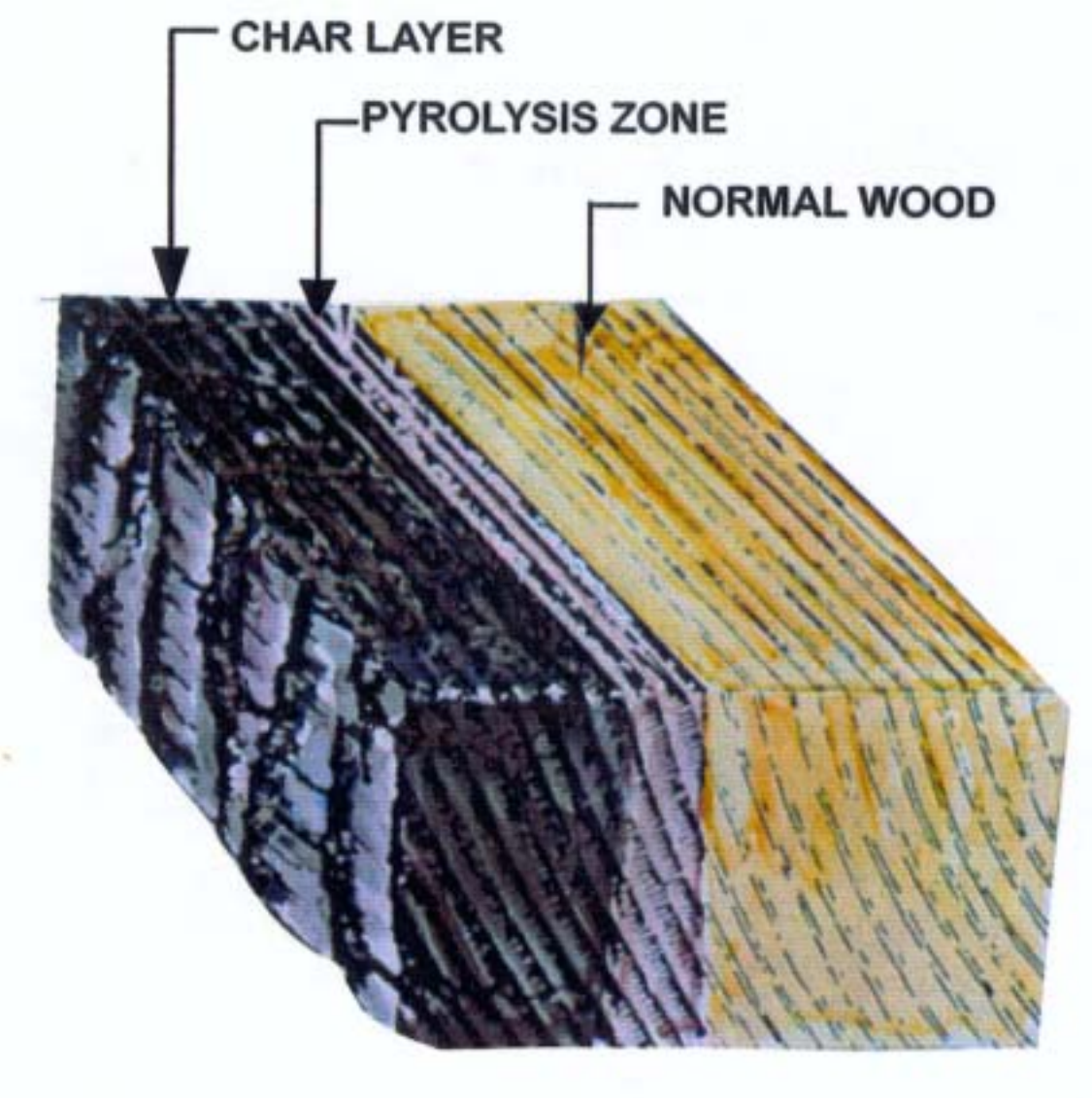
CHAR LAYER
PYROLYSIS ZONE
NORMAL WOOD

Number of stories in timber allowed in Nordic building codes:

	Up to 1993	1994	1997	1999	2004	2007 ?
Sverige	2	∞	∞	∞	∞	∞
Norge	3	3	∞	∞	∞	∞
Finland	2	2	4*	4*	4*	∞ ?
Denmark	1-2	1-2	1-2	4	∞	∞

*** sprinklers required**

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Multi-storey timber buildings

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Wälludden, Sweden 1996

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Ylöjärvi, Finland 1996

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Design possibilities

- Separating structures
- Load bearing structures
- Detailing
- Wooden facades
- Active fire protection

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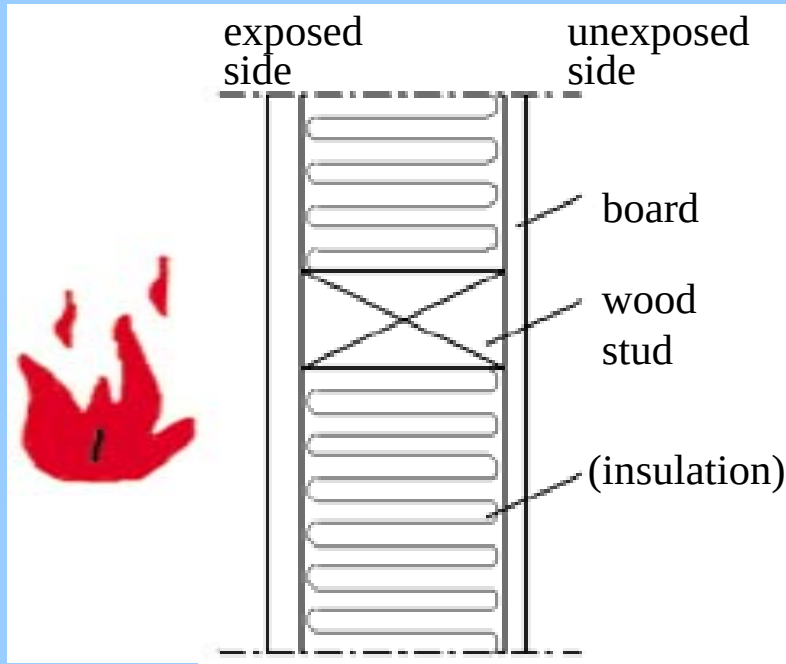
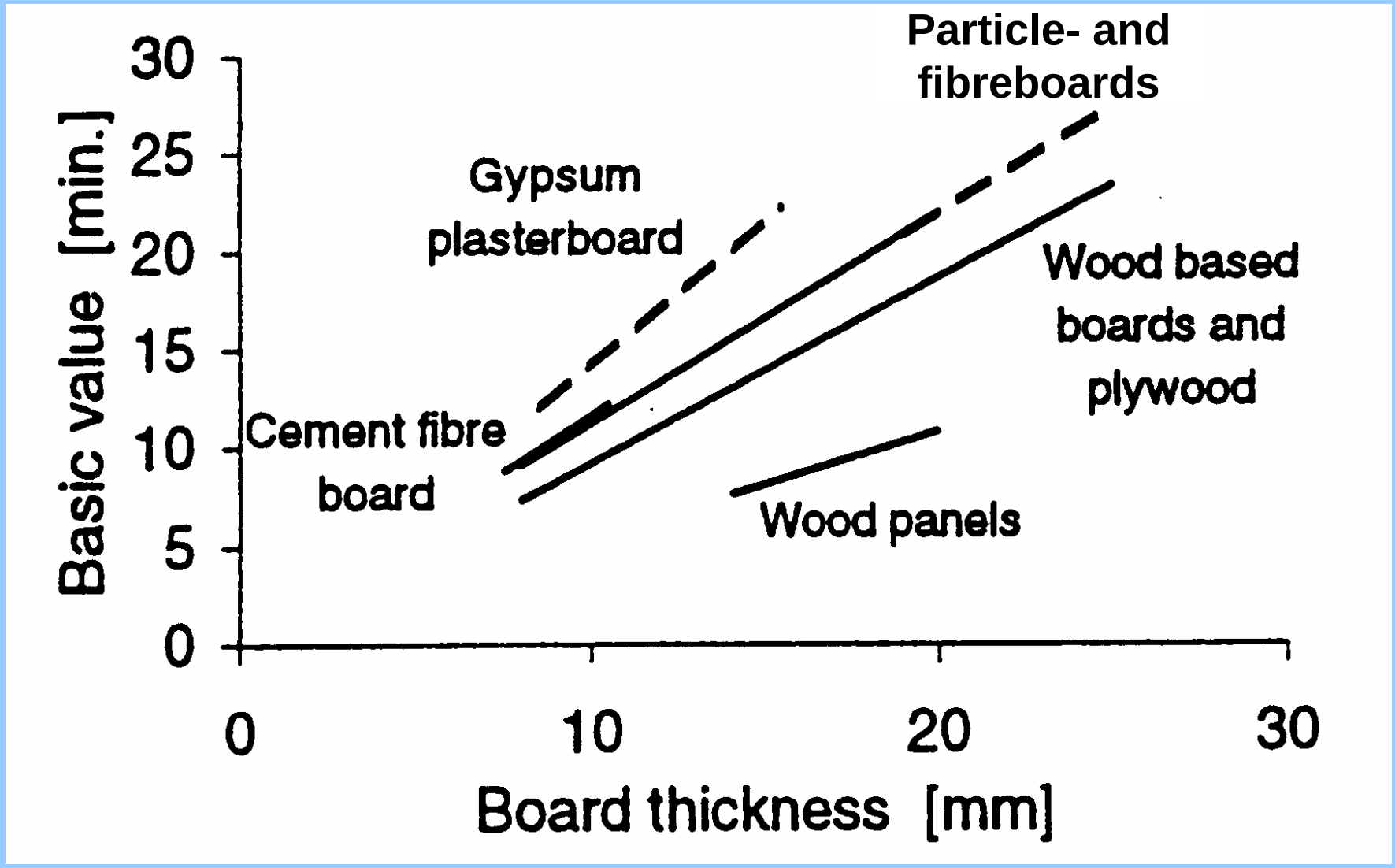
Component additive method for separating structures, EI:

$$t_{ins} = \Sigma\, t_{ins,0,i}\, k_{pos}\, k_j \text{ [min]}$$

t_{ins}	total fire resistance
$t_{ins,0,i}$	basic value for material ‘i’
k_{pos}	position coefficient
k_j	coefficient for joint influence



Board thickness increases the fire resistance



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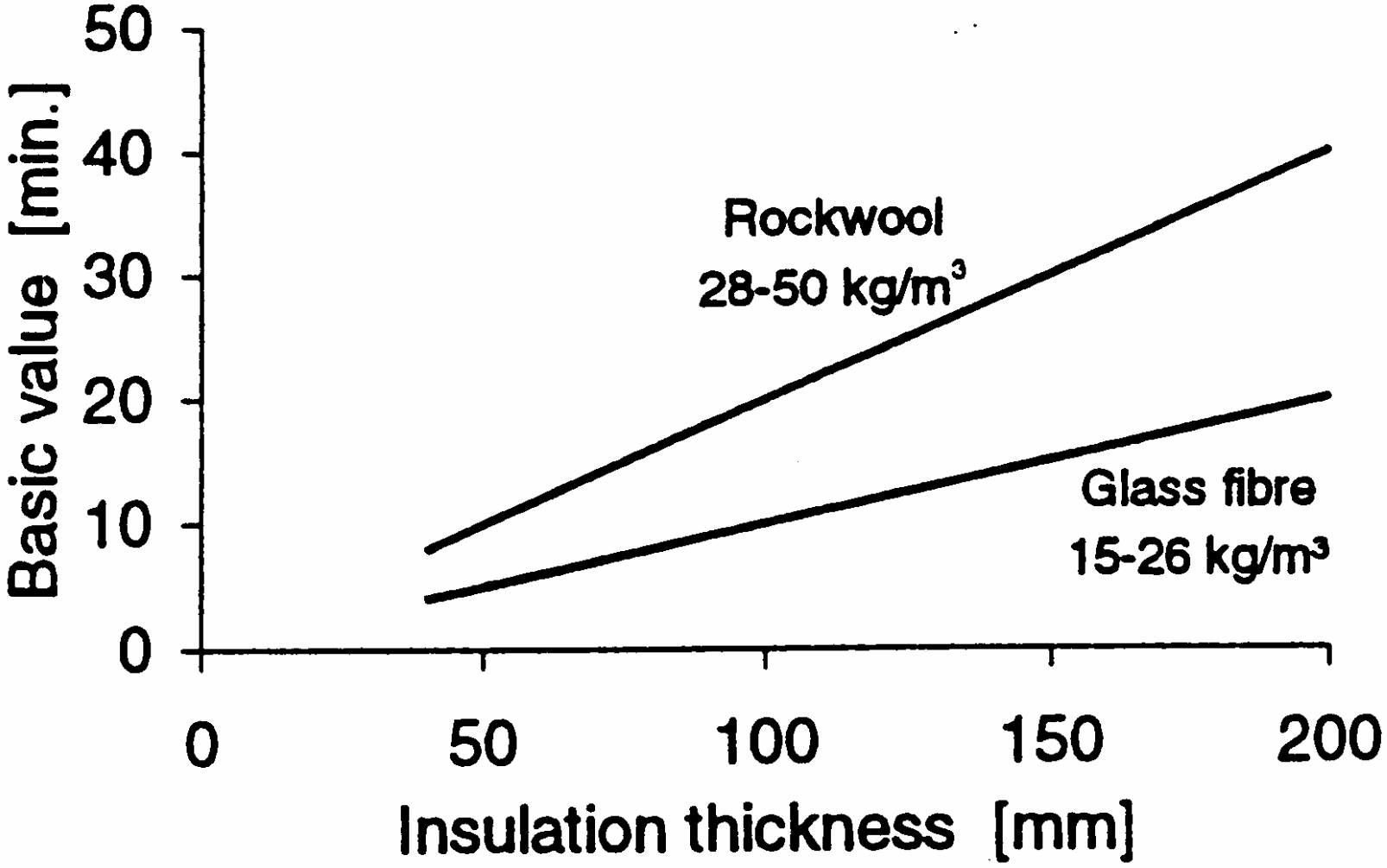
Insulation thickness increases the fire resistance



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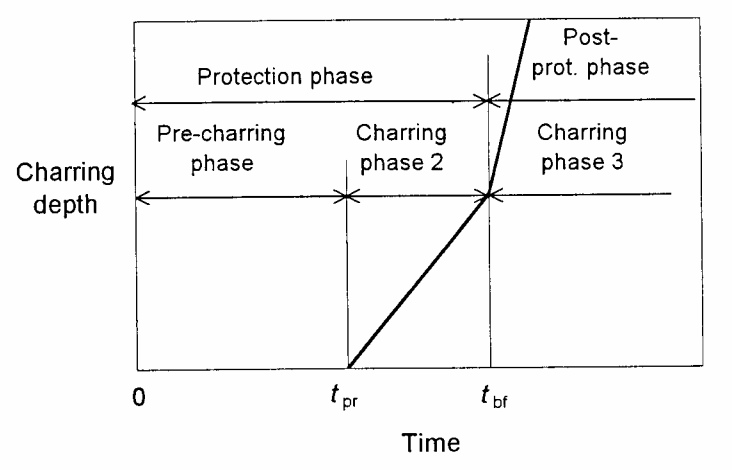
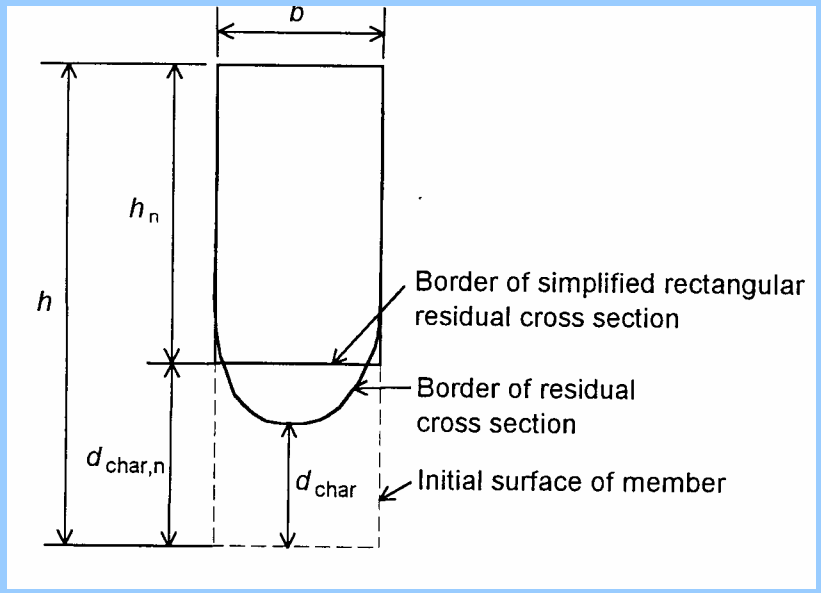
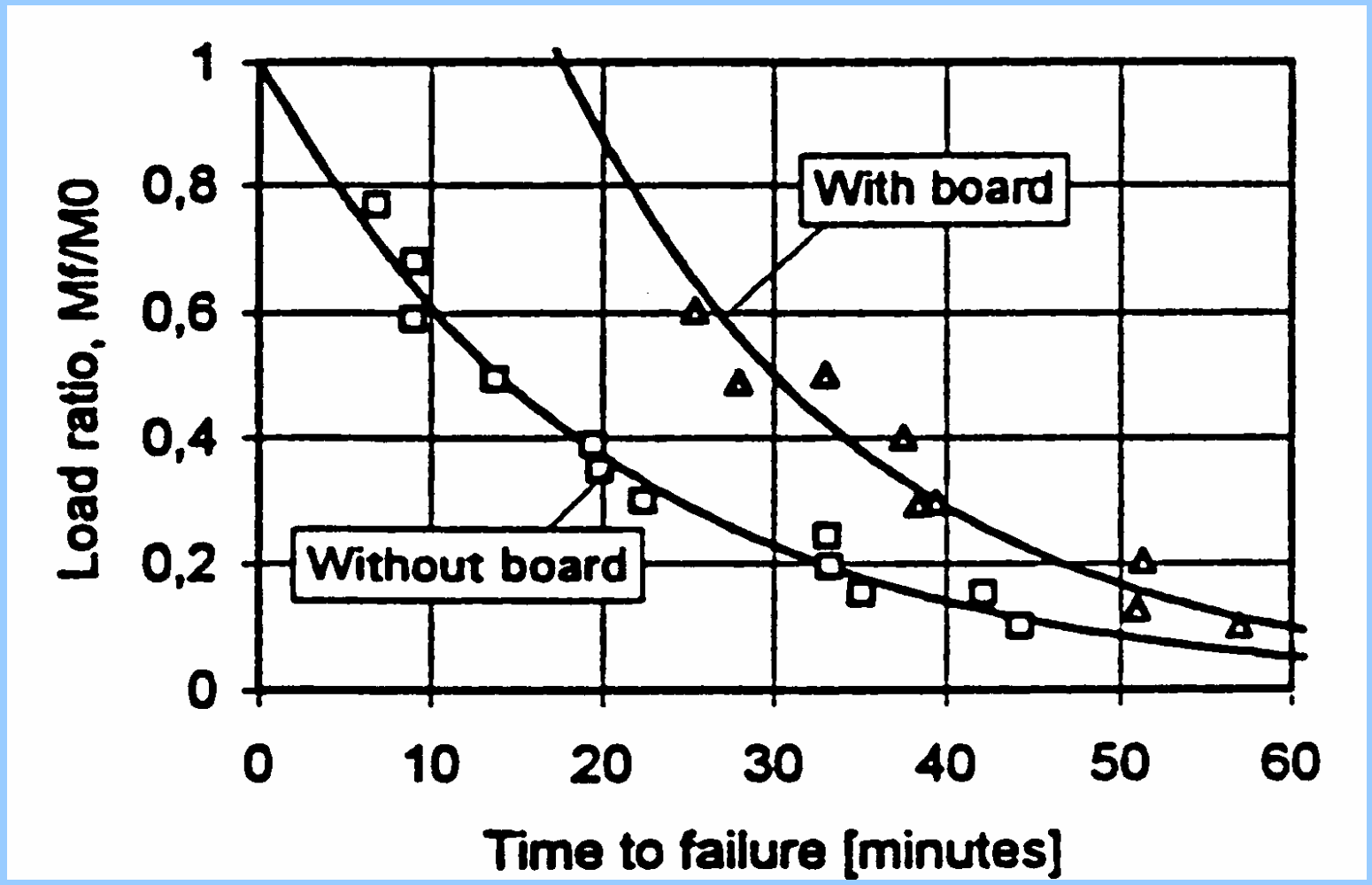
New model for load bearing capacity at fire

- residual cross section
- reduced strength at elevated temperature
- protection by boards and insulation
- anchorage of fasteners
- timber strength class





Load-bearing capacity at fire



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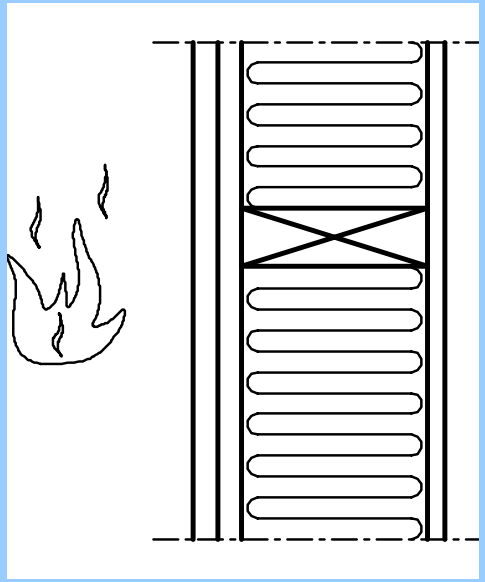
Example:
Load-bearing capacity at fire

	REI 90			
	45 x 145 mm			
	strength class			
	C14	C18	C24	C30
kN/stud	25,6	31,5	38,1	41,4

2 x GF
rock wool



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Detailing

- Fire stops
- Ventilation openings
- Attic separations

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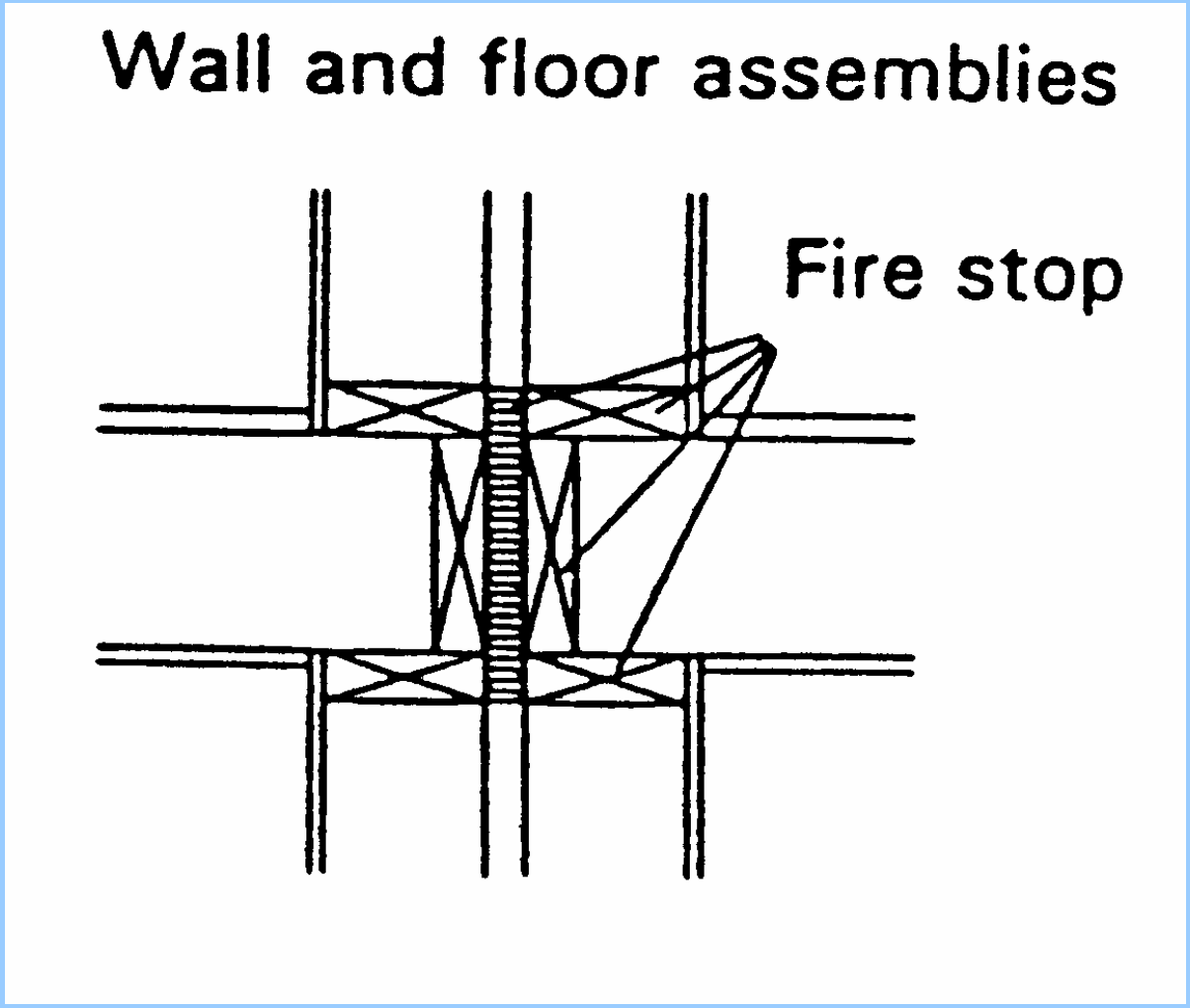
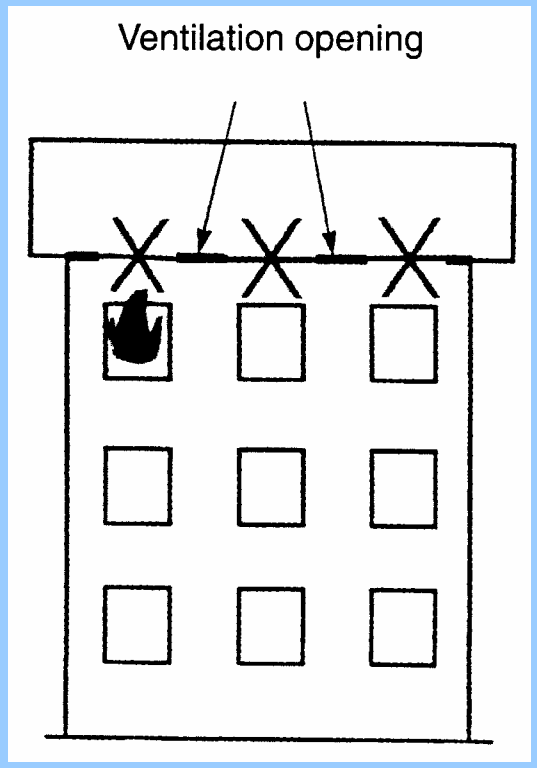
Fire stops, example



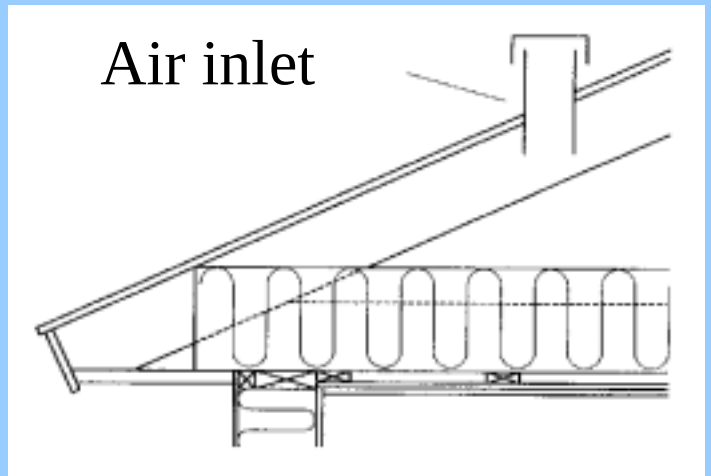
Ventilation openings
NOT at eave over window

Risk for fire spread

NOT over window

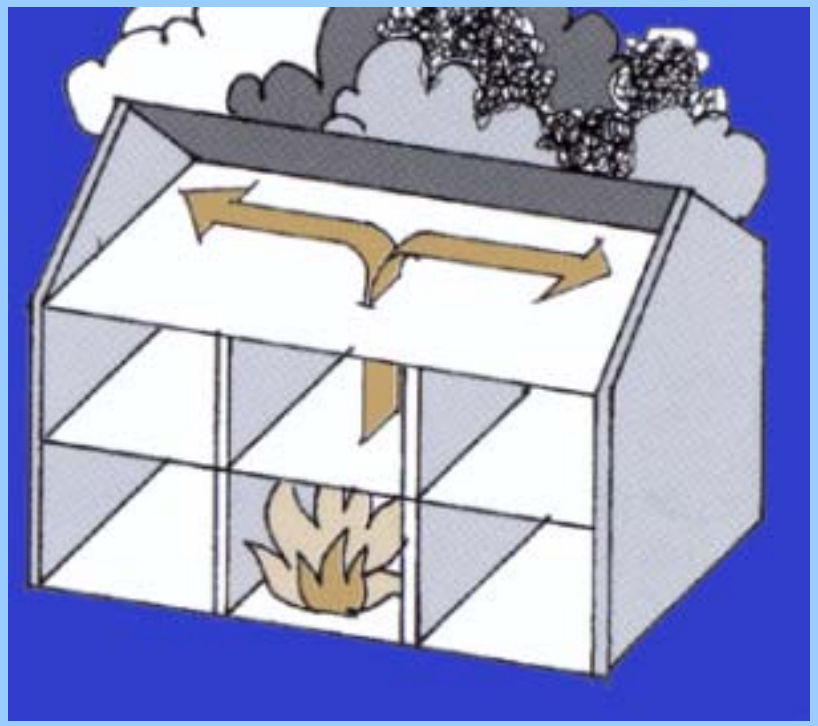


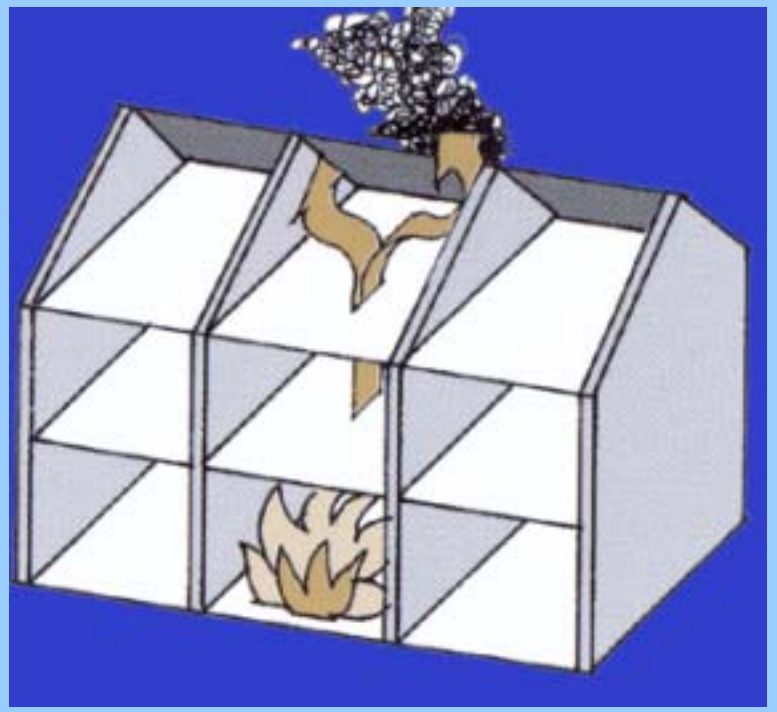
Ventilation on roof



Attic separation

(e g over fire cells underneath)





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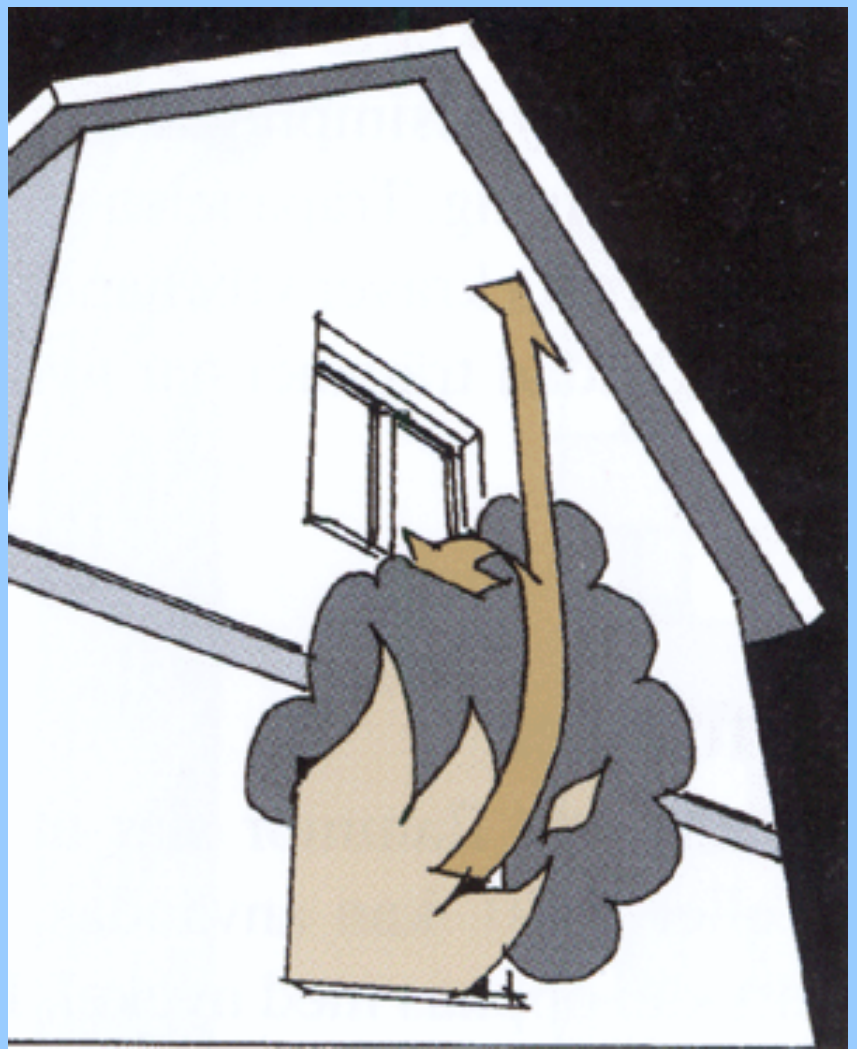
Wooden facades -
General limitations



Wooden facades if

- partial wood
- fire rated windows or shutters
- cantilevers over windows
- small or no windows
- fire retardant wood
- residential sprinklers

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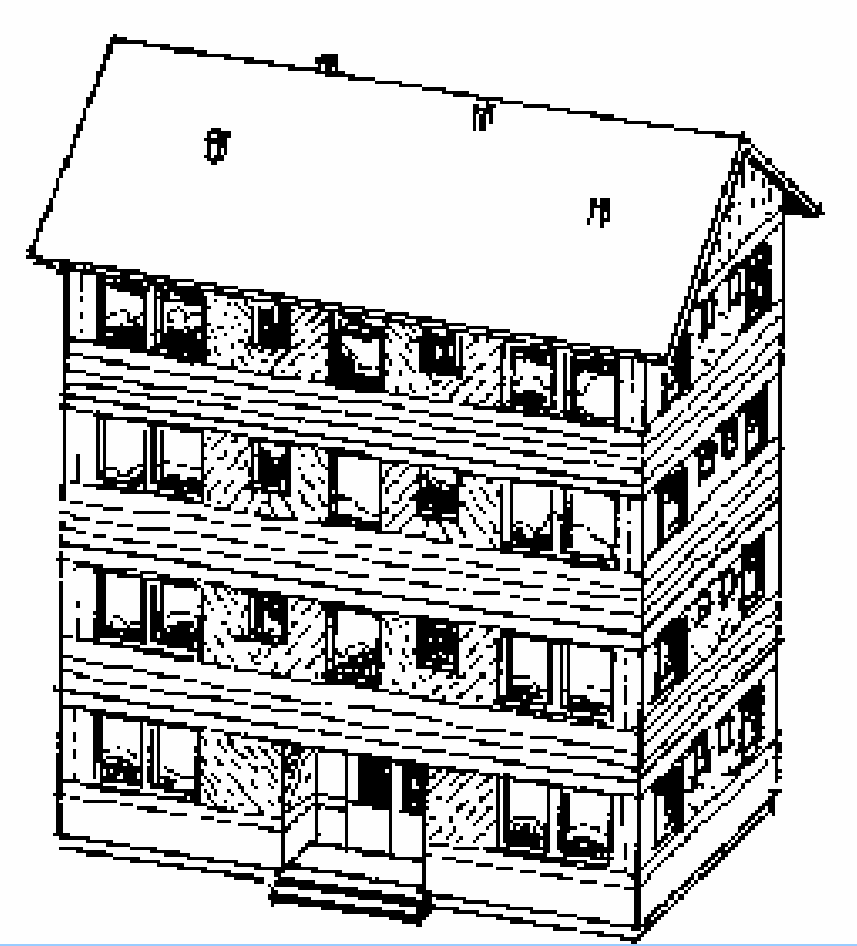
Partial wood



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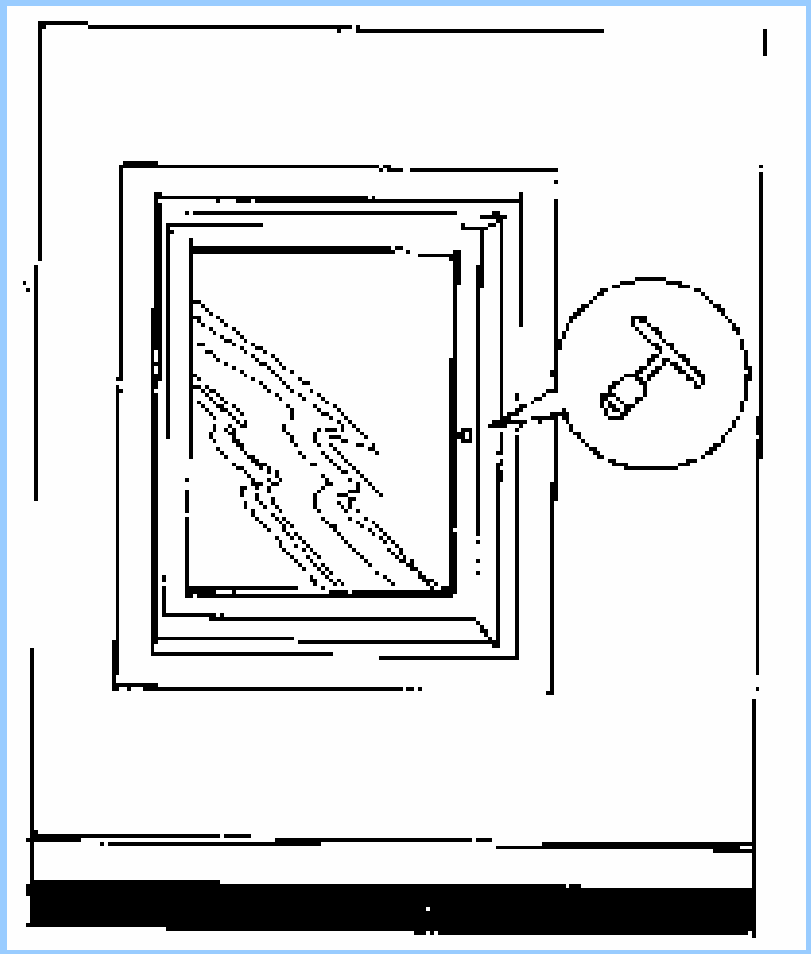
Fire rated windows



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Lotsen, office, Sweden 1996

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Design for fire safety

- Passive fire protection
- Active fire protection
- Fire brigades

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Active fire protection by residential sprinklers

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Alternative building design with sprinklers:

- facades

- interior linings

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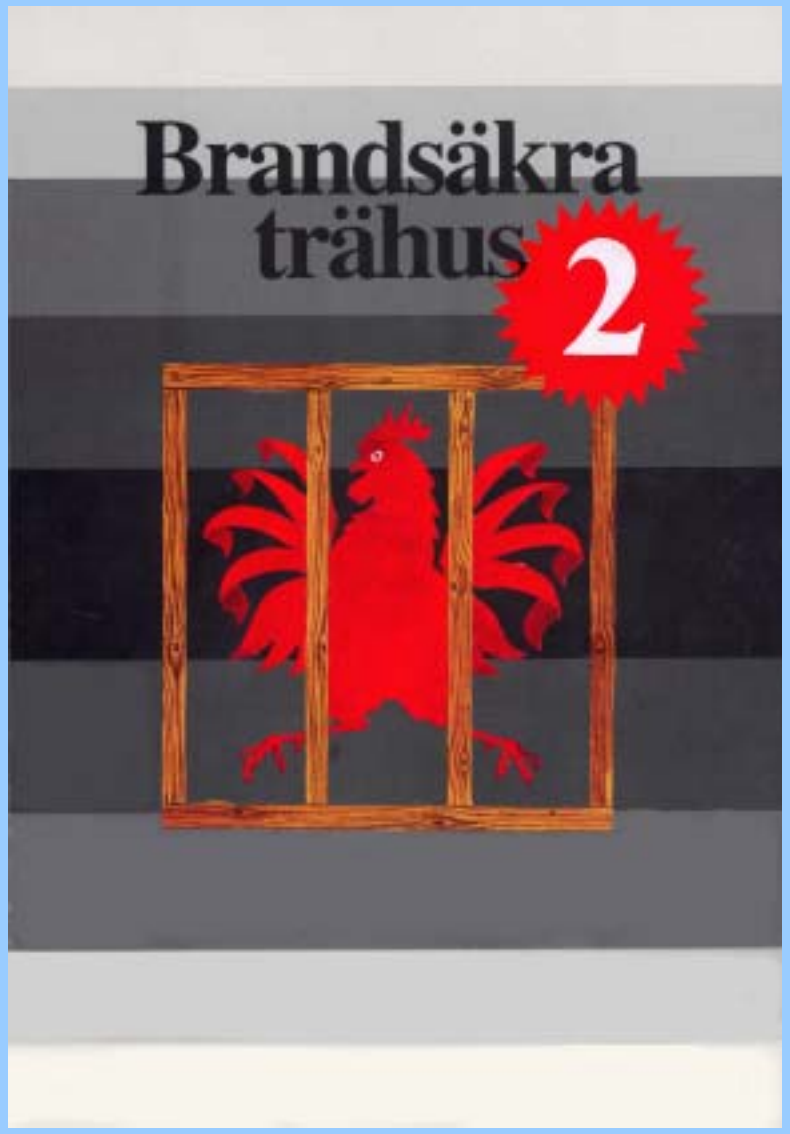
Nordic design guide



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Thank you!

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