

Eindhoven University of Technology Fellow / FSE

Expertclass ‘FSE - Next Generation’ Fire safety of mass timber buildings

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Introduction to Arup

Total design for mass timber buildings

Fire safety challenges

Our role as ‘next generation’ fire safety engineers

Enabling sustainable and innovative solutions

Arup

Celebrating 50 years of
Fire Safety
at Arup

50

1946

Opgericht door Sir Ove Arup

18,000+

Leden

£2.2bn

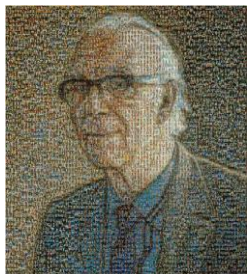
Omzet (2022/23)

94

Kantoren

34

Landen



Employee owned
Quality driven

Total design

ARUP



**STRUCTURAL
ENGINEERING**



**MECHANICAL
ENGINEERING**



**FIRE
SAFETY**



ACOUSTICS



SUSTAINABILITY



GEOTECHNICS



**ELECTRICAL
ENGINEERING**



BUILDING PHYSICS



LIGHTING



BIM



**WIND
ENGINEERING**



**VERTICAL
TRANSPORT**



FAÇADES



VIBRATIONS



DIGITAL

An aerial photograph of the London skyline, featuring prominent skyscrapers like The Shard, the Gherkin, and the Walkie-Talkie building. The River Thames flows through the city, and the London Eye is visible in the distance. The image is used as a background for the text overlay.

Role of fire safety engineering in total design -
“Enabling innovation, safety and solutions”

ARUP

“Enabling fire safe innovations”



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Why timber buildings?

Our aim is to create more sustainable buildings without compromising on safety and increase comfort of living.

UN Sustainable Development Goals, creating better outcomes for people, places and planet.



“Concrete & Steel where needed –
Timber where possible!”

“Leading sustainable development”



www.arup.com/perspectives/publications/promotional-materials/section/designing-with-timber



www.arup.com/perspectives/publications/research/section/rethinking-timber-buildings



www.arup.com/insights/fire-safe-design-of-mass-timber-buildings/

Arup design of timber buildings

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Metropol Parasol, Spain

www.arup.com/perspectives/publications/promotional-materials/section/designing-with-timber
direct link: [Designing with timber - Arup](#)



www.arup.com/projects/haut



Mass timber – a quick recap



Cross laminated timber (CLT)



Glue laminated timber (Glulam)



Laminated veneer lumber (LVL)

(c) Puuinfo

Relevant global experience

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Believe in Better Building,
London, UK



Life Cycle Tower one
Dornbirn, Germany



Sayama Lakeside
Cemetery Community Hall
Saitama, Japan



Mactan Cebu
International Airport
Cebu City, Philippines



Macquarie University Incubator
Sydney, Australia



Ascent tower, *Milwaukee, USA*



Kroon Hall, Yale University,
New Haven, USA.



Metropol Parasol,
Seville, Spain



Relevant Netherlands experience



HAUT



Elements



Tangentlocatie



DPG Mediavaert



Nieuwegein (2nd opinion)



Spark



SAWA (2nd opinion)



The Dutch Mountains



Habitat Royale



Timber design is hot!

However, recent research and project are demonstrating that traditional life safety codes do not all yet address additional fire risks in timber building.

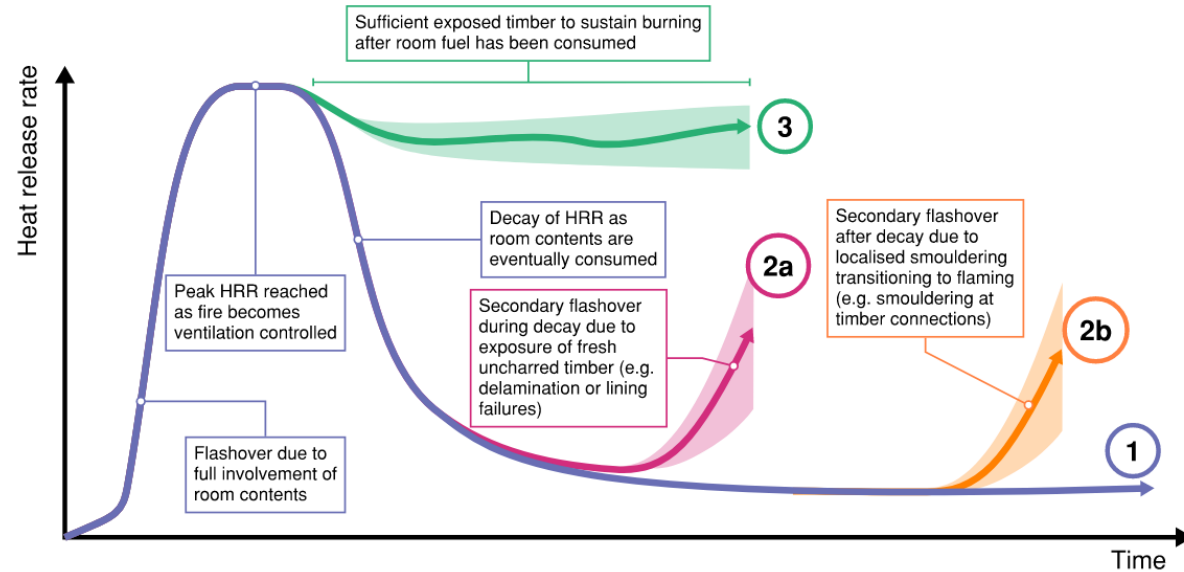
“Bouwbesluit schiet tekort voor brandveilige hoogbouw in hout”

Artikel: Cobouw 06.10.21

Foto: J.P. van Eesteren

Fire risks of building in timber:

- Timber structures increase fire load in buildings
- Extended fire duration
- Impact temperature development
- Self-extinguishment uncertain
 - 1. Self-extinguishment
 - 2. Regrowth – 2nd flashover
 - 3. Continuous burning



“FSE – Next Generation”

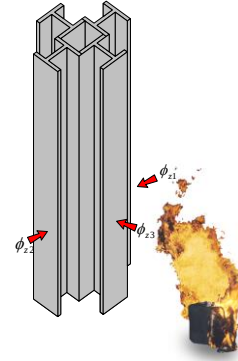
*Enabling sustainable and innovative design in a
responsible and fire safe manner.*



Means of Egress



Fire brigade intervention



Structural fire resistance

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Active fire safety systems

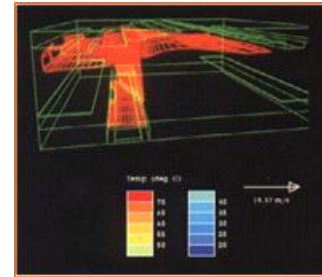
Integrated fire strategy



Research and evidence
from testing



Building regulations,
code, client & insurers
requirements



Limit smoke spread



Limit fire spread - fire
compartments



Main aims

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- Veilig vluchten
- Het beperken van rookverspreiding binnen het gebouw
- Het beperken van brandspreiding binnen het gebouw
- Voorkomen brandoverslag naar derden en buurpercelen
- Veilig uitvoeren van reddingswerkzaamheden
- Constructieve veiligheid en instandhouding draagconstructie



Functionele eisen

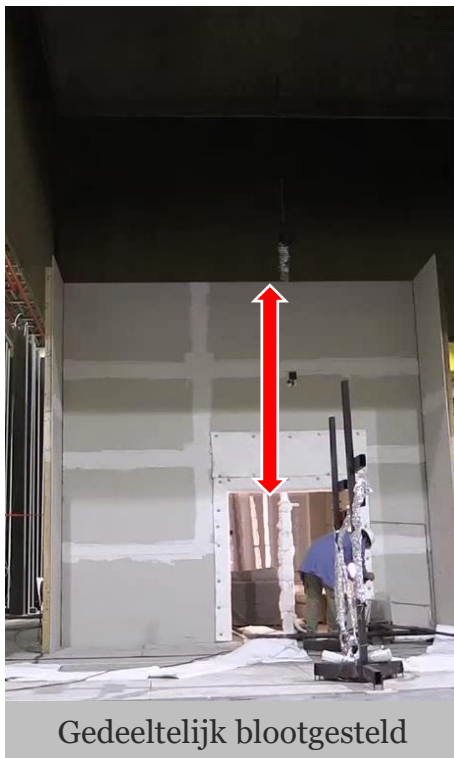
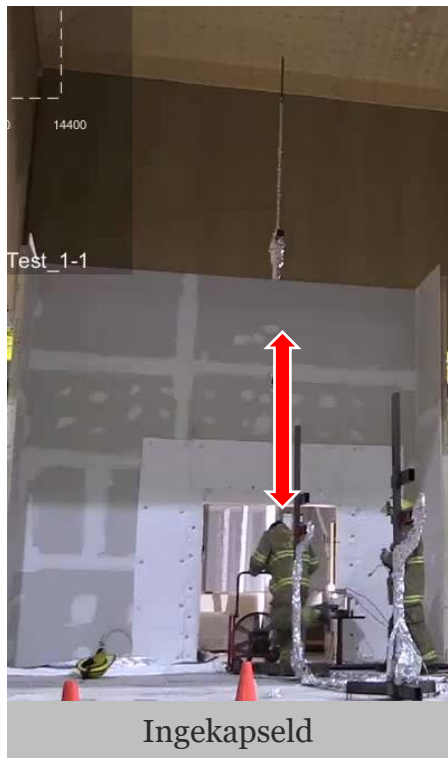
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Ingekapseld



Gedeeltelijk blootgesteld



Functionele eisen ^{ARUP}

- Veilig vluchten
- Het beperken van rookverspreiding binnen het gebouw
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Functionele eisen

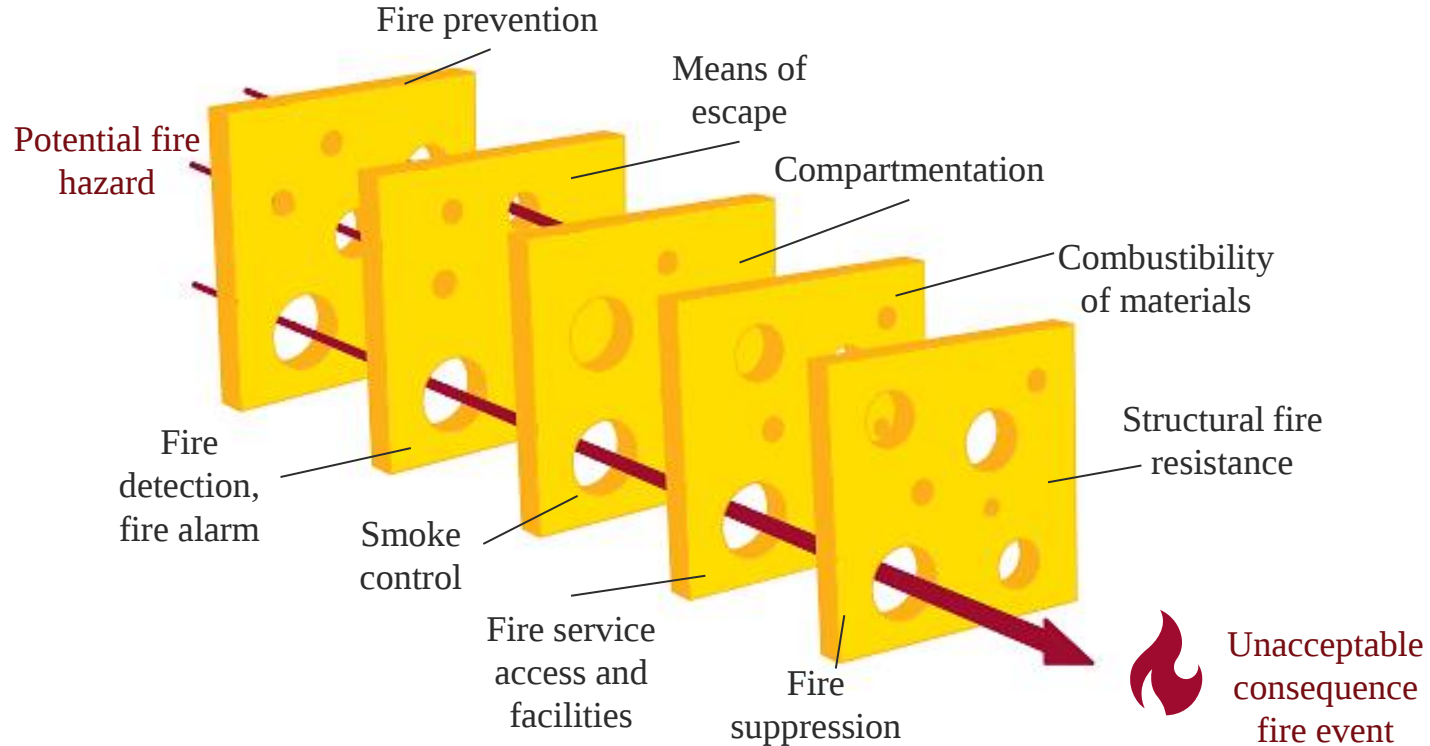
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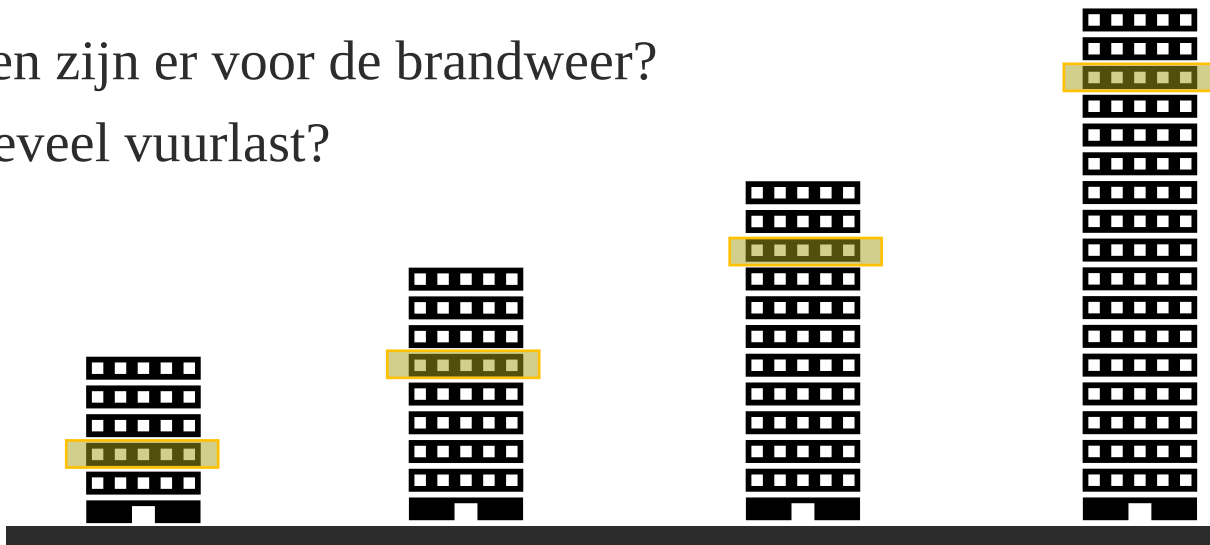
Fire strategy and design principles

Fundamentals



Voor alle gebouwen dezelfde maatregelen?

- Nee!
- Slapen in het gebouw?
- Hoe wordt het gebouw ontruimd?
- Welke mogelijkheden zijn er voor de brandweer?
- Type gebouw en hoeveel vuurlast?
- Vluchtroutes
- Gevelopbouw
- Hoogte
- ...etc



Brandveiligheid massieve houtbouw

Toelichting NTA 6125

Werkgroep 351 007 007 "Brandveiligheid en bouwen met hout".

Pascal Steenbakkers (Coördinatie en rapporteur voor NTA)

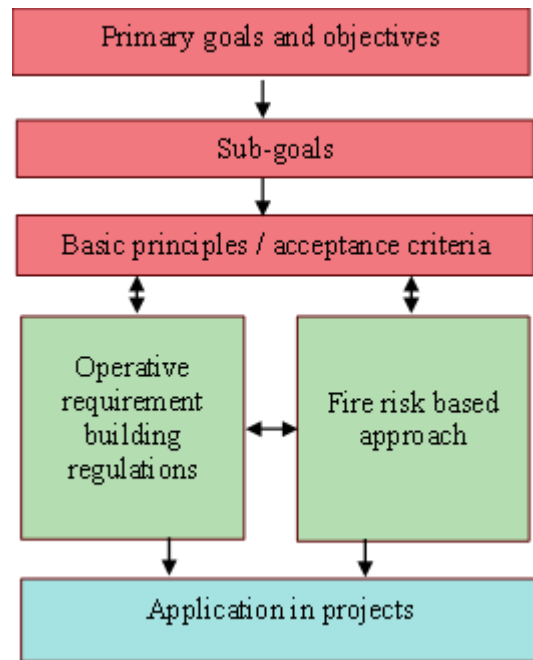
IJsbrand van Straalen (rapporteur NTA)

Daniel Brandon (rapporteur NTA)



The screenshot shows the NEN website header with navigation links: Norm kopen, Norm ontwikkelen, Trainingen, Evenementen, and Certificatie & keurmerken. Below the header is a search bar and a breadcrumb trail: Home > Start ontwikkeling NTA Brandveilig bouwen met hout. The main heading is 'Start ontwikkeling NTA Brandveilig bouwen met hout' dated 20 sep. 2023. A subtext states: 'De NEN-werkgroep 'Brandveiligheid en bouwen met hout' is per 1 oktober 2023 gestart met de ontwikkeling van een Nederlands Technische Afspraak (NTA). De NTA gaat over aanvullende afspraken die gemaakt moeten worden wanneer hout als bouw materiaal wordt gebruikt in plaats van traditionele materialen zoals staal en beton.' Below the text is a photograph of a wooden roof structure engulfed in flames.

Method for performance and risk based assessment



Application for new mass timber buildings

NTA 6125 - Proposal supplementary requirements in the Environmental building decree (Bbl)		Passive fire protection	Automatic fire suppression system	Structural fire protection	Use exposed mass timber with constant charring rate	Fire & smoke sealing and joints	External firefighting access	Alternative package fire risk assessment
Highest occupied floor level (m)	Packages of supplementary measures:	See 6.1	See 6.2	See 6.3	See 6.4	See 6.5	See 6.6	See 6.7
Category I: $0\text{ m} < h_{\text{BBL}} \leq 7\text{ m}$ (residential function): $0\text{ m} < h_{\text{BBL}} \leq 10\text{ m}$ (ground-based single-family houses): $0\text{ m} < h_{\text{BBL}} \leq 5\text{ m}$ (other purpose groups): consequence class CC1a	Package 0: No additional measures - Apply Bbl	See 5.2.1	-	-	-	-	-	-
Category II: $7\text{ m} < h_{\text{BBL}} \leq 13\text{ m}$ (residential function): $5\text{ m} < h_{\text{BBL}} \leq 13\text{ m}$ (other purpose groups)	Package 1: Active suppression system	See 5.2.2.1	-	☑	-	☑	-	-
	Package 2: Protection of timber (up to 150 m^2)	See 5.2.2.2	1	-	☑	☑	-	-
	Package 3: Protection of timber (up to $1\,000\text{ m}^2$)	See 5.2.3	2	-	☑	☑	-	-
	Package 4: Full protection - first phase fire (up to 150 m^2)	See 5.2.2.4	4	-	☑	-	☑	-
	Alternative package: Fire risk assessment	See 5.2.2.5	-	-	-	-	-	☑
Category III: $13\text{ m} < h_{\text{BBL}} \leq 20\text{ m}$	Package 5: Active suppression system (up to 150 m^2)	See 5.2.3.1	-	☑	-	☑	-	-
	Package 6: Active suppression system with protection (up to $1\,000\text{ m}^2$)	See 5.2.3.2	1	☑	-	☑	-	-
	Package 7: Protection to limit the risk of fire spread (up to 150 m^2)	See 5.2.3.3	2	-	☑	☑	-	-
	Package 8: Protection to limit the risk of fire spread (up to $1\,000\text{ m}^2$)	See 5.2.3.4	3	-	☑	☑	-	-
	Package 9: Full encapsulation (entire fire duration)	See 5.2.3.5	5	-	☑	-	☑	-
	Package 10: Compartments up to 150 m^2 with access via non-enclosed exterior corridor	See 5.2.3.6	1	-	☑	☑	☑	-
	Alternative package: Fire risk assessment	See 5.2.3.7	-	-	-	-	-	☑
Category IV: $20\text{ m} < h_{\text{BBL}} \leq 35\text{ m}$	Package 11: Active suppression system with protection	See 5.2.4.1	2	☑	☑	☑	-	-
	Package 12: Full encapsulation (entire fire duration)	See 5.2.4.2	5	-	☑	-	☑	-
	Package 13: Limit effect of external flames outside external reach of the fire service (up to 150 m^2)	See 5.2.4.3	3	-	☑	☑	☑	-
	Package 14: Compartments up to 150 m^2 with access via non-enclosed exterior corridor	See 5.2.4.4	2	-	☑	☑	☑	-
	Package 15: Compartments up to 150 m^2 with access via non-enclosed exterior corridor	See 5.2.4.5	1	☑	☑	☑	☑	-
	Alternative package: Fire risk assessment	See 5.2.4.6	-	-	-	-	-	☑
$h_{\text{BBL}} > 35\text{ m}$	Alternative package: Fire risk assessment	See 6.7	-	-	-	-	-	☑
Outside scope	Alternative package: Fire risk assessment	See 6.7	-	-	-	-	-	☑

Options for mitigation measures

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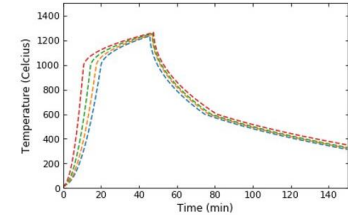
- Provide level of protection to some exposed surfaces
- Use timber with constant charring rate
- Active fire suppression systems
- Analysis on fire load and behaviour
- Internal and external fire compartment barriers



Adhesive in support of constant charring



Adhesive that loses integrity upon heating



Project HAUT, Amsterdam: principles of fire strategy:

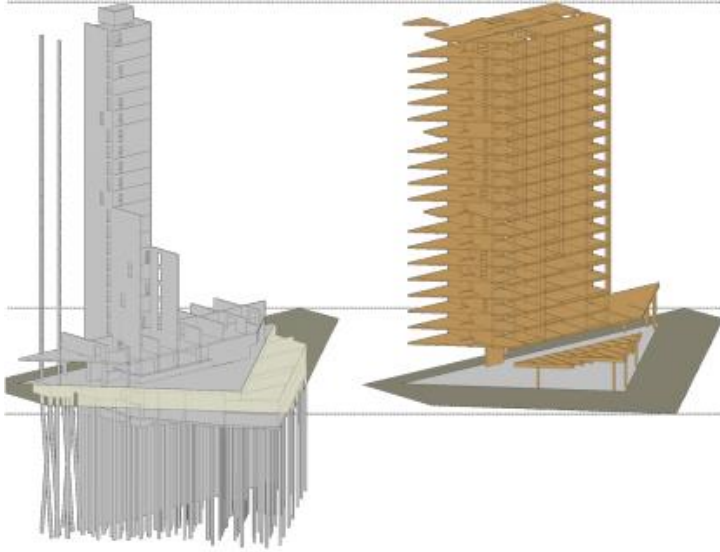
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- Haut Amsterdam
- 70 meter
- Residential
- Top-end apartments with large windows
- CLT timber structure:
 - Exposed floor
 - Protected walls
- Watermist system commercial
- Concrete core:
 - Two escape routes
 - Fire brigade access
- Manual all out alarm



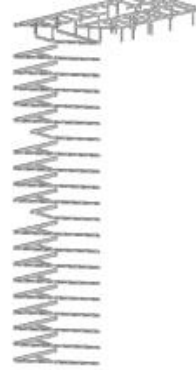
HAUT: Structural design

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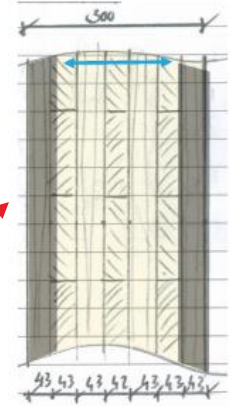


Concrete:
Core and foundations

Timber walls
Hybrid floors



Steel:

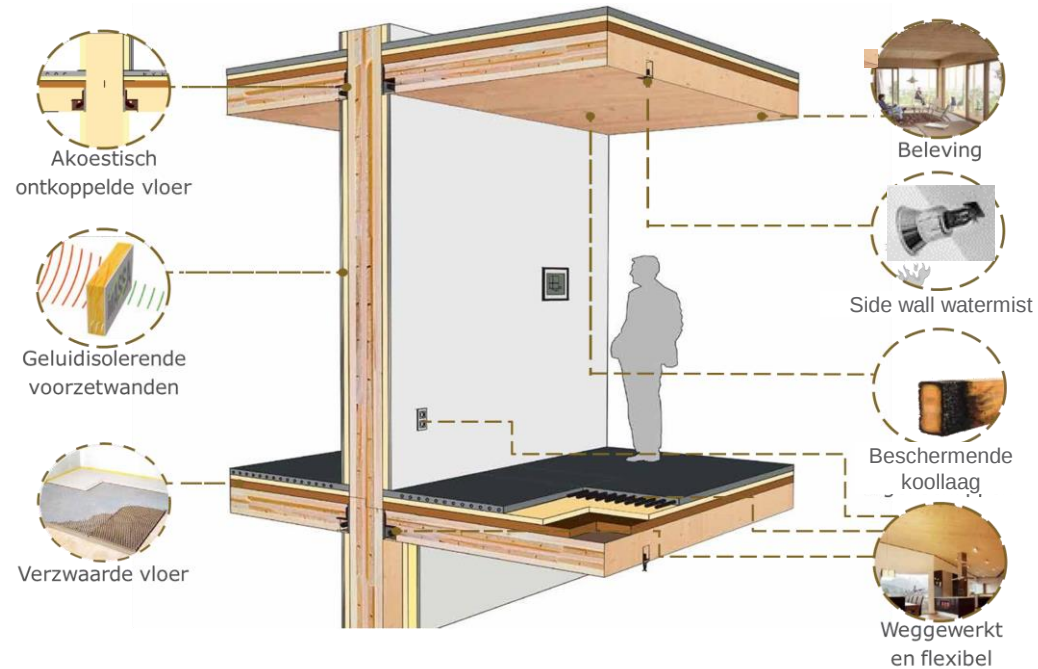


Hybrid floor – timber & concrete

HAUT:

Design Concept

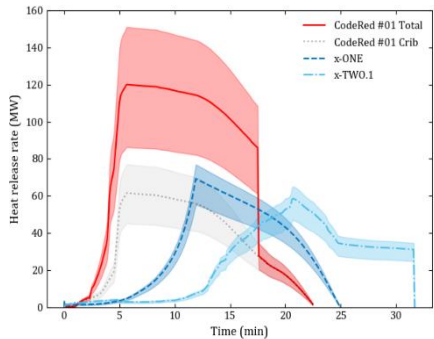
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Example – fire resistant and acoustic panels

The right balance for responsible total design:

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Summary

- Sustainable design in mass timber!
- Additional fire risks can be mitigated as part of a total design.
- Support and stimulate innovations and creative solutions, such as clay protection of biobased constructions.
- Role for Next Generation:
“Enabling sustainable and innovative design in a responsible and fire safe manner”.





If interested in:

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- Discussion on the role of Next generation
- Internships and trainingships
- Brainstorming on graduation thesis
- Career developments and Arup university
- Walk-in day in the office to get an impression and be inspired.
- Short/long term assignments in other offices
- Working in Arup

Please contact:

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Questions?

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