

Kenniscentrum Leefomgeving

Tall buildings Safety by risk assessment

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Kom verder. Saxion.




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Safety definitions

Prescriptive rules:

- Building Code (2003 / 2012)
 - many fixed requirements for fire safety to control the maximum effect
 - easy yes/no judgment
 - obstruction to innovation

Tabel 2.1 -

Keuzemogelijkheden	Impactfactor van de brandveiligheid met betrekking tot bereikbaarheid en evacuatie
Keuzemogelijkheid 1: Het is niet toegestaan om de brandveiligheid te garanderen op een andere manier dan door de brandveiligheidsvoorschriften te volgen.	80
Keuzemogelijkheid 2: Het is toegestaan om de brandveiligheid te garanderen op een andere manier dan door de brandveiligheidsvoorschriften te volgen, mits de veiligheid wordt aangetoond.	90
Keuzemogelijkheid 3: Het is toegestaan om de brandveiligheid te garanderen op een andere manier dan door de brandveiligheidsvoorschriften te volgen, mits de veiligheid wordt aangetoond en de brandveiligheidsvoorschriften worden overtroffen.	100

Performance-based approach:

- Safety = (Risk)⁻¹
- Risk assessment:
 - Probability and consequences
- Project-specific parameters
 - Source and response
- Taylor-made fire safety (FSE)



Safety definitions

$$\text{Risk} = \text{Probability} \times (\text{Consequences})^n$$

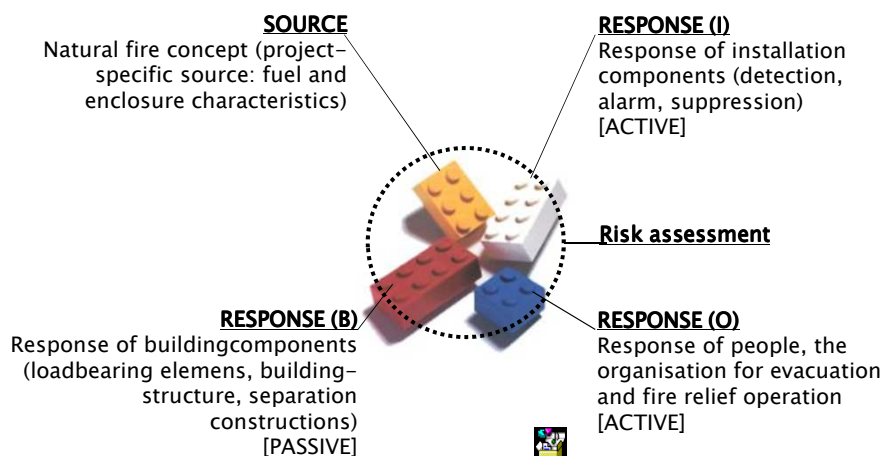
Consequences defined as failure of a risk subsystem:

- Acceptable failure of egress route(s)
- Acceptable failure of attack route(s)
- Acceptable failure of compartment (acceptable spread of fire and smoke)
- Acceptable failure of building structure
- Acceptable failure of environmental protection

Tall buildings > 70 meter are beyond the scope of the building code → different approach needed!

Safety definitions

Source and response in a risk-based approach



Source: fire

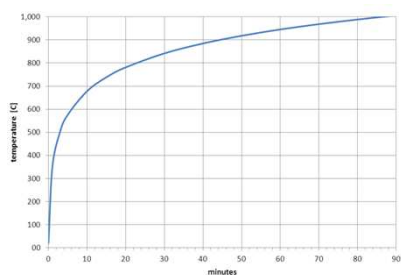
Interaction between fire and enclosure

- Influence fire → enclosure
- Influence fire ← enclosure

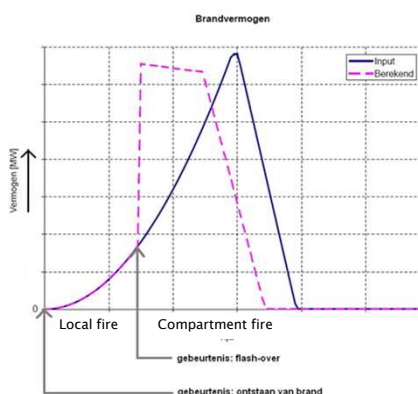


Natural fire concept

In stead of a standard fire curve...



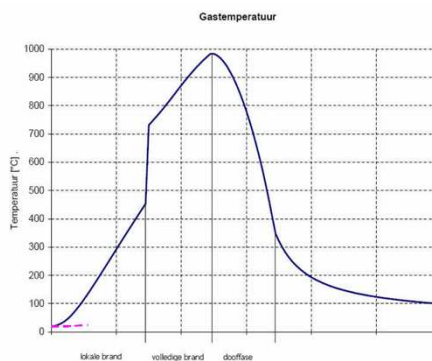
... a natural scenario for the heat release rate →



Natural fire concept

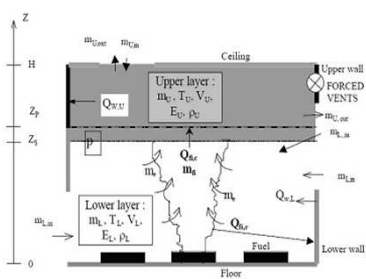
Two critical events:

- Start of a local fire
Depends on buildingsfunction and compartment area
- Flashover to compartment fire
Depends on RHR-scenario and the characteristics of the compartment envelope



Natural fire concept

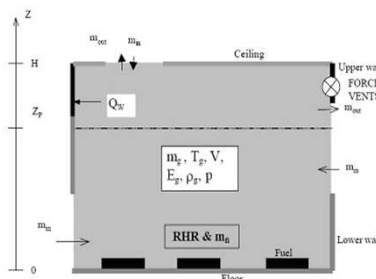
Pre flashover: two zones (local fire)



flashover

flash-over conditions

Post flashover: one mixed zone (compartment fire)



Natural fire concept

Pre flashover:

- Safe egress in compartment
- Safe attack in compartment (offensive fire attack)

Post flashover:

- Safe egress route(s)
- Safe attack route(s)
- Safe compartments (limitation spread of fire and smoke)
- Safe building structure
- Safe environment

Risk-based approach

Semi-probabilistic approach:

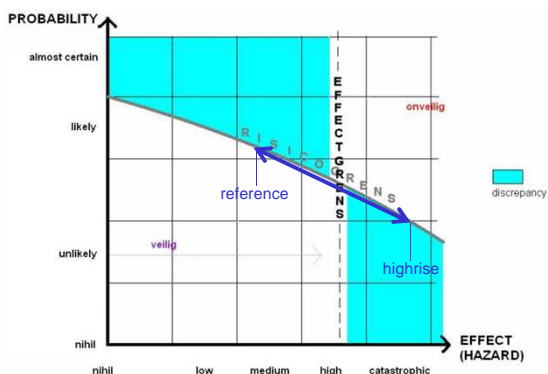
- 'characteristic thermal load' conform Eurocode 1 (NEN-EN 1991-1-2+NB): heat release rate with risk-factor
- thermal and mechanical response of loadbearing structures and separation constructions based on Eurocode or equivalent fire duration (standard fire curve)
- In combination with risk assessment in risk subsystems:
 - Structural failure
 - Compartment failure
 - Egress failure
 - Fire-fighting failure

Risk-based approach

How to assess risks if there are no objectives?

→ Use the risk-level of the (prescriptive) building code!

- Extrapolate the risk level from a normal multi-storey building that fits in the building code to a highrise building
- For all subsystems



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Case: office building

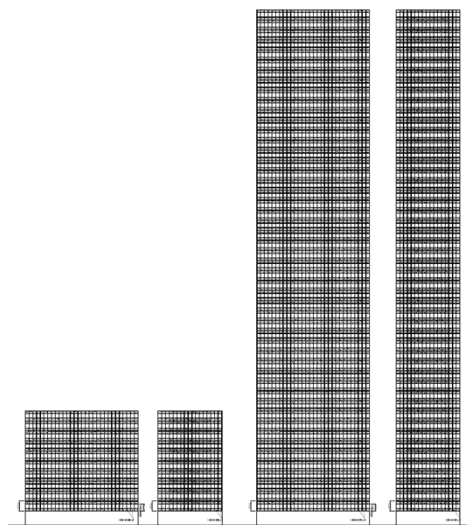
Reference building:

- 10 storeys
- glass facade

Highrise building:

- 50 storeys
- glass facade

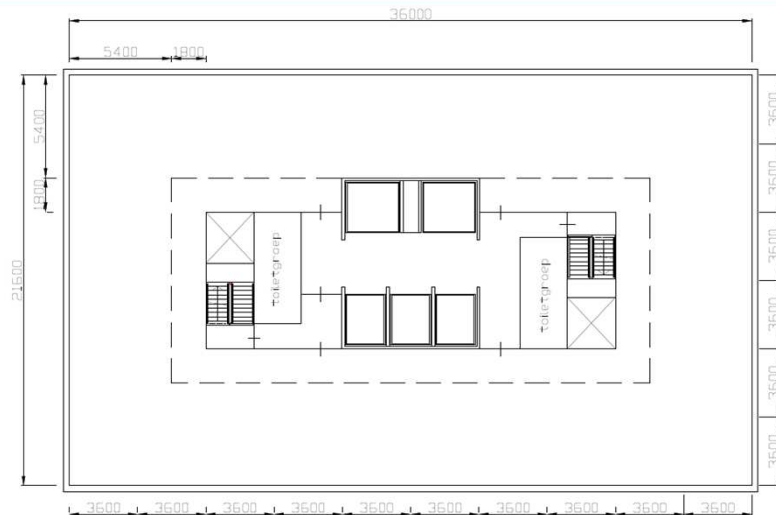
All floors have
same lay-out



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Case: office building



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Case: office building

Common fire safety measures:

- Lobby (core area) outside fire compartment
- 2 escape routes (staircases)
- Safe access routes for fire brigade
- Elevator for fire brigade

Additional fire safety measures for highrise:

- Pressurized escape routes (core/lobby)
- Sprinklered compartments
- Longer egress time (30 min.)
→ safer escape routes!



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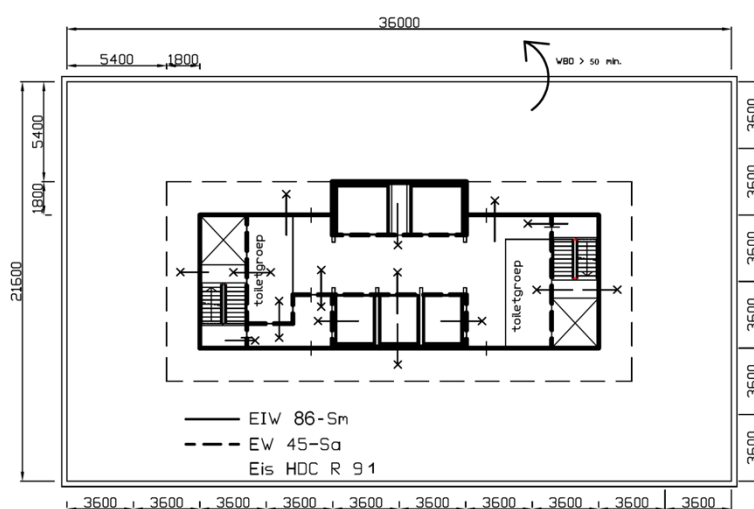
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Case: office building

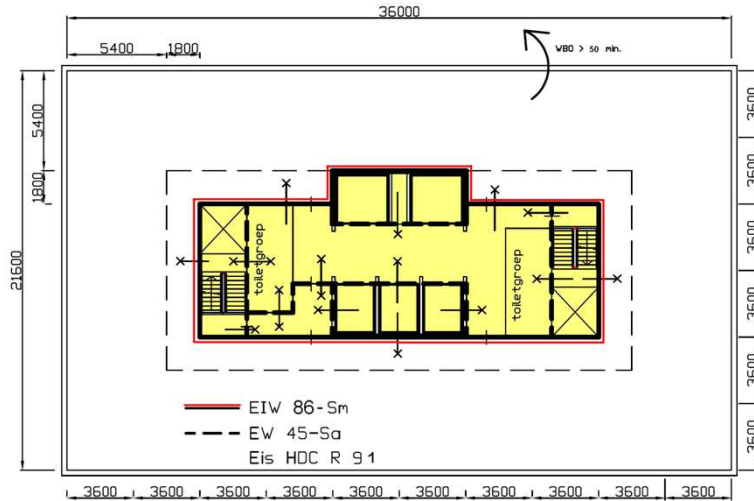
Consequences in equivalent fire duration (standard fire curve) for different risk subsystems:

Doel	Situatie	Equivalente brandduur [min.]	Eis conform Bouwbesluit [min.]
1 (hoofddraagconstructie)	Referentie	75	60 (R)
	Hoogbouw	91	
2 (compartimentering)	Referentie	65	60 (EIW)
	Hoogbouw	50	
3 (vlucht- en aanvalsroutes)	Referentie	71	60 (EIW)
	Hoogbouw	86	

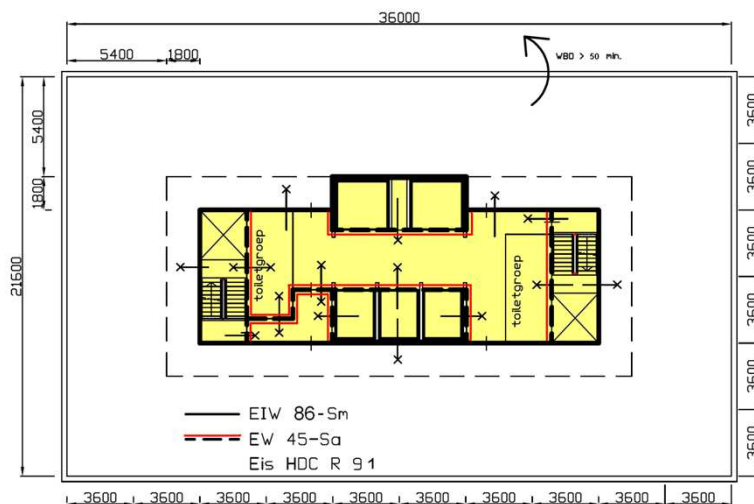
Case: office building



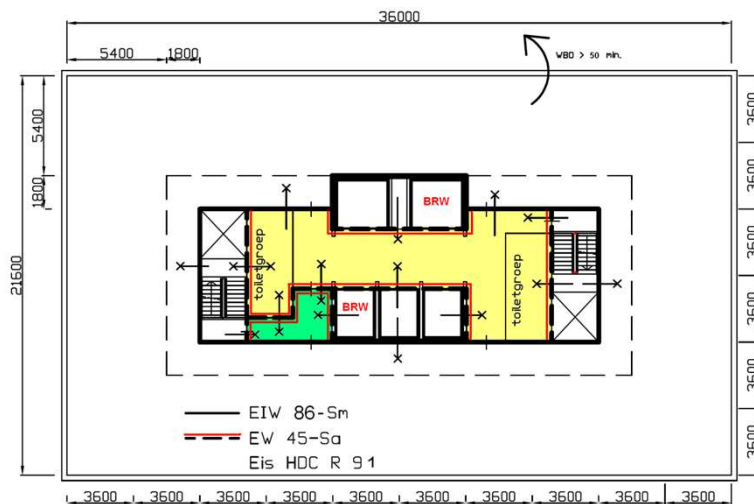
Case: office building



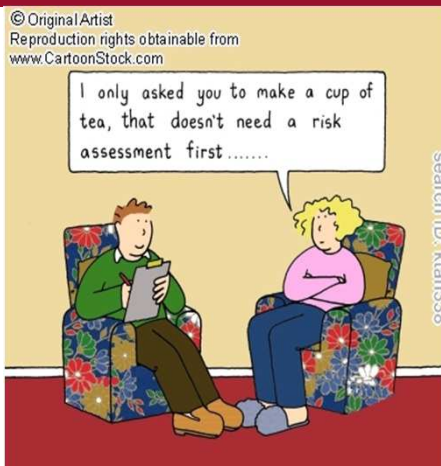
Case: office building



Case: office building



Thanks for your attention



Risk-based approach only for special projects?

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