



# Fire resistant cementitious matrix composite, for several applications

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- Content
  - Alkali activated materials: what?
  - Comparission OPC
  - applications



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## Alkali activation: what?

- Al or Fe silicate + alkaline solution
- OPC: alkaline solution is created via dissolution of  $\text{Ca}^{2+}$

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## Reaction - polymerization



Precursor Powder  
MODEL SYSTEM



Silicate solution



Mix to obtain  
homogenous mixture

mixing  
&  
moulding



Hardened  
cement  
paste/mortar

Hardening  
/Curing



'geopolymer'

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## Alkali activated materials: components

Alkaline

Acidic

Many examples with 'wastes' known:

Al-silicates / Fe-silicates  
Slags from metallurgy  
ashes from incineration  
fly ashes  
household waste  
biomass ashes

BUT applications outside Belgium (Europe)

Just starting now in Belgium

Compressive strength > 50 MPa

Limited # examples : e.g. Vubonite

Mostly: very fast reaction – 'repair' cement

**Compatible with glass fibres**

possibility to make glass fibre concrete

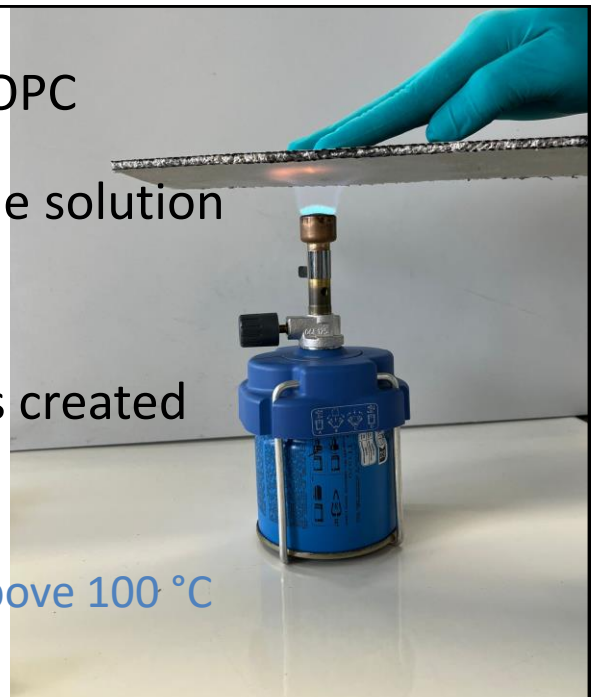
Compressive strength > 50 MPa

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## Comparison OPC

- Al or Fe silicate + alkaline solution
  - -> Inorganic polymer
  - Cannot burn
- OPC: alkaline solution is created via dissolution of  $\text{Ca}^{2+}$ 
  - -> hydrated silicate
  - Dehydrates/degrades above 100 °C



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## Comparison OPC

- Al or Fe silicate + alkaline solution
  - Drawback: 2 components needed
  - Alkaline solution is less safe than water
  - Systems where only water need to be added exist
- OPC: only add water

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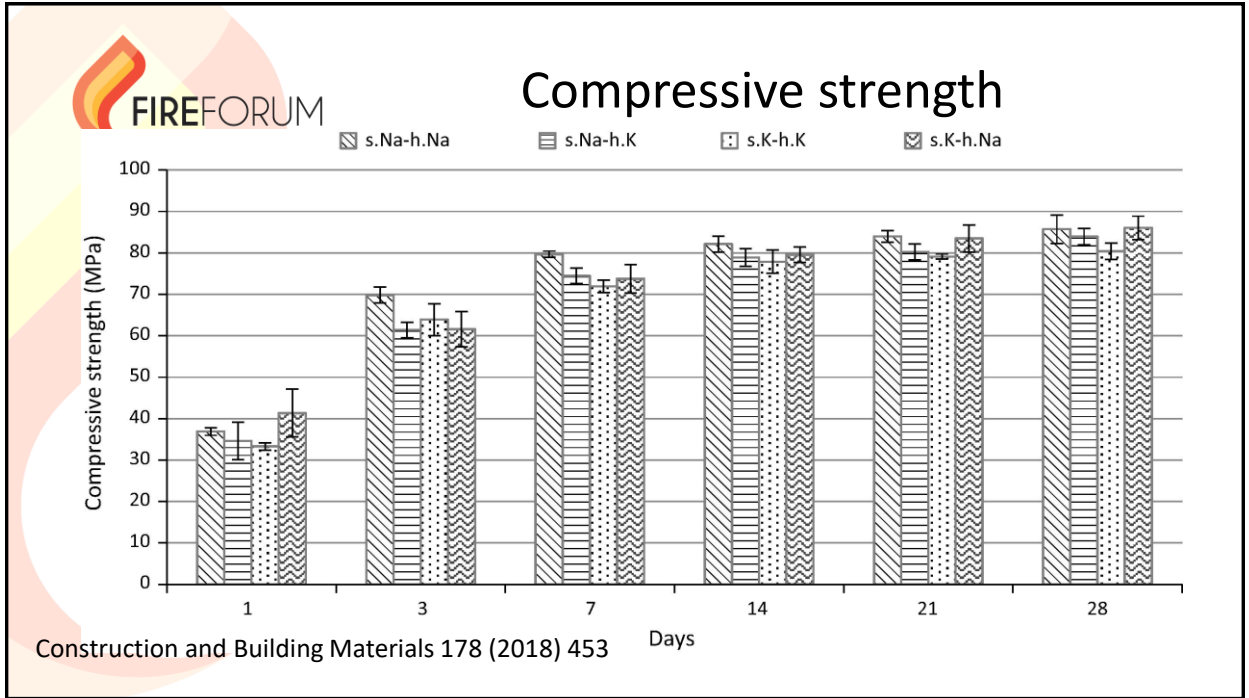


## Comparison OPC

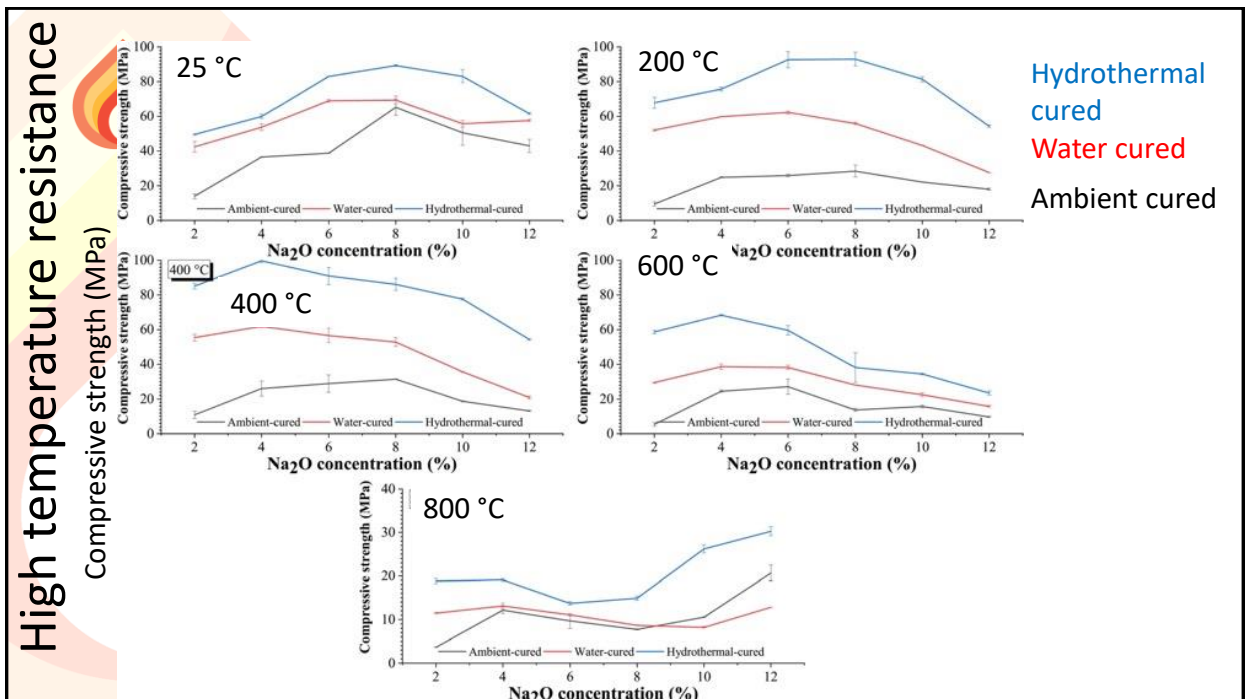
- Compressive strength: comparable
- Fire resistance
- Cost
- Reduced CO<sub>2</sub> emission
- Reduced virgin material use



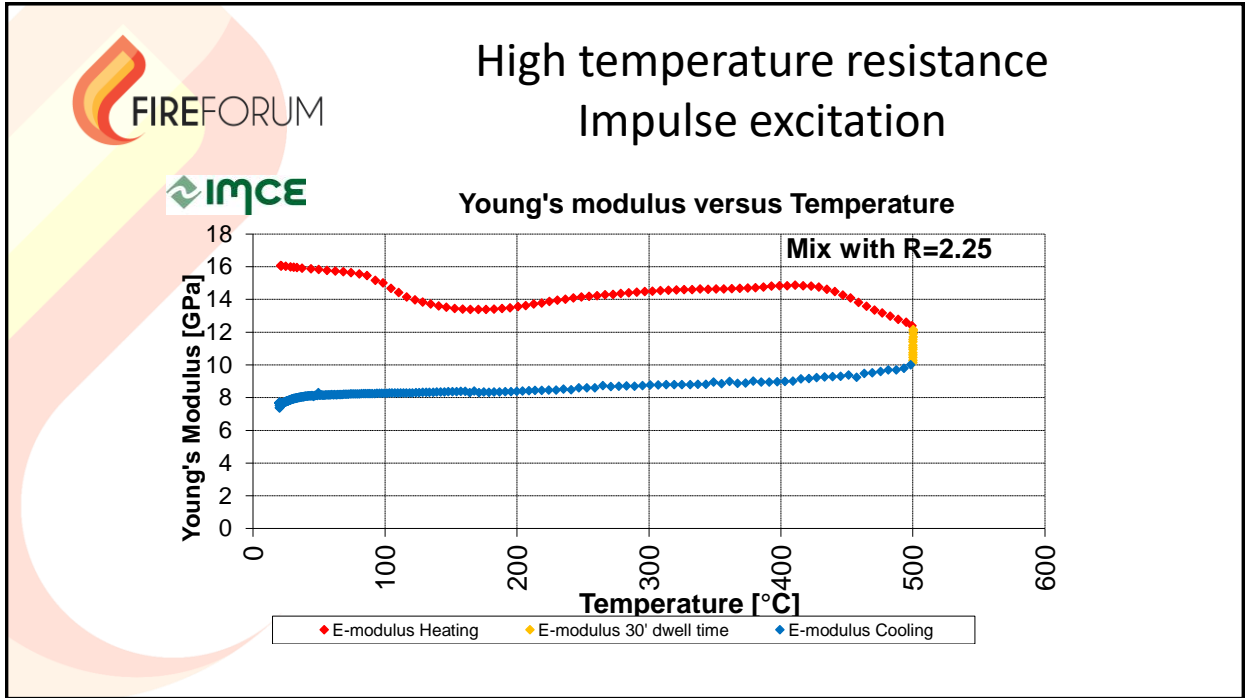
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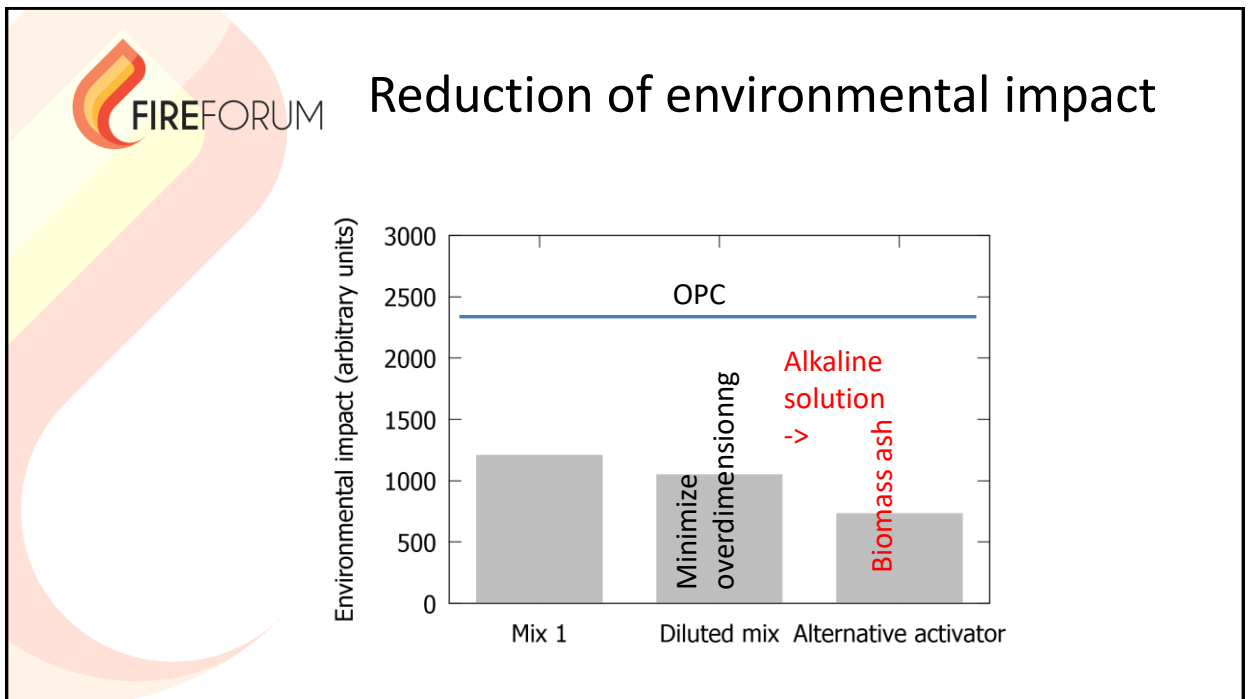
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## Applications

- Green(er) concrete
- Fire resistant applications:
  - Tunnel panels (SMARTG)
  - Escape routes
  - Fire doors/walls
  - Components of battery packs
  - Art work (instead of polyester-glass fiber composites)
- Current direct
- SmartG

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## Building blocks



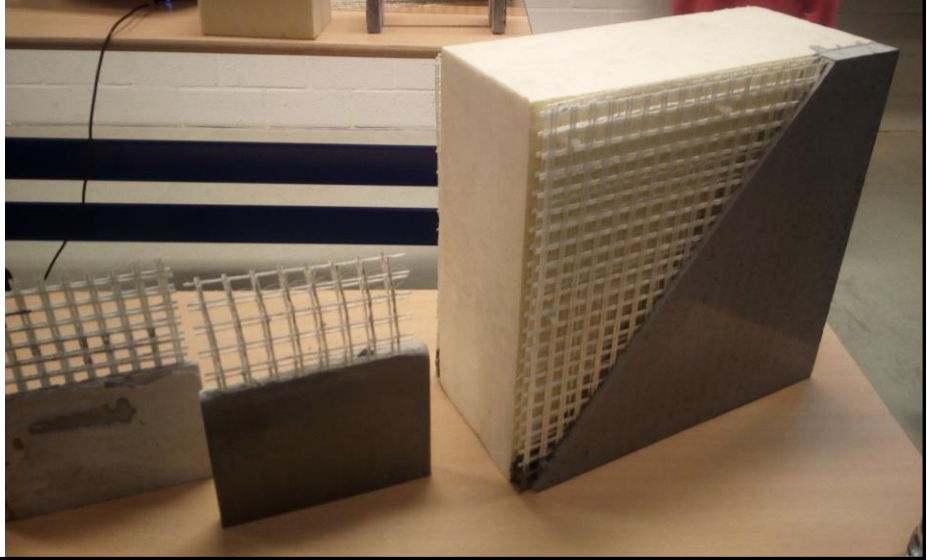
Example Y. Pontikes, MTM, KULeuven

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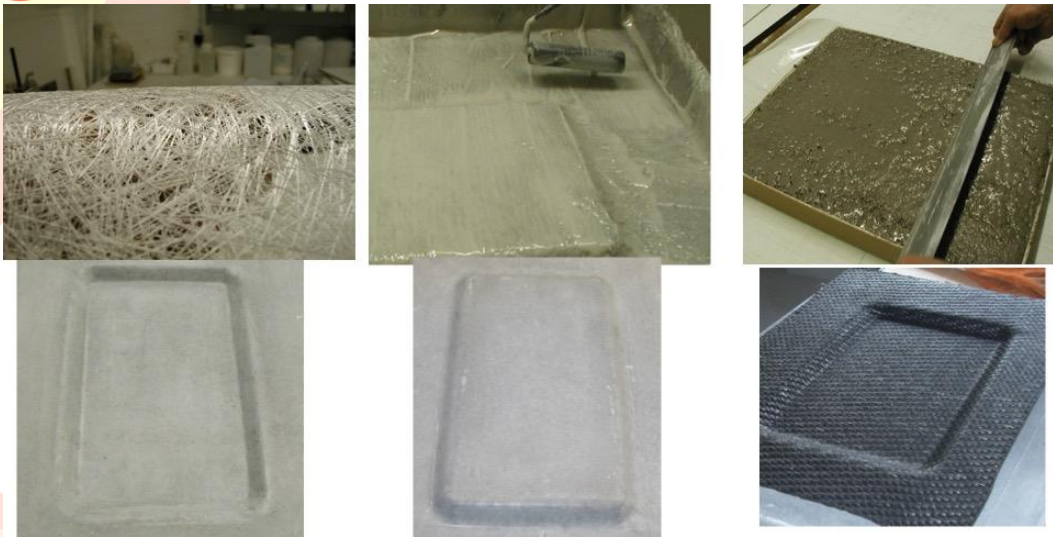
## Textile reinforced cements



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## Textile reinforced cements



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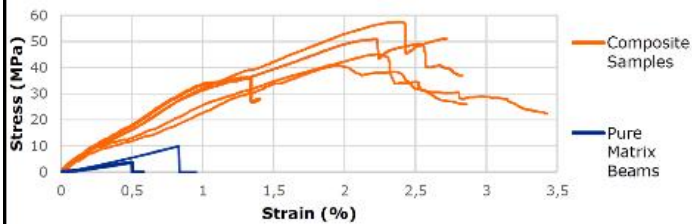




## Textiel reinforced composites

- Current Direct – Battery pack applications

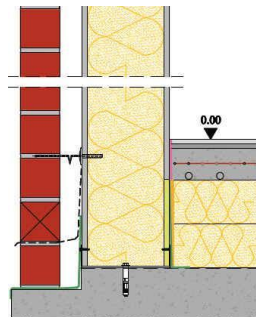
Comparison of Stress/Strain curves between pure matrix beams and composite samples



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## Sandwich panels



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**FIREFORUM**

**Foams**

Alkaline activation

Mechanical foaming; Chemical foaming

\*samples by Roberto Murillo, SREMat, KU Leuven

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**FIREFORUM**

**Foams: Microstructure**

\*Representative CT cross sections of samples a) 0.1A/0.35, b) 0.2A/0.4, c) 0.2A/0.45, d) 0.3A/0.45, verifying the formation of highly porous network structures.

A: Aluminium (wt%)\*; L/S ratio

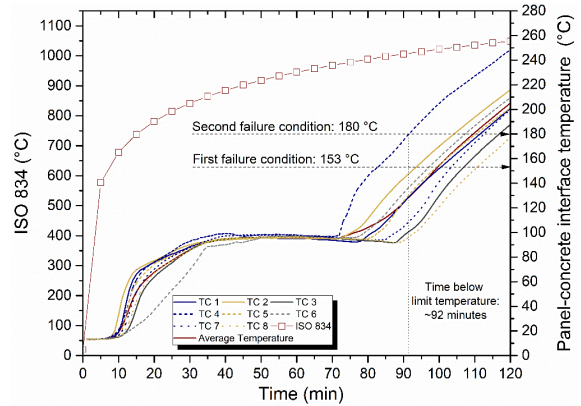
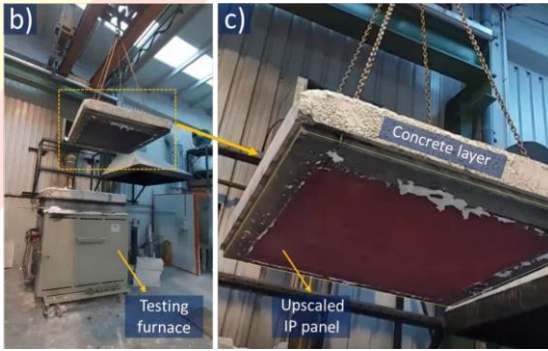
\*Tobias Hertel, et al. Use of modified bauxite residue-based porous inorganic polymer monoliths as adsorbents of methylene blue, Journal of Cleaner Production, 2019

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# Foams: Upscaling

Panels for passive fire protection: **CONCRETE** vs Alkali activated



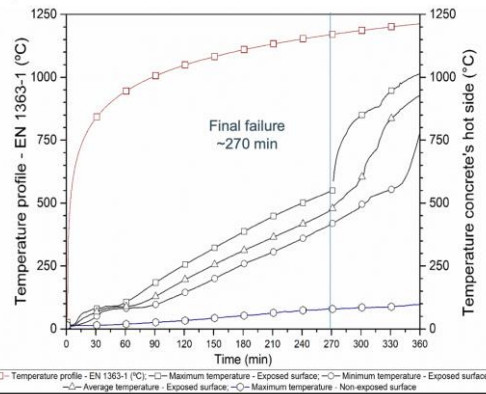
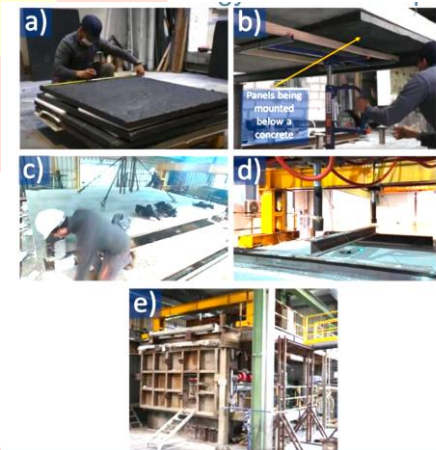
**Fire protection rating: 92 minutes**

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# Foams: Upscaling

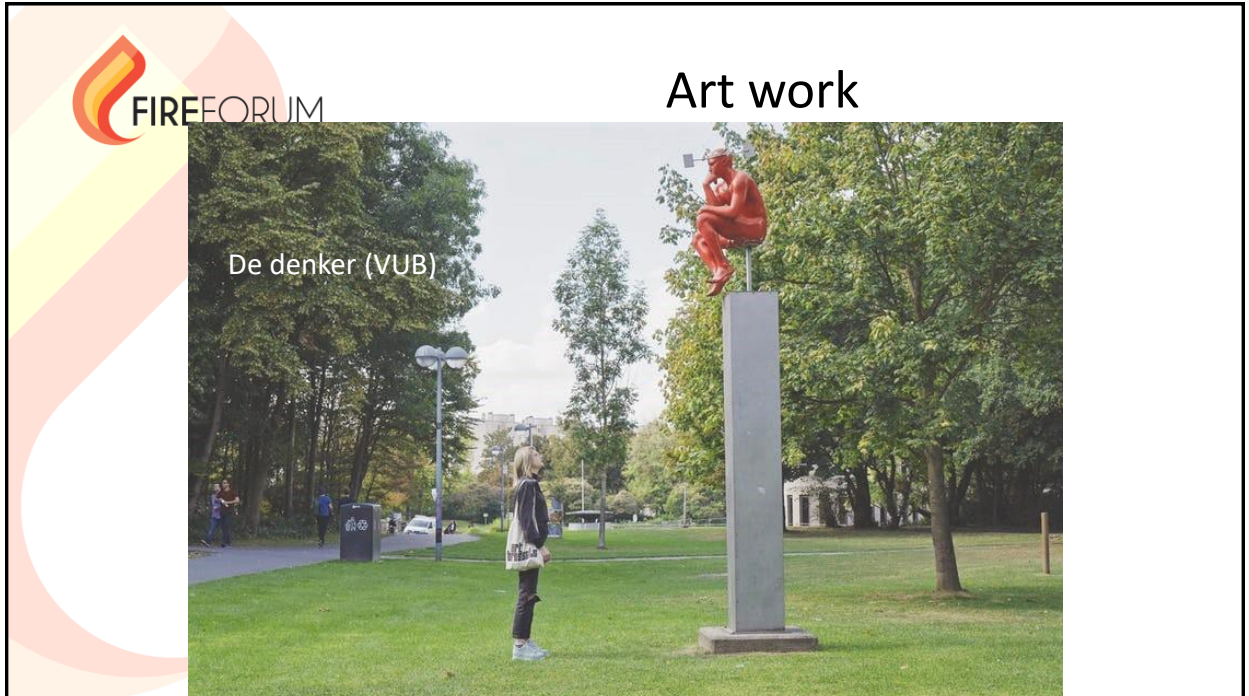
Panels for passive fire protection\*: **Concrete vs ALKALI ACTIVATED**



**Maximum protection : 270 minutes**

\*work done in the SREMat research group at KU Leuven

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**FIREFORUM** **Conclusion on Alkali activated cements**

Alkali or acid activation =

- No spalling of concrete
- Dimensionally stable in fire
- Lower environmental impact
- Fiber reinforced composite can be made = material and weight saving
- No corrosion

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THANK YOU – QUESTIONS?

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several applications

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