Lightweight, modular & prefab formwork for renovating floors

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BRUSSELS RETROFIT INNOVIRIS STRATEGIC PLATFORM ENVIRONMENT

Vrije Universiteit Brussel

Introduction – project aim

Conceptual design

Experimental component lay-out

Structural validation of a lightweight composite floor

Fire test on a lightweight composite floor

Challenges before market entry

Conclusions

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Growing renovation market = new opportunities

Increase of Brussels population with 1,5 million (35%) by 2060

Number of renovations has surpassed new constructions

Renovations: weight, manoeuvrability and manual labour

Market for new structural systems designed for renovation

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Our aim:
Develop lightweight floor for renovation!

focus on construction stage

floor consists of prefab elements

minimize weight of individual elements

=> Construction: easy, fast, no heavy equipment, low nuisance

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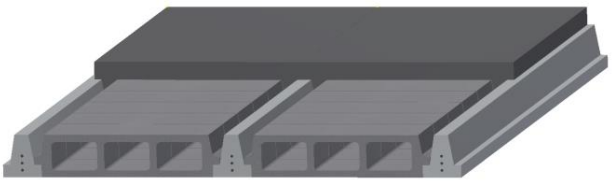
The hybrid floor design is based on the existing beam-and-block system

Steel reinforced concrete beams

Concrete / terracotta blocks

Concrete compression layer



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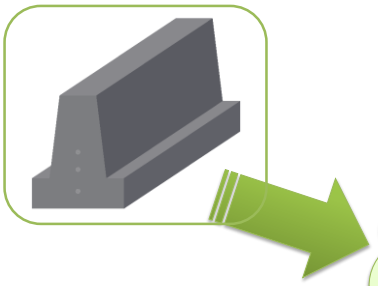
Easy-installation: steel-concrete beams are transformed into hybrid beams



No steel

No tensile concrete

Low-weight composite materials

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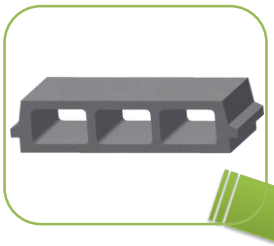
Easy-installation: concrete blocks are transformed into sandwich panels



Low-weight composite materials

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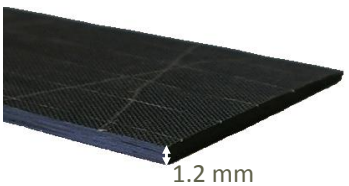
Fibre **R**einforced **P**olymers (FRPs) are needed for their stiffness

- High specific strength and stiffness
- Substitute for the longitudinal steel reinforcement
- Use limited by fire issues



1.2 mm

Carbon strips gratefully received from ECC-TRADECC

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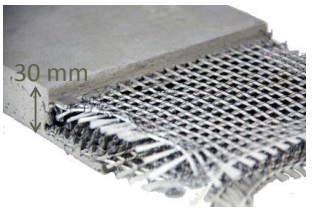
Textile **R**einforced **C**ement (TRC) Composites complement the FRPs

Fire safe

Heat resistant

Environmental friendly



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Inorganic **P**hosphate **C**ement (IPC): a matrix for high fibre volume fraction TRCs

Low cost E-glass fibres

pH-neutral, fine grained IPC

High fibre volume fraction TRC (> 20%)

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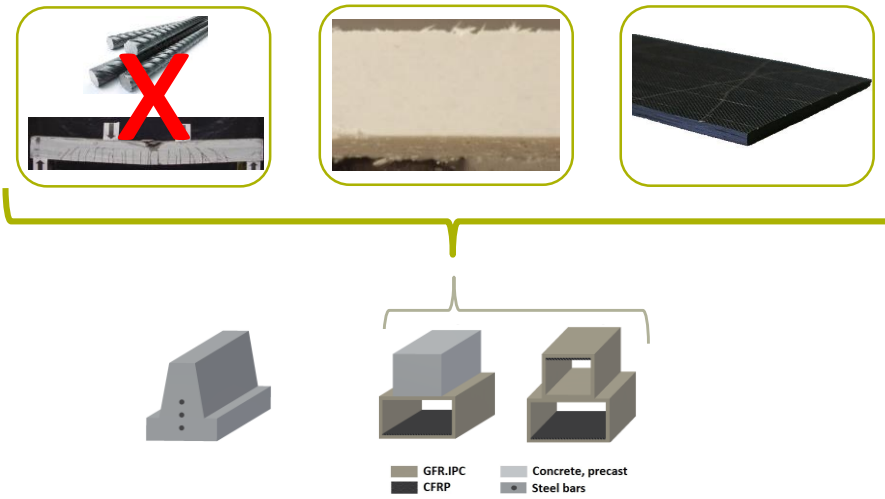
Combining all materials and ideas leads to new concepts



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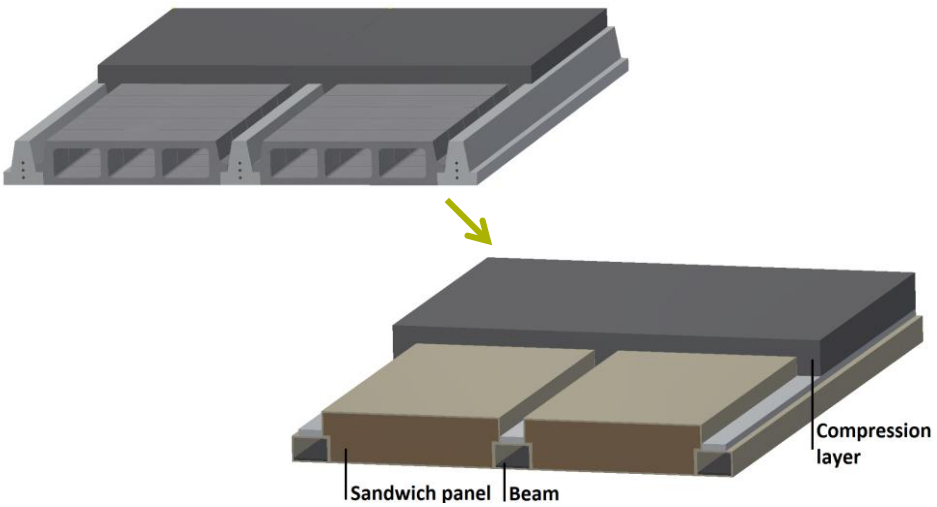
LightComp: a lightweight-in-installation composite floor



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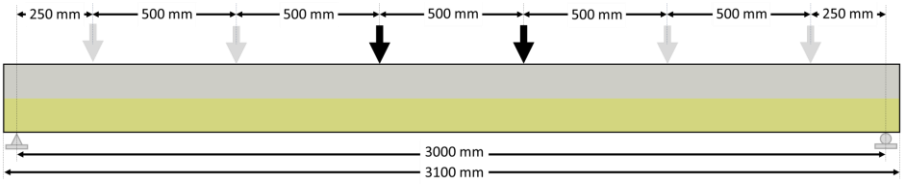
24 real scale beam tests determine the beam's cross section



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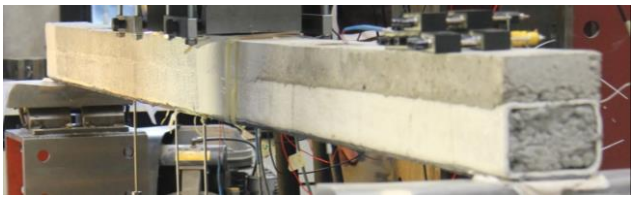
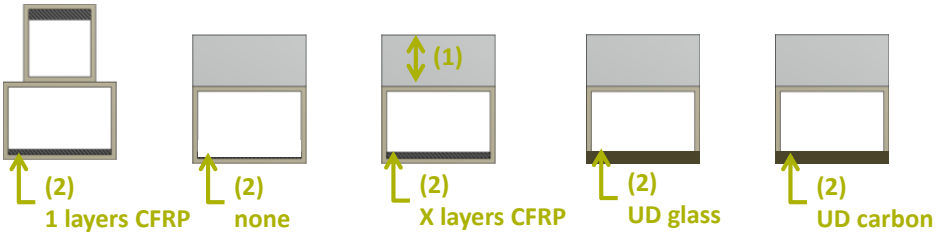


Variations in:

- type of loading
- amount of concrete (1)
- amount and type of reinforcement (2)



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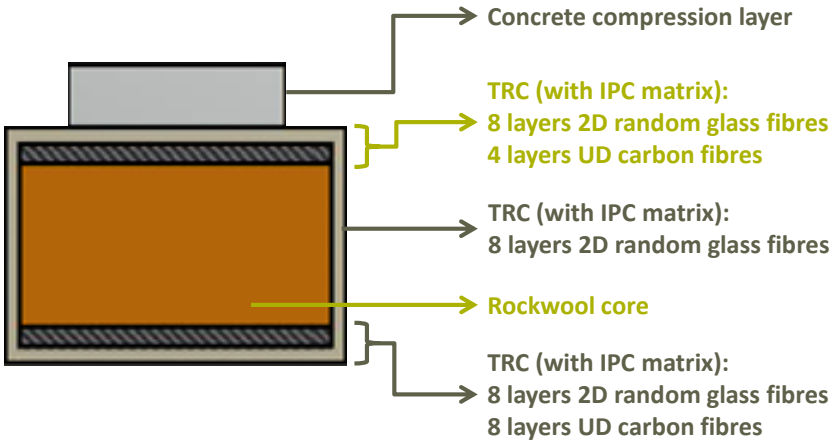
Together with LCA and fire simulation inputs, the beam's cross section became:



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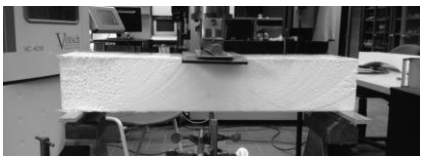
EPS is chosen as core material for sandwich panels



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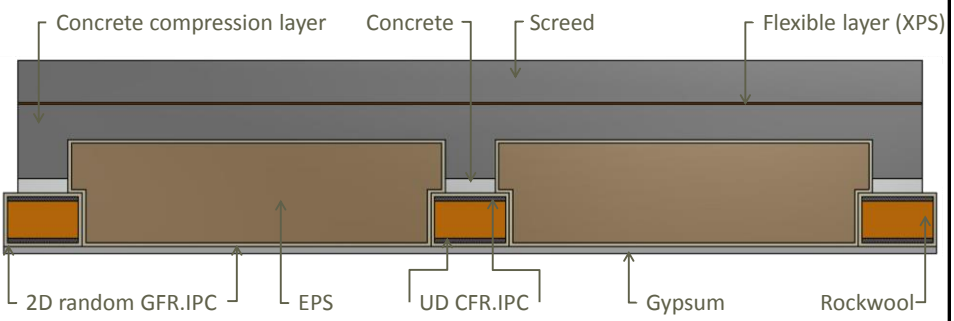
Several finishing layers are added to the stay-in-place formwork



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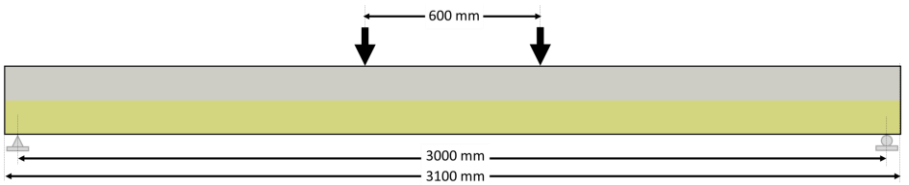
4 real scale floor tests validate the structural feasibility



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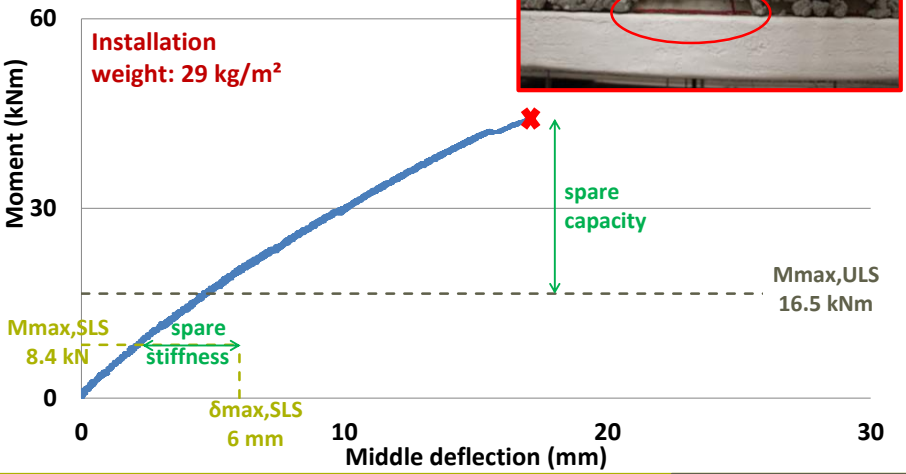
ULS and SLS requirements are met



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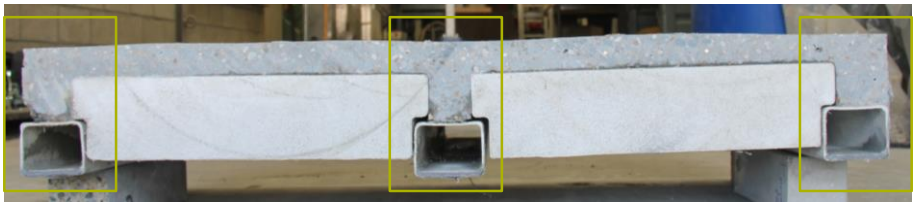
Failure by debonding



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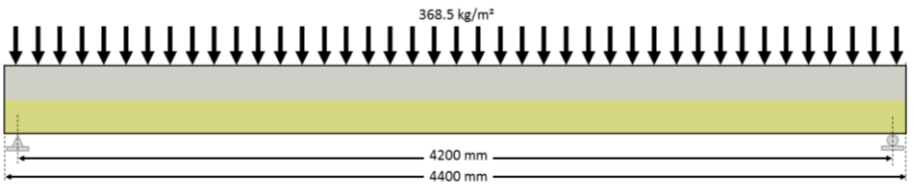
1 real scale floor is tested under fire



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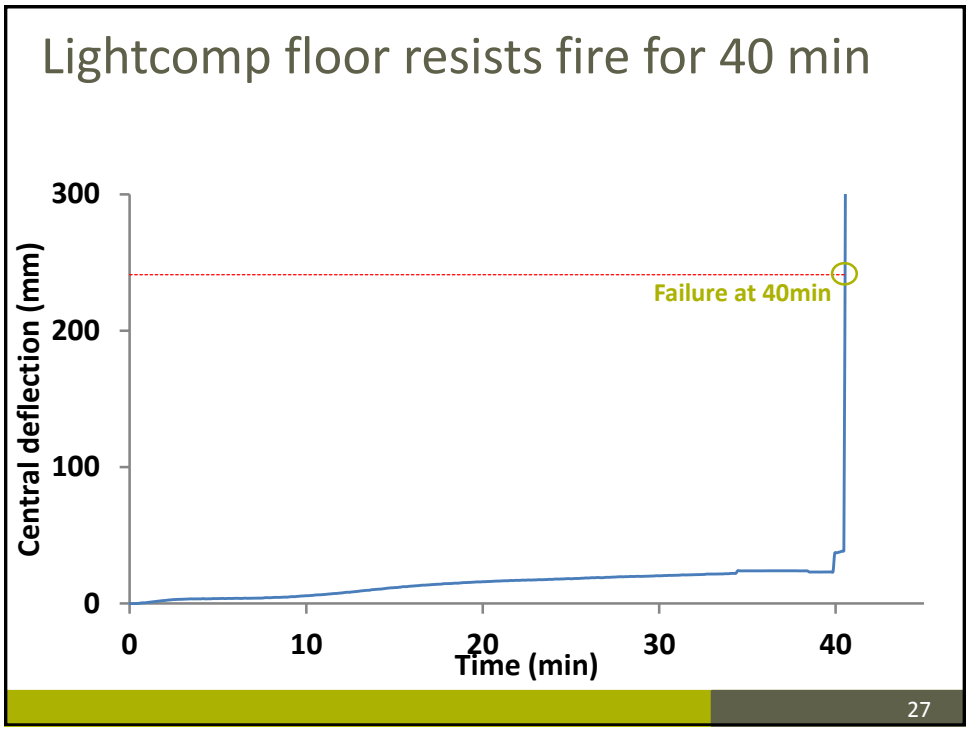
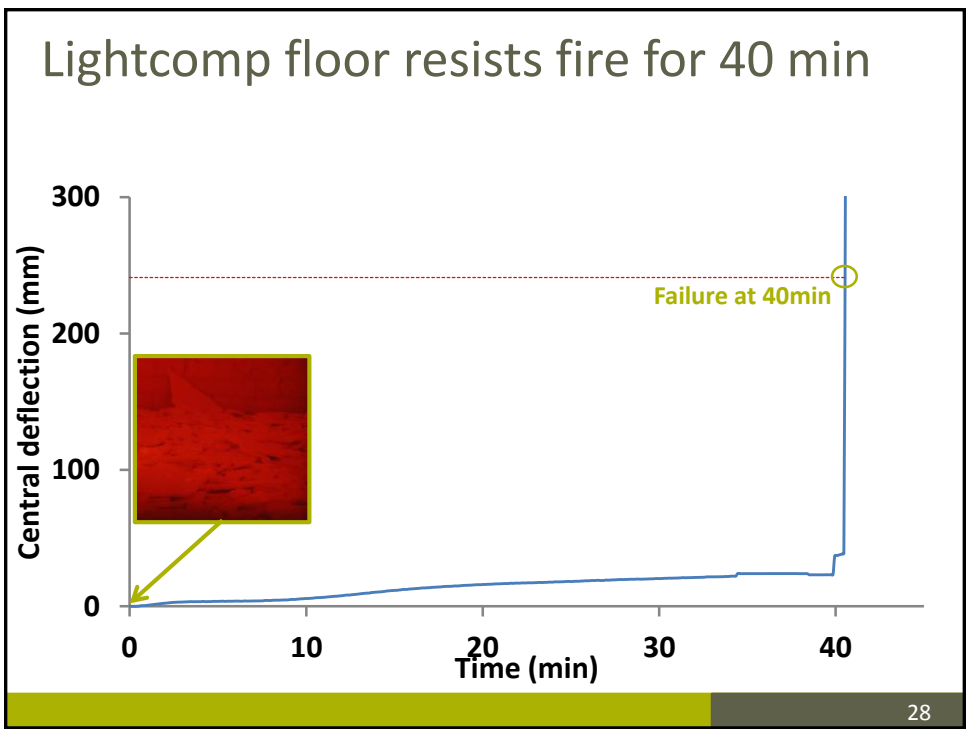

Lightcomp floor resists fire for 40 min
300
200
100
0
Central deflection (mm)
Failure at 40min
0
10
20
30
40
Time (min)
27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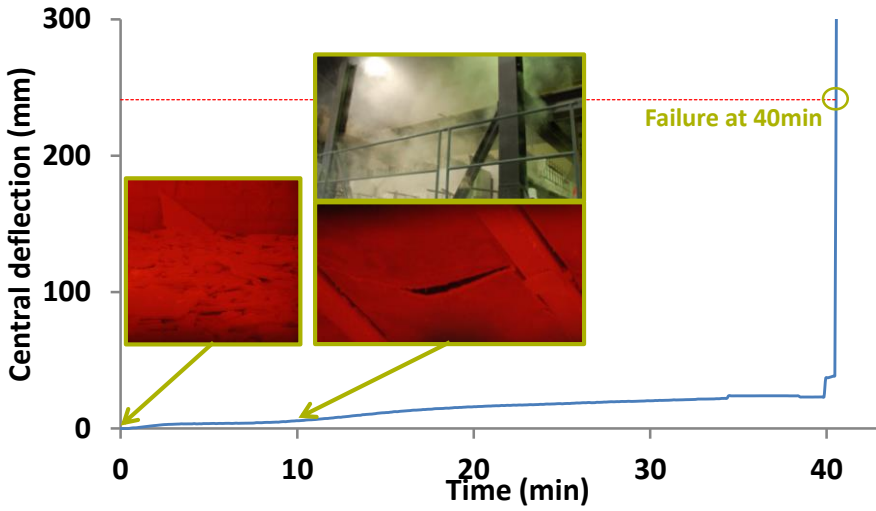
Lightcomp floor resists fire for 40 min



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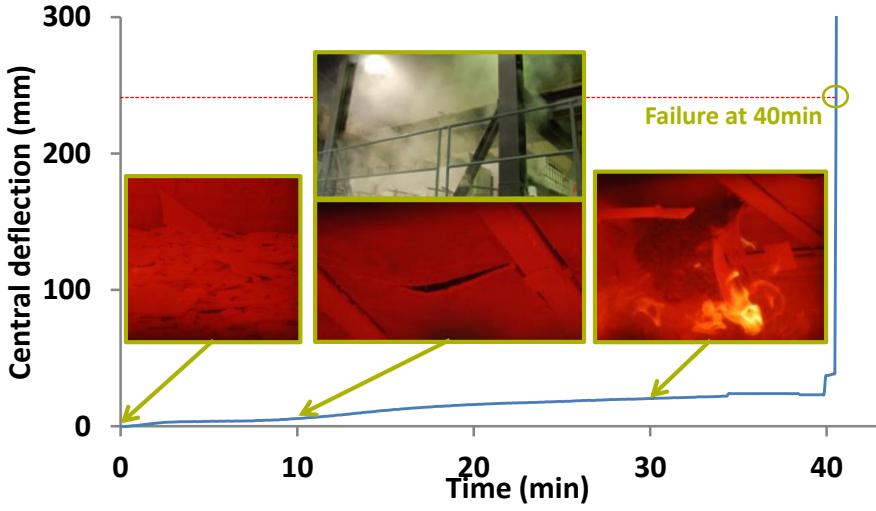
Lightcomp floor resists fire for 40 min



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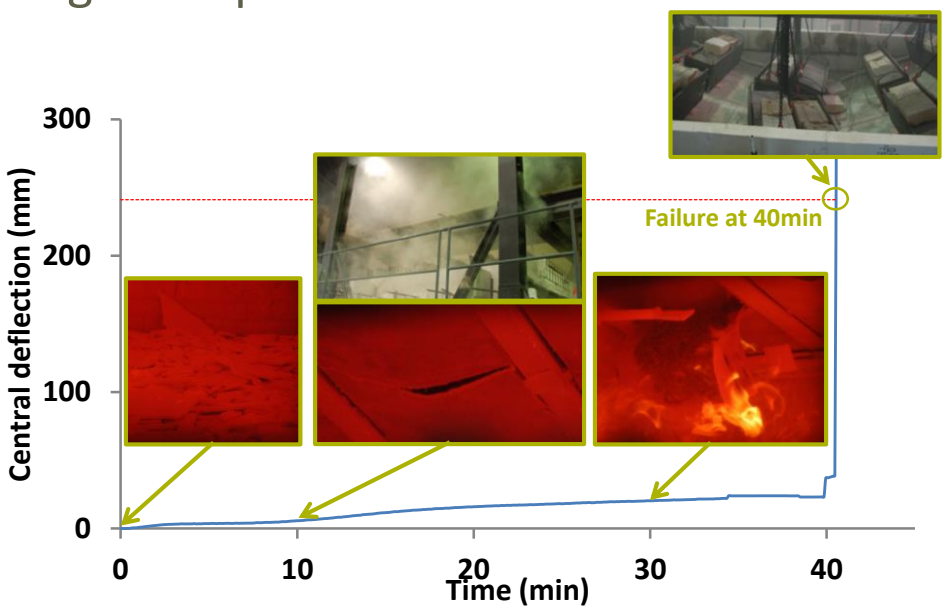
Lightcomp floor resists fire for 40 min



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Challenges

Increase fire resistance time

- New core material for sandwiches
- Better adhesion gypsum layer

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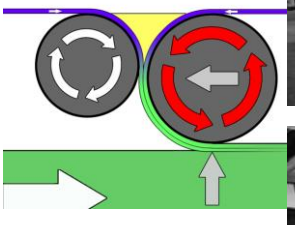
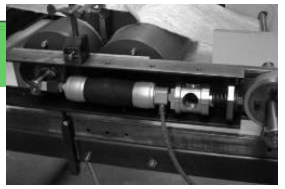
Challenges

Improve production process

- Use of automated production techniques





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Challenges

- Increase fire resistance time
  - New core material for sandwiches
  - Better adhesion gypsum layer
- Improve production process
  - Use of automated production techniques
- Cost reduction
  - Industrial and automated production
  - Large quantity uptake of bulk materials

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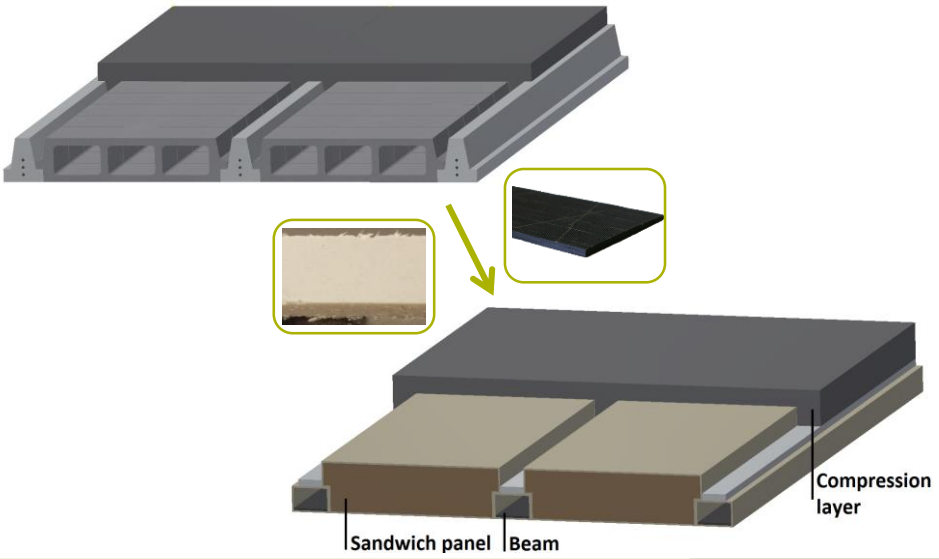
Conclusion



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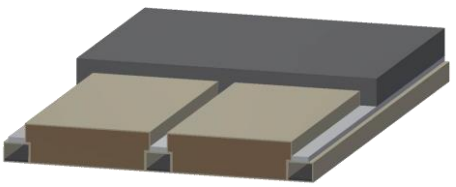

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