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# Fire resistance of geopolymer foam coating

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# Outline

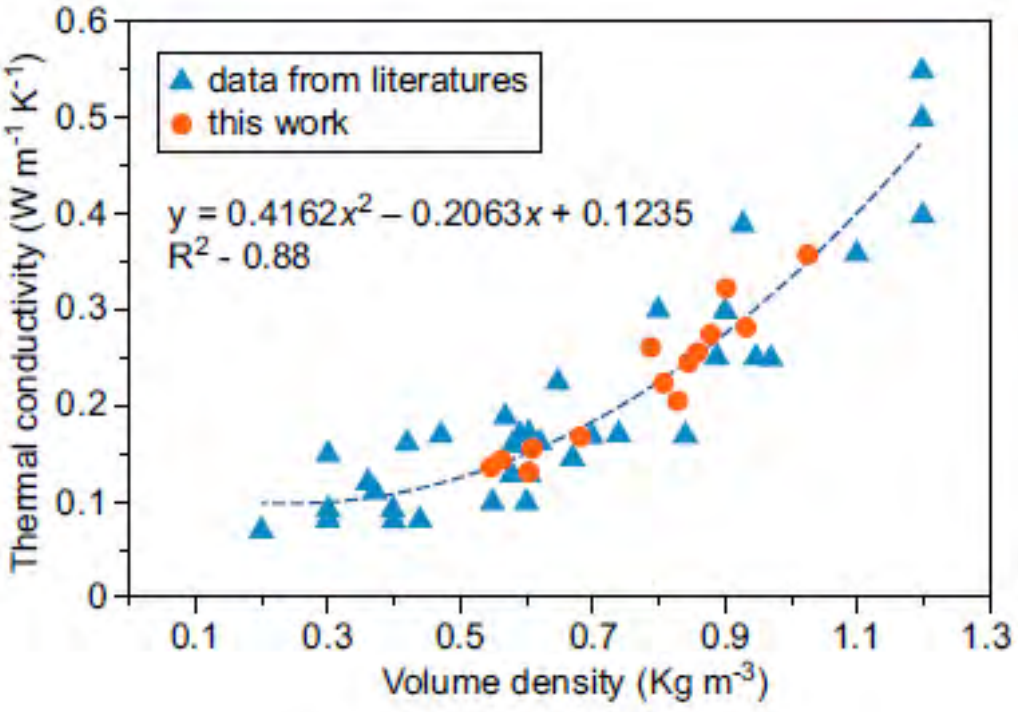
- Introduction
- Materials and experimental details
- Results
- Conclusions

The fire broke the roof of Notre-Dame de Paris cathedral in **Paris**

# Geopolymer foam composite (GFC)

GFC is a **lightweight material** with a density from 200 to 1000 kg.m$^{-3}$

- Mechanical stability at high temperatures,
- **Fire-retardant** material (geopolymer with **potassium activator**),
- Serves as **thermal insulation** after adjusting the water absorption

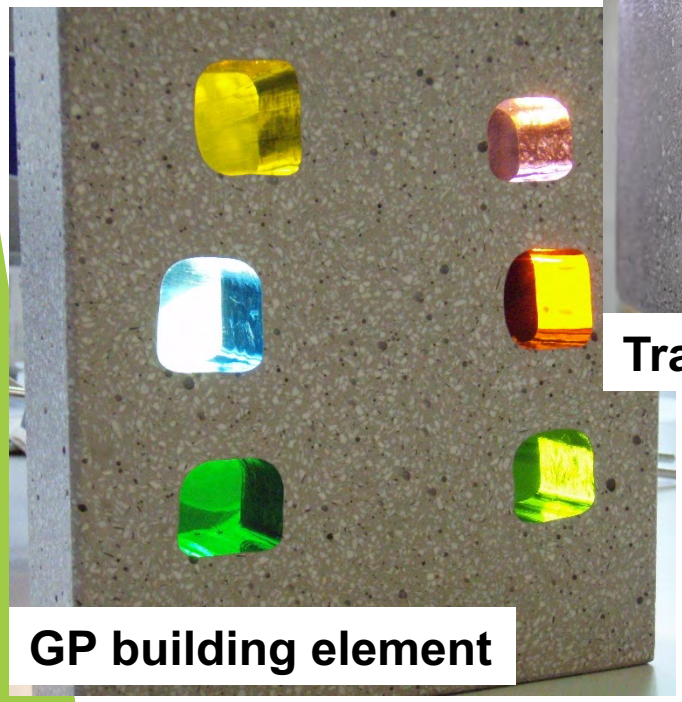



VAN, SU LE, et al. "thermal conductivity of reinforced geopolymer foams" Ceramics–Silikáty 63.4 (2019): 365-373.

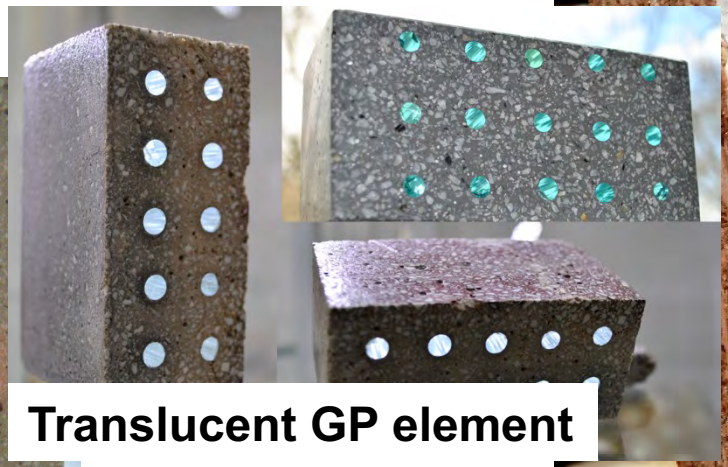
# Useful properties of GFC

GFC have excellent properties.

- Fast curing,
- Relatively low water permeability,
- Resistance to high temperatures,
- High strengths and resistance to acids.



GP building element



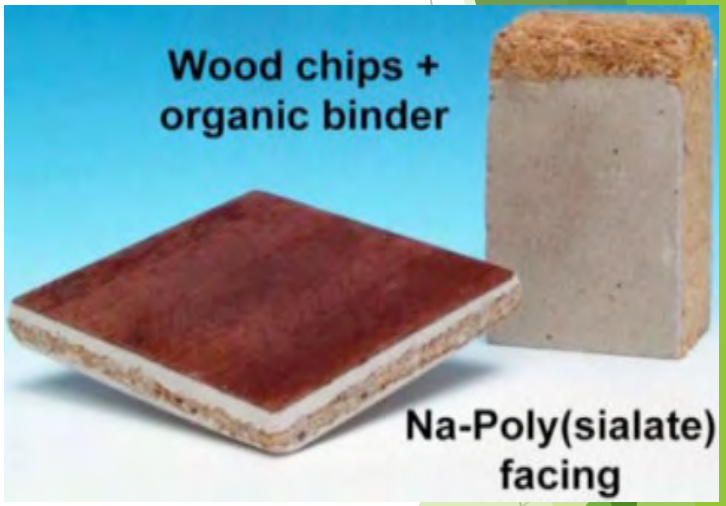
Translucent GP element

GP coating on OSB panel

# Protection of OSB panels against fire

- **GFC** is a **non-flammable material** (provides protection of OSB panels against fire),
- provides **insulation for electrical equipment,**
- serves as a **material for thermal insulation** (ex. furnaces),
- can be used as **fire insulation of buildings.**

House built of OSB panels




**Davidovits** et al. fireproof chipboards protected by geopolymer material

# APPLICATION TECHNOLOGY of GFC (spraying)

Method of application of geopolymer mixture and representation of **unmodified** surface (OSB panel) and surface after application of protective spray

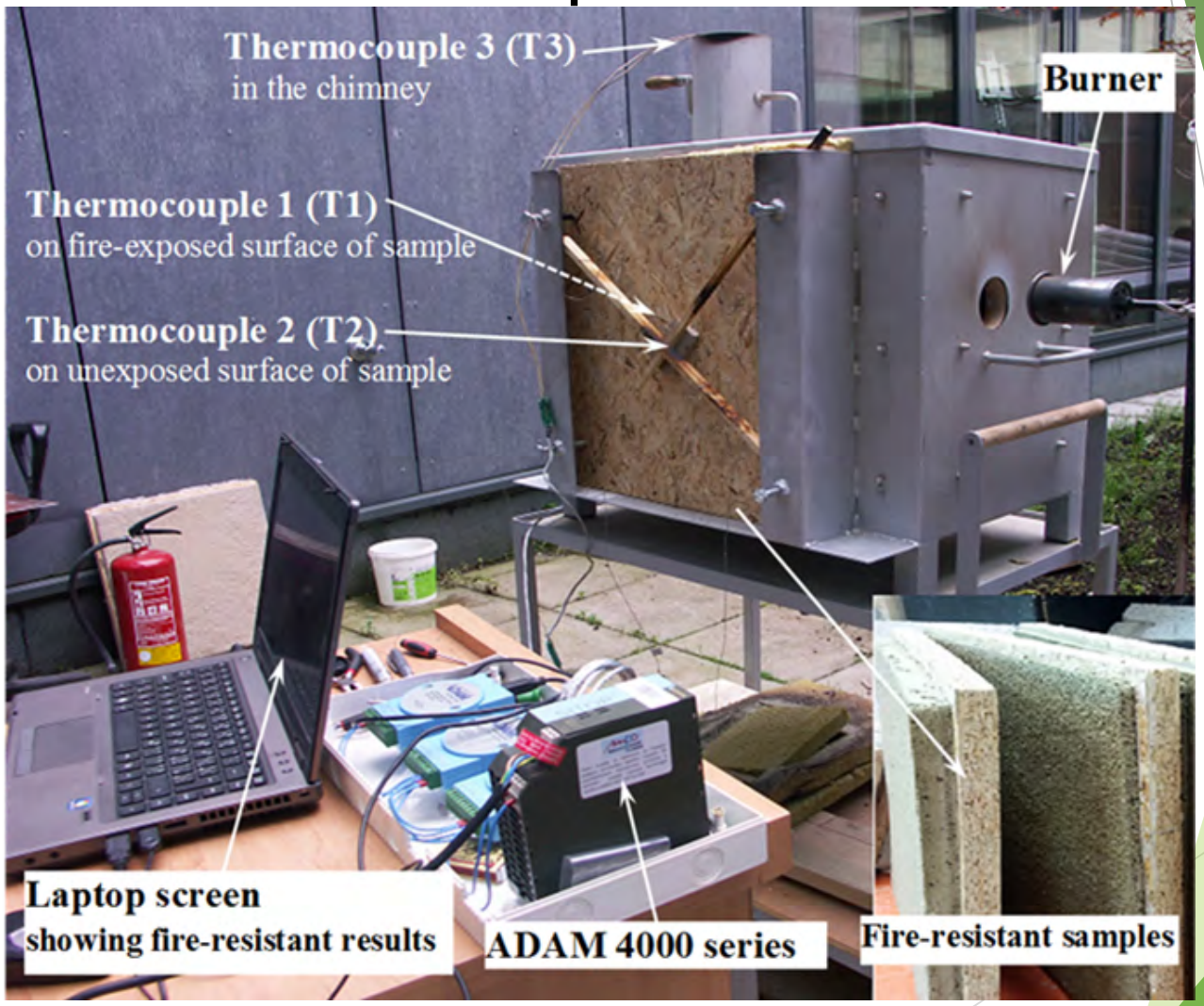
Modified and unmodified surfaces

Protective spray

# Application technology GFC (spraying)

# Fire resistance of OSB panels with GFC

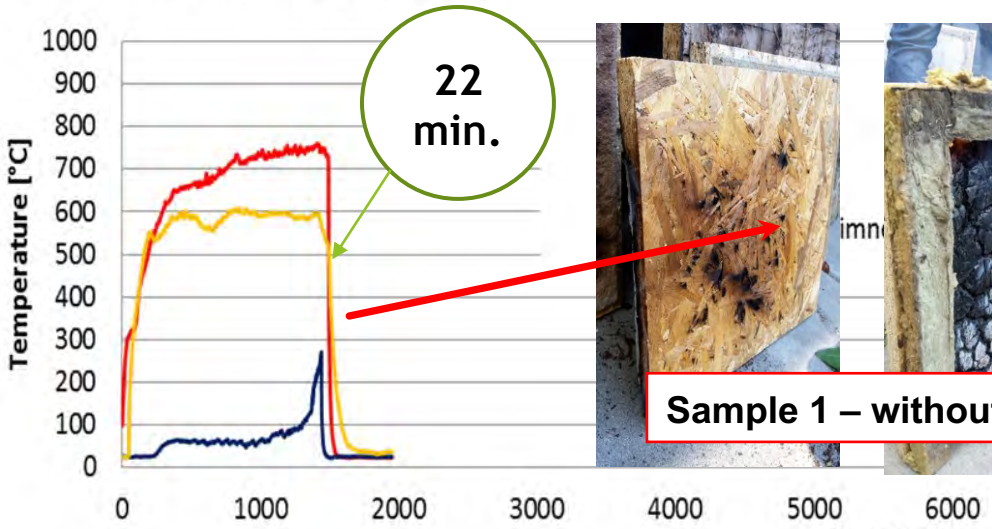
## Production of a furnace for experimental research at TU in Liberec



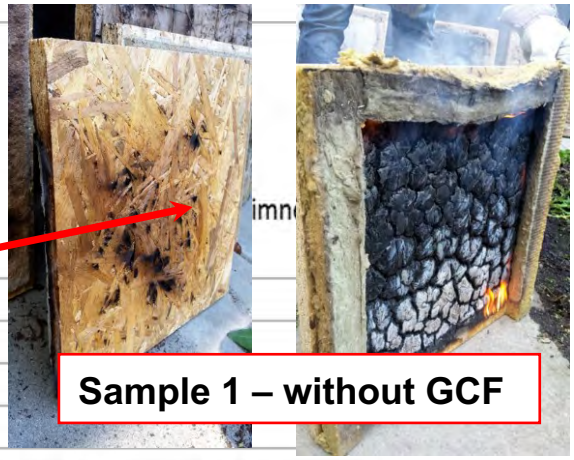

Le, Van Su, et al. "Study on Temperature-Dependent Properties and Fire Resistance of Metakaolin-Based Geopolymer Foams." Polymers 12.12 (2020): 2994

# Fire resistance of OSB panels with GFC (TUL)

**Sample 1: without geopolymer layer**



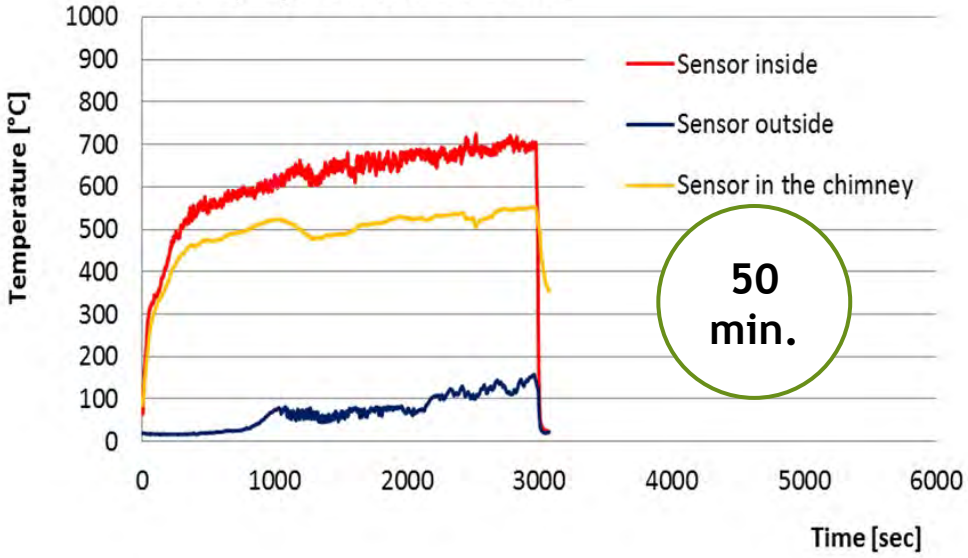

**OSB panels with or without GFC layer after testing**



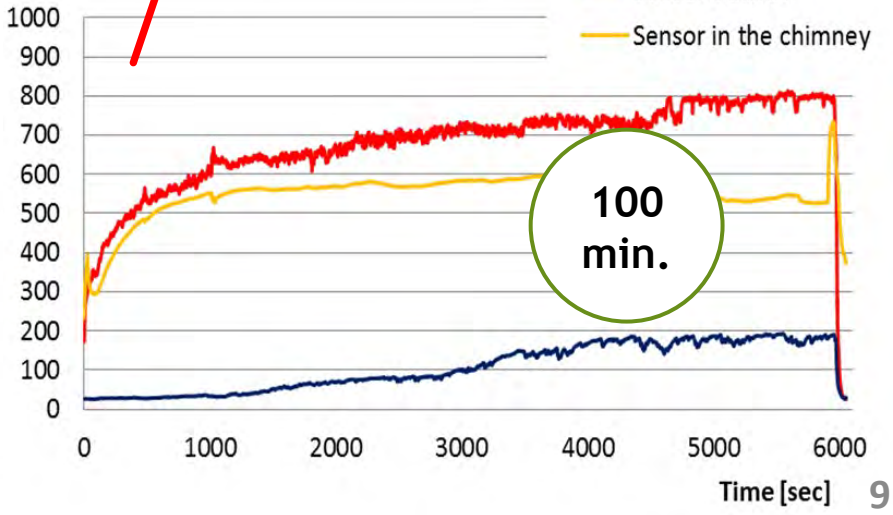
Sample 1 – without GCF

Sample 5 – GCF 20 mm

**Sample 4: 2.5% Al, 60% basalt-fiber waste; without sand; layer thickness 8-10mm**

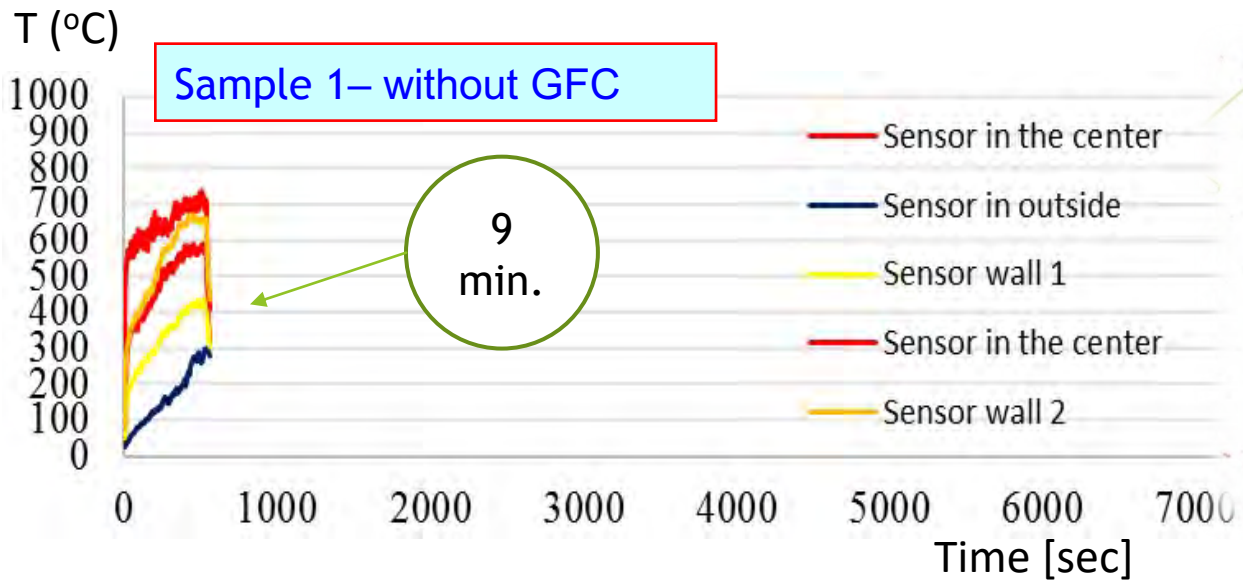



**Sample 5: 2.5% Al; 60% basalt-fiber waste; without sand; layer thickness 18-20mm**

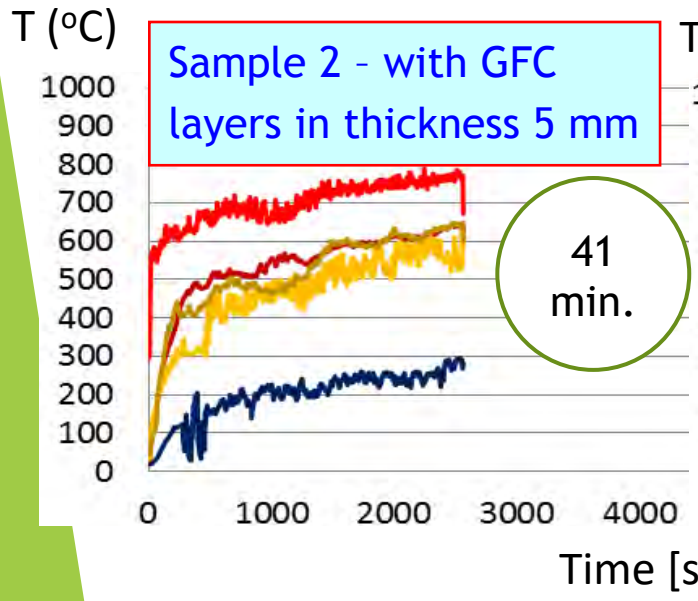


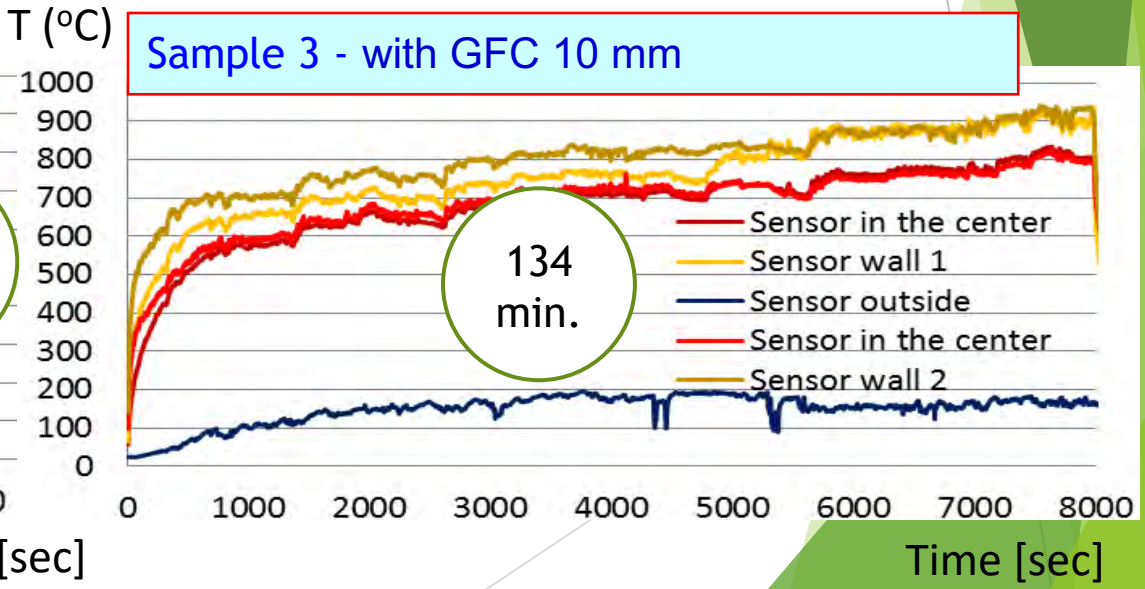
# Fire resistance of steel plates with GFC

## Experimental research at TU in Liberec




**Steel plate Surface after testing**

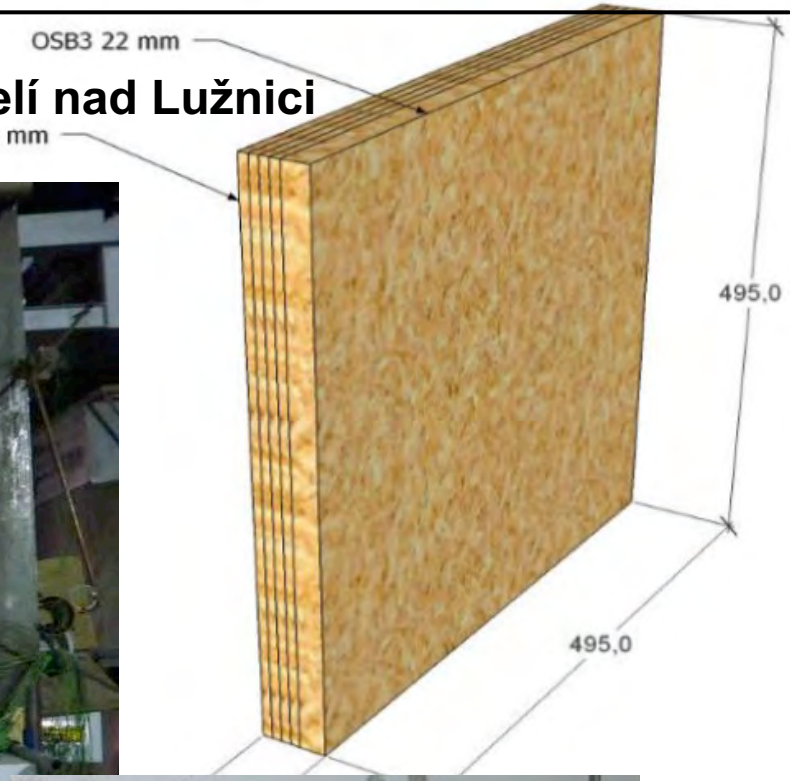


# Fire resistance of OSB panels with GFC

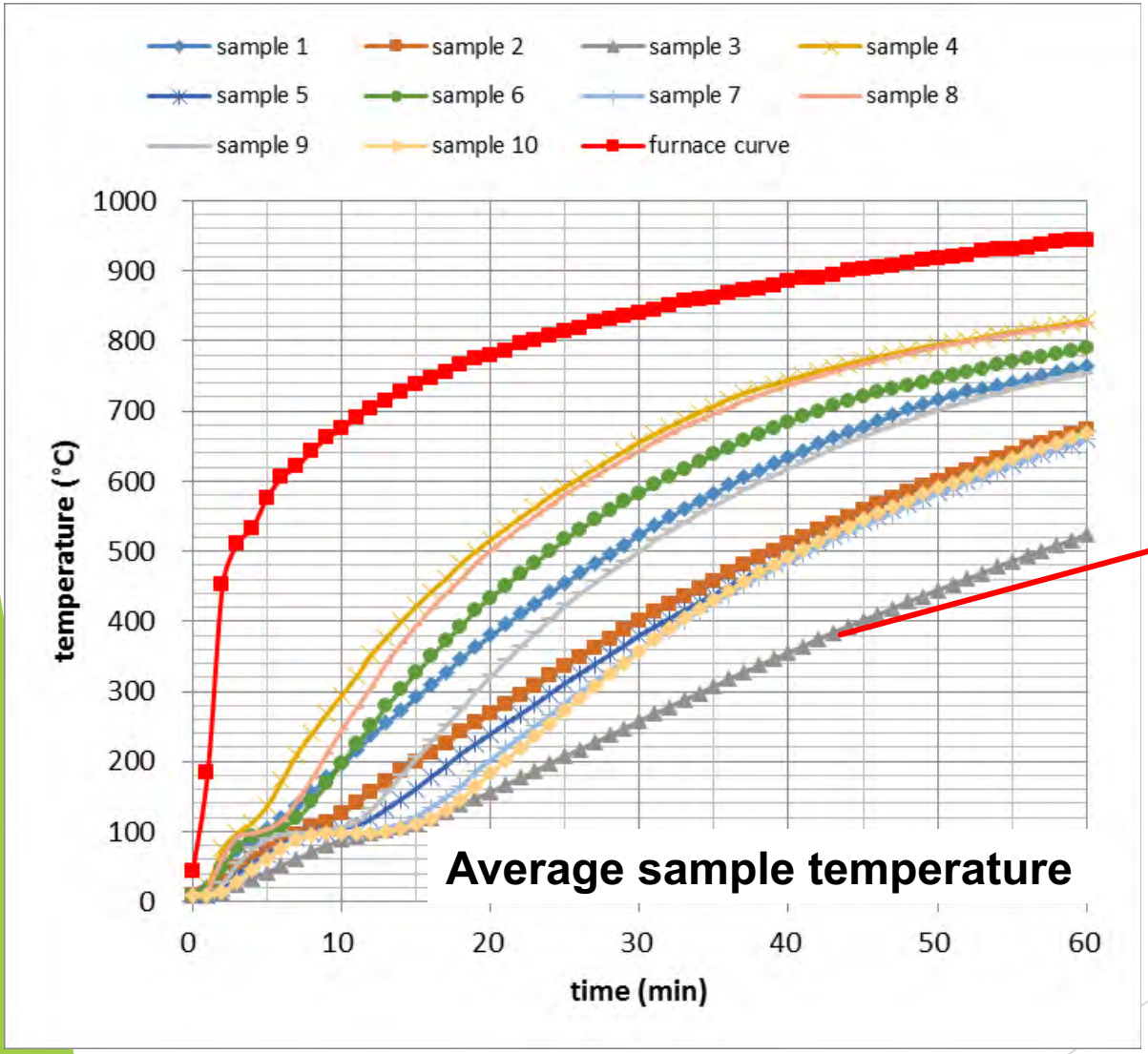
## Fire testing room at PAVUS a.s. Company , Veselí nad Lužnicí


OSB panels with GFC before the test



# Fire resistance of steel plate with GFC

## The fire testing room at PAVUS a.s. company (steel plates)



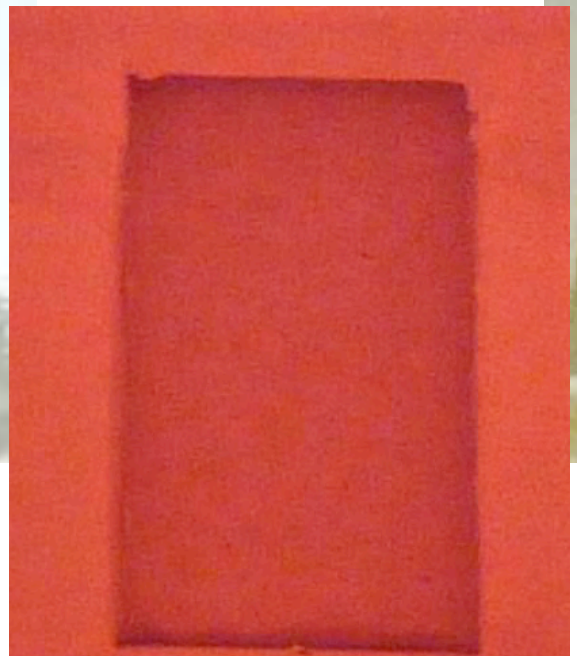

| Sample | Substrate sample | | Geopolymer composite thickness (mm) |
|---|---|---|---|
| | Material | Thickness (mm) | |
| 1 | Steel plate | 10 | 5.4 ±0.5 |
| 2 | | 10 | 10.0 ±0.8 |
| 3 | | 10 | 16.3 ±0.6 |
| 4 | | 5 | 5.1 ±0.6 |
| 5 | | 5 | 16.2 ±0.5 |
| 6 | | 3 | 11.4 ±0.5 |
| 7 | | 3 | 20.6±0.7 |
| 8 | | 2 | 11.7 ±0.5 |
| 9 | | 2 | 16.6 ±0.9 |
| 10 | | 2 | 20.7 ±0.8 |

# Fire resistance of steel plate with GFC

## Fire testing at PAVUS a.s company (steel plate)

Sample 3, protection thick. 16,3 mm **before test**

Sample 3, protection thick. 16,3 mm **after test**



Sample 3, protection thick. 16,3 mm **during the test**

# Commercialization

Commercialization of **the newly developed GFC application technology** to increase the protection and safety of the population in crisis situations, especially **in fires and other situations where high temperatures were observed.**

*Start of test– 0:00:00 h*


*Finish of test– 0:57:09 h*


***Representation of the load-bearing walls*** *"EUROPANEL GP20" in the company PAVUS, a.s. in* ***Veselí nad Lužnici***

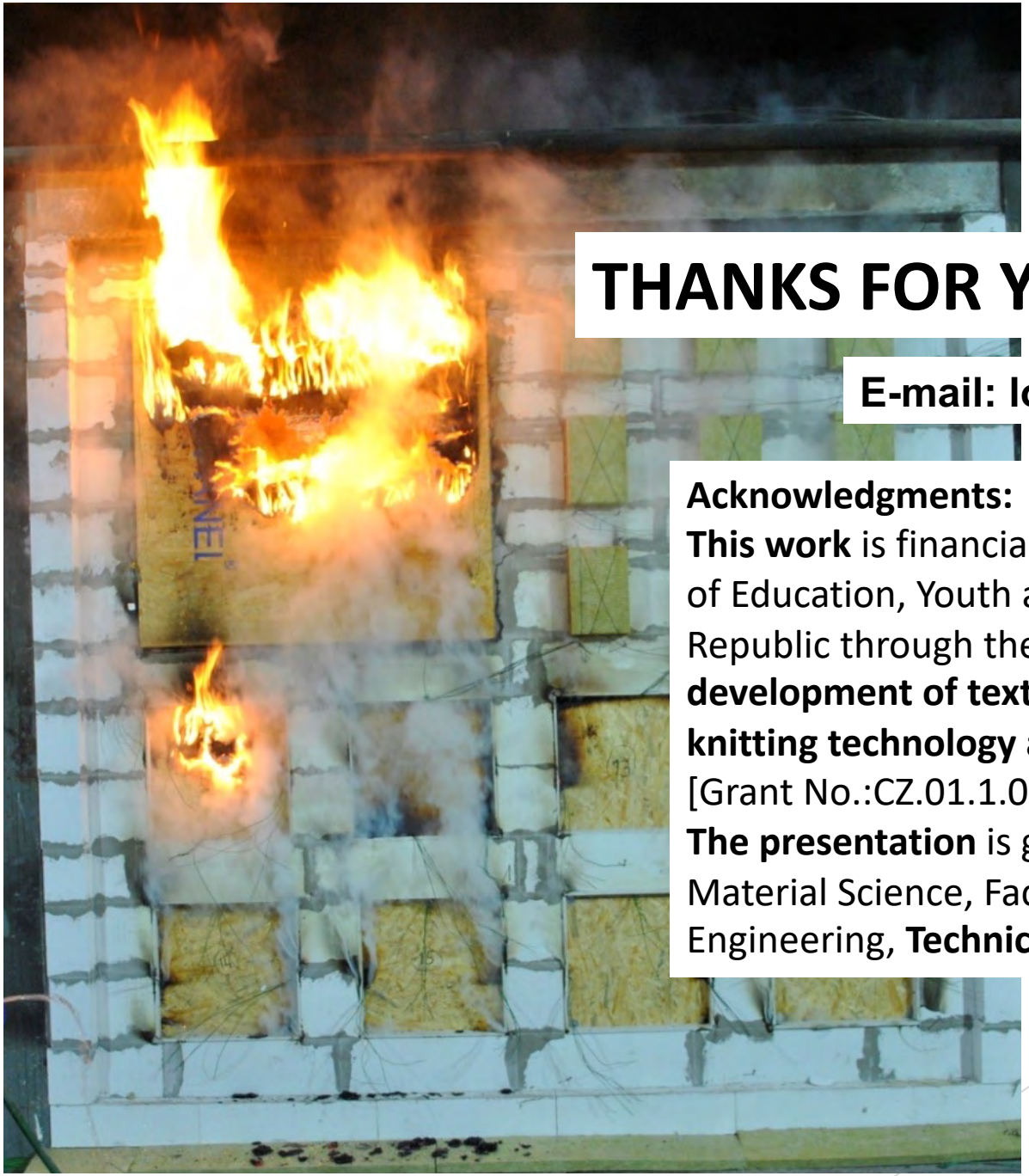
# Commercialization

**PLAGA a.s.** - application of **GCF protective layer** in October 2018 in order to protect **steel columns** from fire damage. A **20 mm** thick GCF layer was applied to **48 columns** with a diameter of **273 mm** and a length of **4200 mm**. Gas tank Prague 7.


# Conclusions

- GFC is suitable for surface coating on **wood and steel boards** by **spray method**.
- Reinforcing the right content of **basalt fibers** in the geopolymer can be created a **geopolymer foam** having the **heat-resistant property**.
- The **sandwich panel** coated by the **geopolymer foam** layer and nanofibrous membrane can be used for **thermal insulation** and **fire-resistance**.

In conclusion, the author's research results have shown that a GF is an excellent coating material for the **fire-resistant** purpose at **high-temperature**.



# THANKS FOR YOUR ATTENTION

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