Valorization of industrial waste for the development of fire resistant materials

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NAME: **MNLT INNOVATIONS P.C.**
CATEGORY: Small-Medium Enterprise
OFFICE BASE: Kifisias 125-127, 11524 Athens,

SERVICES:

- **Development of material prototypes**
- **Turning waste into valuable product**
- **(Novel) products commercialisation**
- **Product/Process Life Cycle Cost Analysis**
- **Technological support and progress monitoring**
- **Product/Process Designing and Development**

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FIREFORUM

SMART-G

PASSENGER
FOR SUSTAINABLE AND EFFICIENT RE-FREE MAGNETS

SMART-G
(ERA-MIN)

PROJECT AIM
Development smart geopolymers for the construction sector

PASSENGER
(EU H2020)

PROJECT AIM
Development of REE-free permanent magnets for electromobility, pumps and motors and wind turbines.

MINE4BUILD
(C.FUNBDING)

PROJECT AIM
Development of innovative low-cost building materials valorising mining wastes

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FIREFORUM

SMART-G
(ERA-MIN)

SMART-G

Vrije Universiteit Brussel - Physical chemistry and polymer science

University of Aveiro - Department of Materials and Ceramic Engineering

MNLT Innovations GP - Research and Development

Cracow University of Technology - Faculty of Civil Engineering; Faculty of Material

IESL/FORTH - Institute of Electronic Structure and Laser

ResourceFull – Research and Development

Mytilineos S.A. - Metallurgy Buisness Unit

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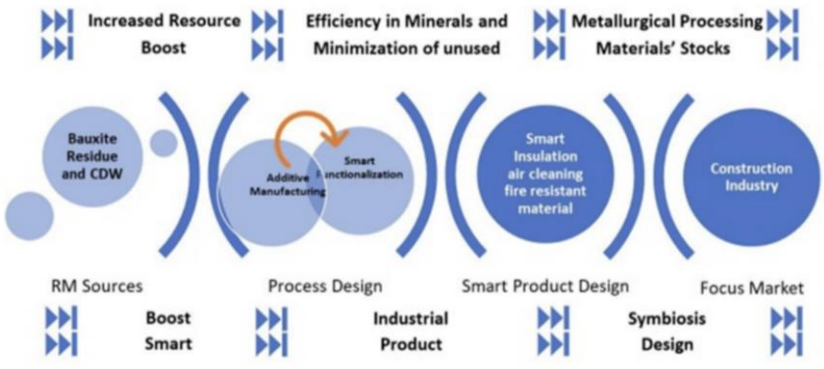
(ERA-MIN)



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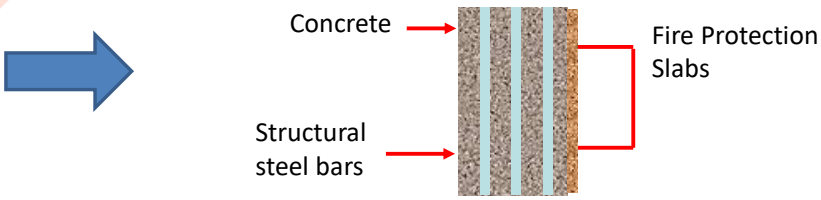
Problem to solve

- Steel rebars lose their mechanical strength and thus their structural integrity at temperatures in-between 550 °C and 600 °C requiring external fireproofing to avoid their damage in a fire event.
- The spalling phenomena of concrete are expected at temperatures higher than 180-200 °C (Khoury 2000, Phan 2008)

The temperature at the concrete should not exceed 200 °C



An effective passive fire protection can be achieved if the temperature on the concrete lining/fireproofing material interface is always restricted at values lower than 180-200 °C, avoiding in this way both concrete spalling and steel rebars softening.

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Target

1. Development of lower density materials (density <1400 kg/m³)
2. Non combustible
3. Resistance to ISO – 834
4. Satisfactory mechanical properties

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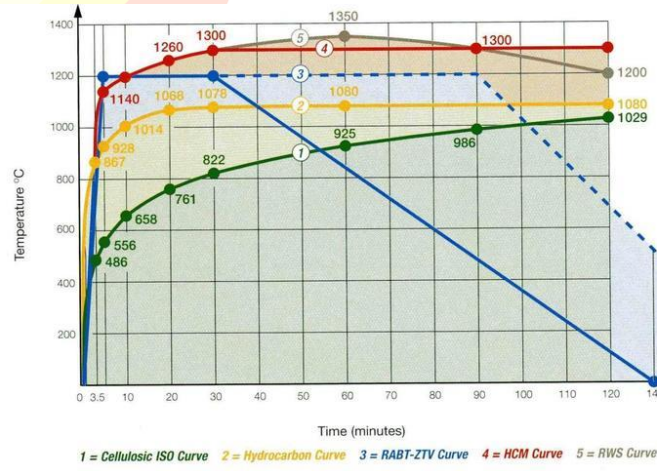
Evaluation



- Temperature limits at the interface :
- ISO 834 : 180 ° C
- RABT : 380 C
- RWS : 380 ° C

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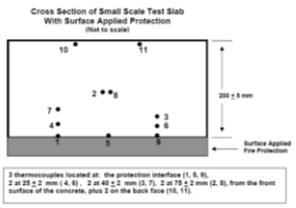
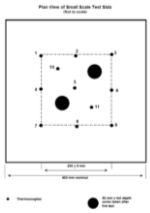
Evaluation

Fire Resistance Test (EFNARC Guidelines)





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Regulation

Construction Sector
• ICC (2006), "International Building Code", Falls Church, International Code Council
• NFPA (2006), "Building Construction and Safety Code", NFPA 5000, Quincy, National Fire Protection Association
• NFPA (2006), "Standard Methods of Tests of Fire Endurance of Building Construction and Materials," NFPA 251, Quincy, National Fire Protection Association.
• ASTM (2007), "Standard Test Methods for Fire Tests of Building Construction and Materials", ASTM E119-07a, West Conshohocken, American Society for Testing and Materials
• UL/ANSI (2011), "Standard for Fire Tests of Building Construction and Materials", UL/ANSI 263, Underwriters Laboratories Inc. (UL), Edition 14th
• EFNARC, "Specification and Guidelines for passive fire protection testing in tunnels"
• GB (2006), "Classification for burning behaviour of building materials and products", GB 8624, China National Standards
• GB (2014), "Code for fire protection design of buildings, GB 50016", China National Standards
• DIN (1998), "Fire behaviour of building materials and elements Part1: Classification of building materials, Requirements and testing", DIN 4102, German Institute for Standardization

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Geopolymers

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First stage

NaOH or KOH

water

Preparation of acivator

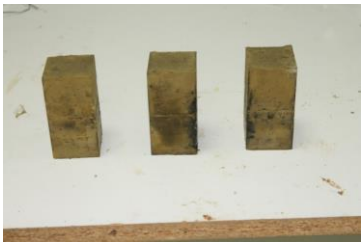
Second Stage

Solid aluminoslicate material / other solid material

Preparation of the paste

Third stage

Forming and casting the paste in appropriate types and curing at temperatures ranging from room temperature to 100 ^{o} C



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Theoretical Aprroach

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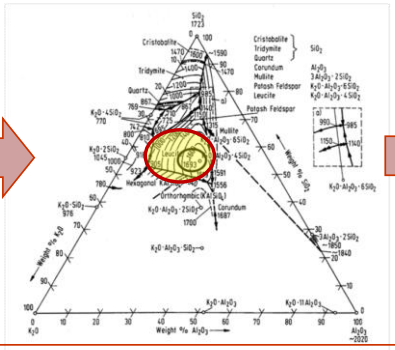
The idea was to focus on phases which is are stable phase at temperatures up to 1100^{o} C

Waste steams
- Slags

Alkali Activator
NaOH, KOH solution

Synthesis parameters
Ratios: S/L; Si/Al; K/Si



Ternary diagram: Al_2O_3 – K_2O (Na_2O) – SiO_2

Evaluation of Thermal stability

fire resistant materials

Modifications of material's composition

(Factsage Software)

Corrections of synthesis / additions

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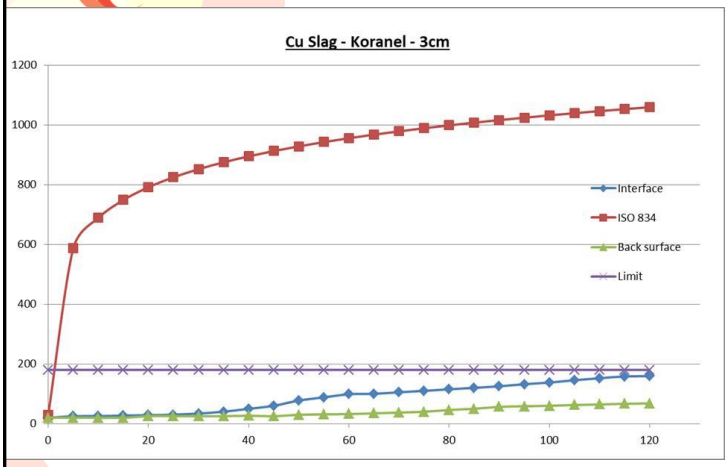
Implementation



Element	%w/w
Slag	70
Al_2O_3	5.5
KOH	9,2
Al powder	0,14
H_2O	15.16
Density	1000 kg/m3

- The temperature at the interface is lower than the limit defined by the ISO-834 curve
- The temperature in the concrete is 60-160°C which is lower than the spalling temperature

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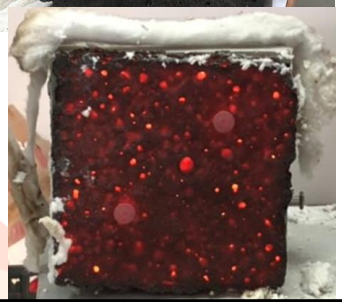
Results

Before Testing



After Testing

Excellent Behavior after fire testing

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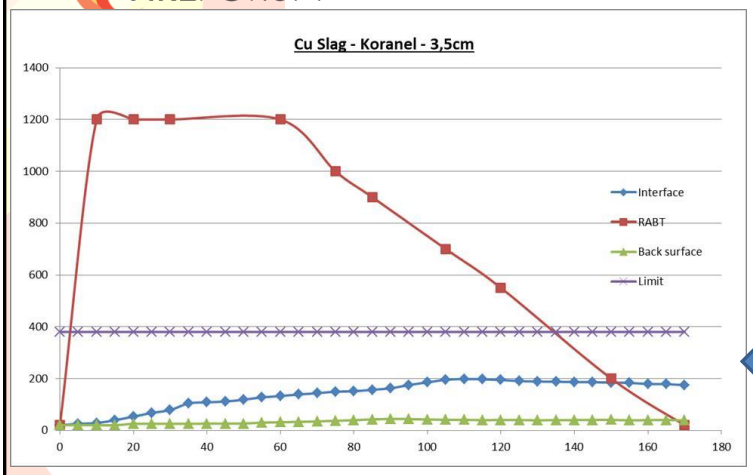
Implementation



Element	%w/w
Slag	67
Al_2O_3	8.2
KOH	9,2
Al powder	0,14
H_2O	15.46
Density	1020 kg/m3

- The temperature at the interface is lower than the limit defined by the RABT curve
- The temperature in the concrete is 60-200°C which is lower than the spalling temperature

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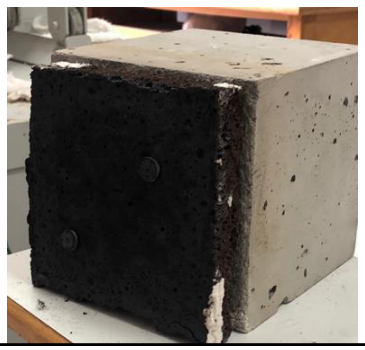
Results

After Testing

- No spalling of concrete
- No yielding of the materials
- No damage

Before Testing



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Thank you

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