REMIX
Interreg Europe

8th Peer Review Meeting
Fundão
10 de dezembro de 2018

REMINE H2020-MSCA-RISE

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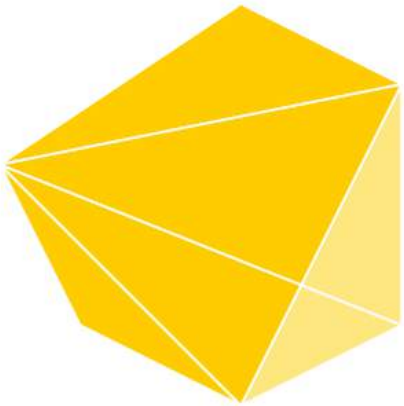
UNIVERSIDADE BEIRA INTERIOR

C MADE
CENTRE OF MATERIALS & BUILDING TECHNOLOGIES

REMINE
H2020-MSCA-RISE

https://reminemsca.wordpress.com

Funding:
This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie sklodowska-Curie agreenment Nº 645696



REMINE

H2020-MSCA-RISE

Reuse of Mining Waste into Innovative Geopolymeric-based Structural Panels, Precast, Ready Mixes and Insitu Applications

Project no. 645696, Coordinator: Beira Interior University (PT) (participants: Brunel University (UK), Silesian University (PL) Bologna University (IT), Granada University (SP), Strathclyde University (UK), Kyiv National University of Construction and Architecture (KNUCA), Alsitek Ltd (UK). Sofalca, Lda (PT), Beira Serra (PT)), 01/01/2015 ~ 31/12/2018, project value €567,000 (EC contribution).

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REMINE
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REMINE international and inter-sector collaboration through research and innovation **staff exchanges**, share knowledge and ideas from research to market (and vice-versa) for the advancement of science and the development of innovation within the **recycling and valorization of mining and quarrying waste + industrial waste + ...**

Aims knowledge development in the fields of materials science, processing engineering, structural engineering, infrastructure systems, arts and design ..to **turn mining waste into valuable materials for infrastructure and building products .. with** market perspectives.

REMINE

REMINE has three main objectives:

- Development of a **high energy-efficient alkali-activated-based structural panel** for building facades, and advanced experimental characterization of rheological, mechanical and physical properties;

- Development of **lightweight and fire resistant precast applications**, combining mining waste mud and natural cork for artistic, architectural and historical heritage restoration;

- Improving opportunities for reuse of mining wastes in **pavements infrastructure and as pouring pavement materials** for insitu application;

REMINE
H2020-MSCA-RISE

Panasqueira mine is one case study for REMINE

Largests Tungsten mine in World;
Major production in 1943:
2500 ton of Wolfram;
During 80's, generates about 600 thousand tones of coarse wastes/ year to explore only 2 thousand tones of Wolfram ore:
0,3% of total escavated!
currently, it is still generating 100 to 200 tons per day.
Around 20% is **waste mud.**

Panasqueira tailings (particularly waste-mud) also contain **high sulphide (As) concentrations and sulphide-related heavy metals (Cd, Cu, Pd and Zn)**

Heavy metal pollution in mine–soil–plant system in S. Francisco de Assis – Panasqueira mine (Portugal)

Carla Candeias [a,*], Rita Melo [a], Paula Freire Ávila [b,c], Eduardo Ferreira da Silva [a], Ana Rita Salgueiro [a], João Paulo Teixeira [a]

REMINE research will **give solutions to safely reuse the waste mud containing arsenic and hazardous heavy metals**, developing novel eco-friendly geopolymeric (alkali-activated) binders, mortars and concretes (foamed concretes) that can effectively immobilize arsenic and heavy metals as solidified/ stabilized products.

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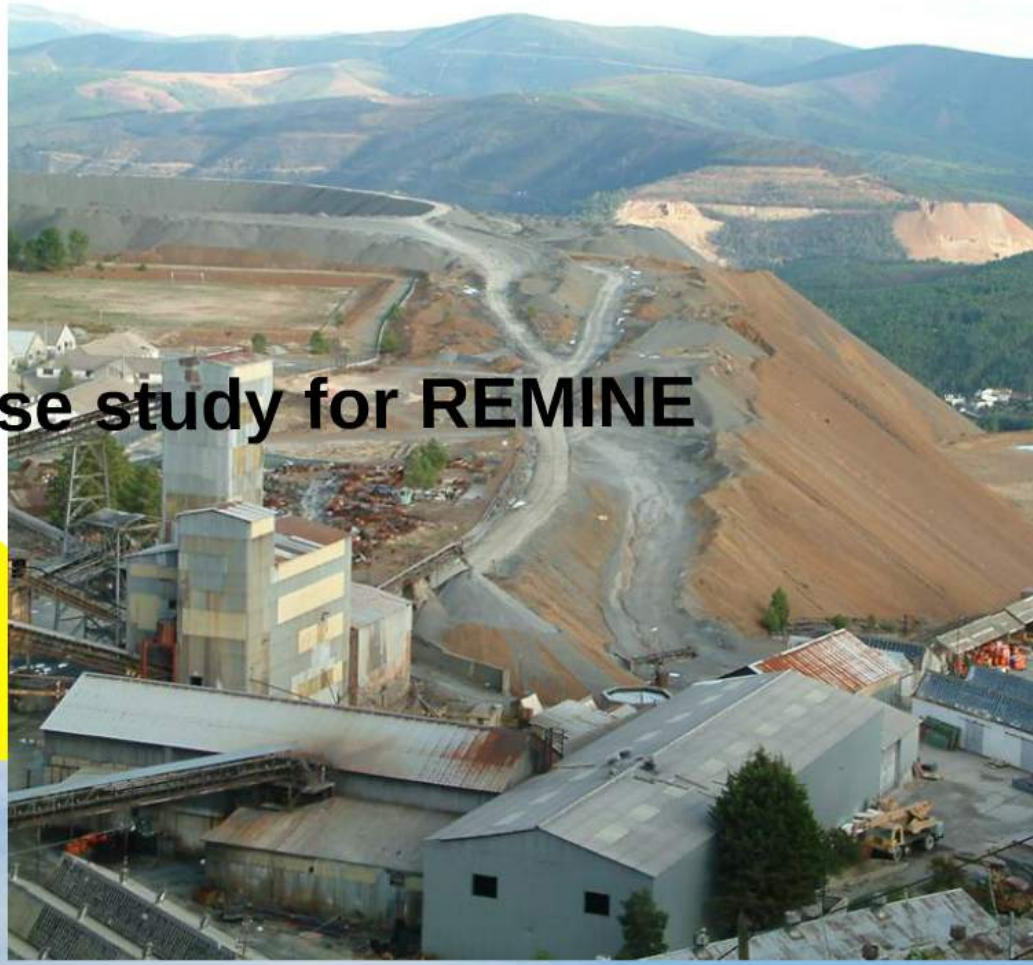

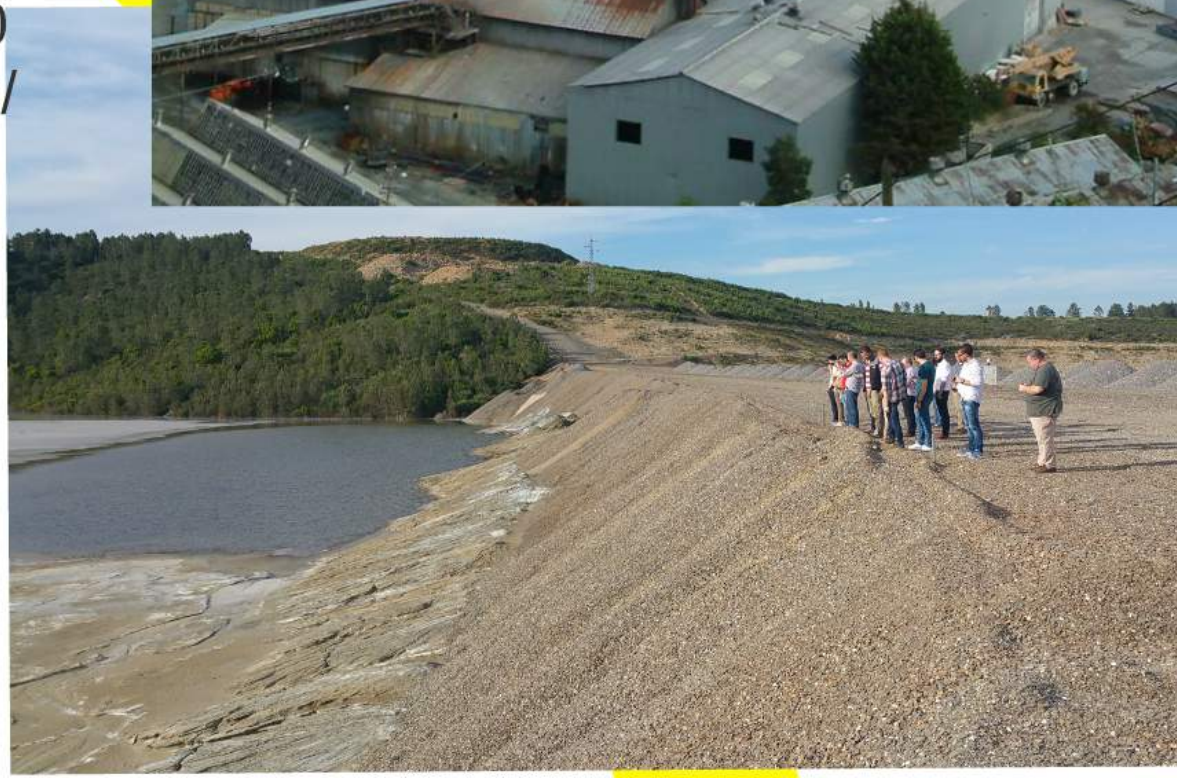

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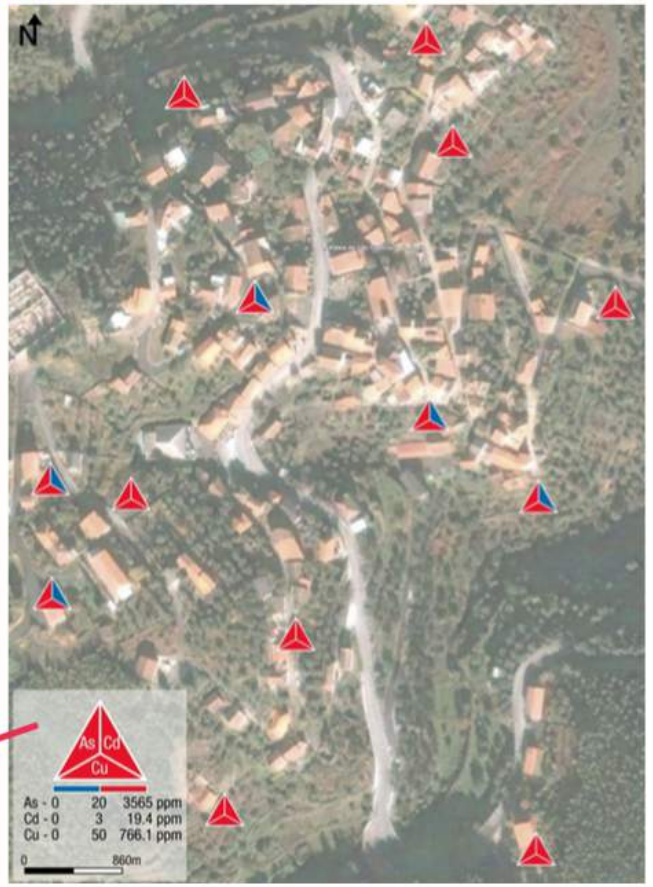

Fig. 5. Cartography of road dust contents for As, Cd and Cu (Google Earth image modified).

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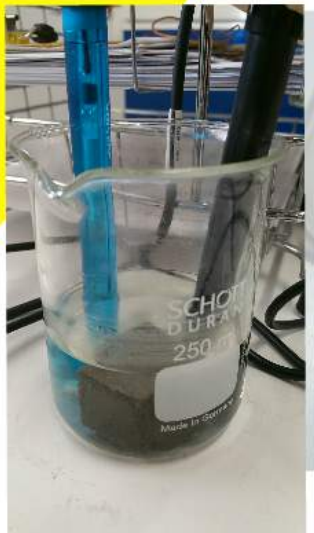

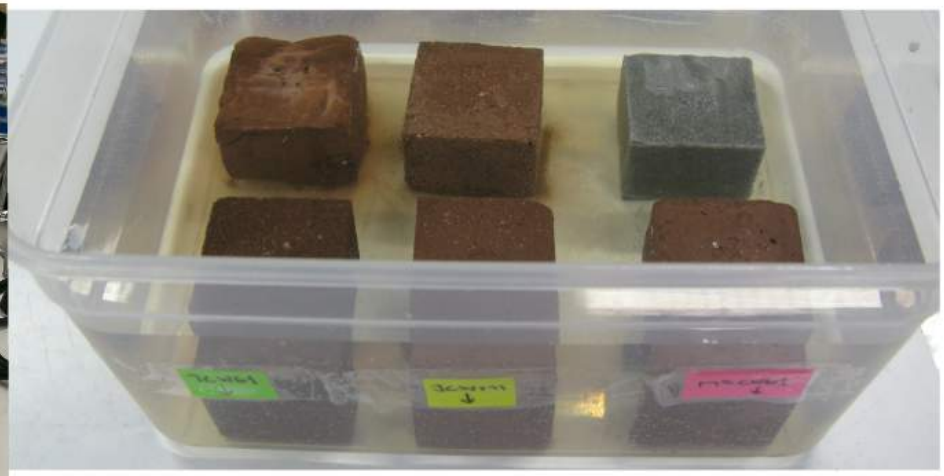

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Coal mining waste;
Slags, Waste glass, Brick waste ...

- novel materials with novel properties, such us **ceramic and refractory materials**, using **unsual wastes;**
waste polymers; ...

Alkali-activation - novel binders

Precursores
Reactive aluminosilicate powder, particularly metakaoline and fly ash

Alkali-activators
Sodium hydroxide;
Sodium silicate;
Potassium Silicate;
calcium hydroxide;
...

alkali-activated bind
disordered alkali aluminosi
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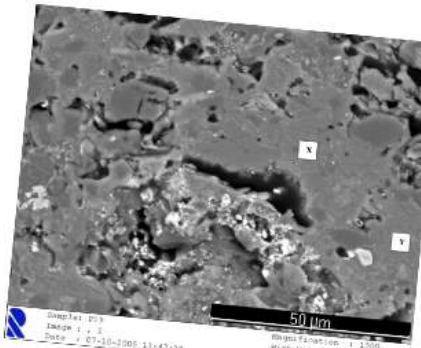

Fig. 3a. SEM micrographs of tungsten mine waste geopolymeric mortar. The areas marked as X and Y are identified as some type of alumino-silicate with the following composition: X[($CaO/SiO_2 = 0$); ($Al_2O_3/Na_2O_{eq} = 2.5$) and ($SiO_2/Al_2O_3 = 4$); Y [($CaO/SiO_2 = 0$); ($Al_2O_3/Na_2O_{eq} = 3.1$) and ($SiO_2/Al_2O_3 = 3.1$).

Ceramic materials - thermal insulation

Ceramic isolation panel, made from mud, cork and glass.

1000 °C firing

Porosity ≥ 50%

Mosh hardness: 6
Thermal Conductivity W/m-K 0.117904

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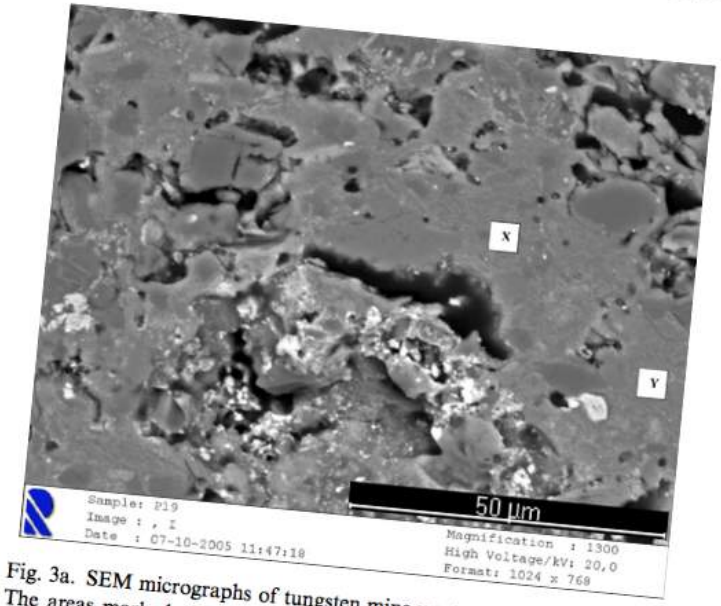

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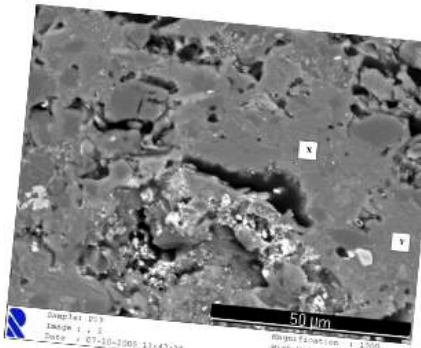

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Main valuable materials for infrastructure and building products .. with market perspectives.

macro-encapsulated aggregates (ME-LWAs) for a precast panel application

patented

artificial aggregates for infrastructures (AAI)

lightwheigt foamed materials, combining mud + waste glass + expanded cork

lightwheigt foamed materials, perfurated blocks + mud waste + brick waste powder

patented

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mud and
chitectural
storation;

for reuse of
nts
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nsitu

stabilized products.

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Ceramic materials - therm

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UPCOMING EVENTS

No upcoming events

RECENT POSTS

- Waste-based + CO2 activated prototypes presented at Coimbra (Portugal)
- ALTERNATIVE FILLERS FOR THE PRODUCTION OF BITUMINOUS MIXTURES: A SCREENING INVESTIGATION ON WASTE POWDERS
- REMINE dissemination during the European Researcher's Night (Bologna 2017)

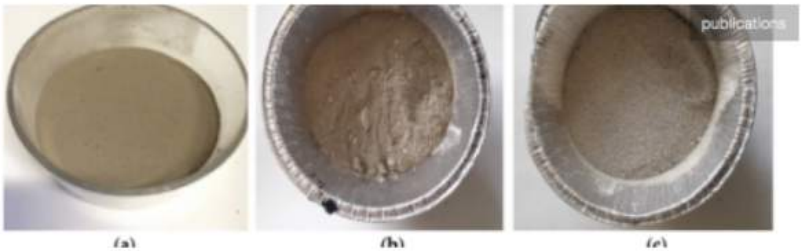
ARCHIVES

- February 2018

WASTE-BASED + CO2 ACTIVATED PROTOTYPES PRESENTED AT COIMBRA (PORTUGAL)

February 15, 2018
by castrogomes
Leave a comment
Edit

"Sustainable building materials and solutions" is the topic of the Public Exhibition promoted by IteCons and CCDRC Centro, ongoing at Alma Shopping – Coimbra, between 14th to 24th February. The [...]



ALTERNATIVE FILLERS FOR THE PRODUCTION

Cesare Sangiorgi University of Bologna Piergiorgio Tataranni University of Bologna Francesco Mazzotta

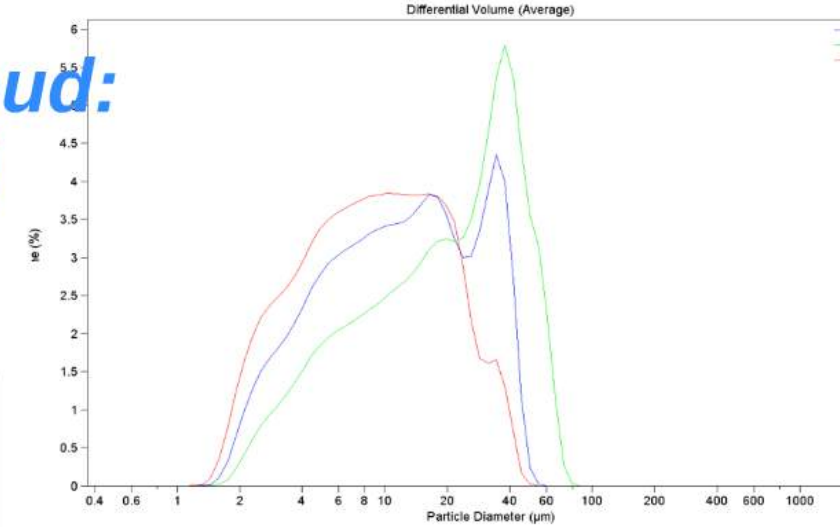
Search ...

PANASQUEIRA mining waste mud: alumino-silicate rich mud

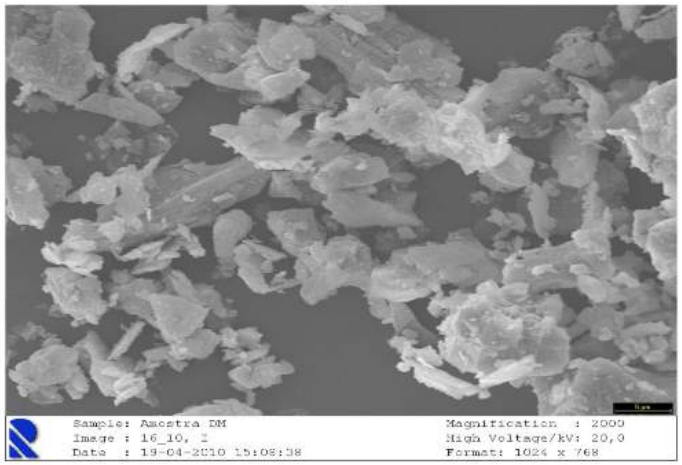
Mining waste mud chemical composition

Oxide	(% in mass)
SiO_2	68.54
Na_2O	1.14
Al_2O_3	18.27
Fe_2O_3	5.64
K_2O	5.24
TiO_2	1.17
H_2O	-

high K, Na



fine powder



PANASQUEIRA mining waste mud Alkali-activation

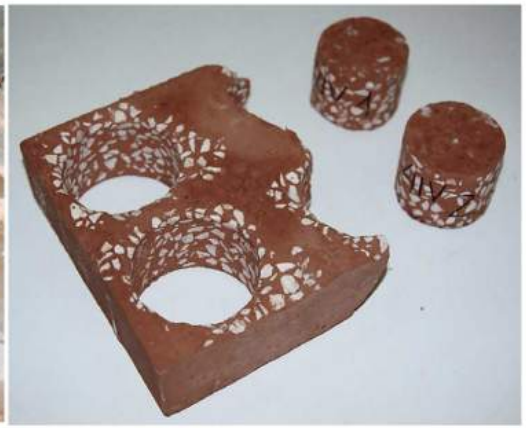
2007 - Initial Research

- dehydroxylated of mine waste powder (calcinated at 800ºC for 2 hours)

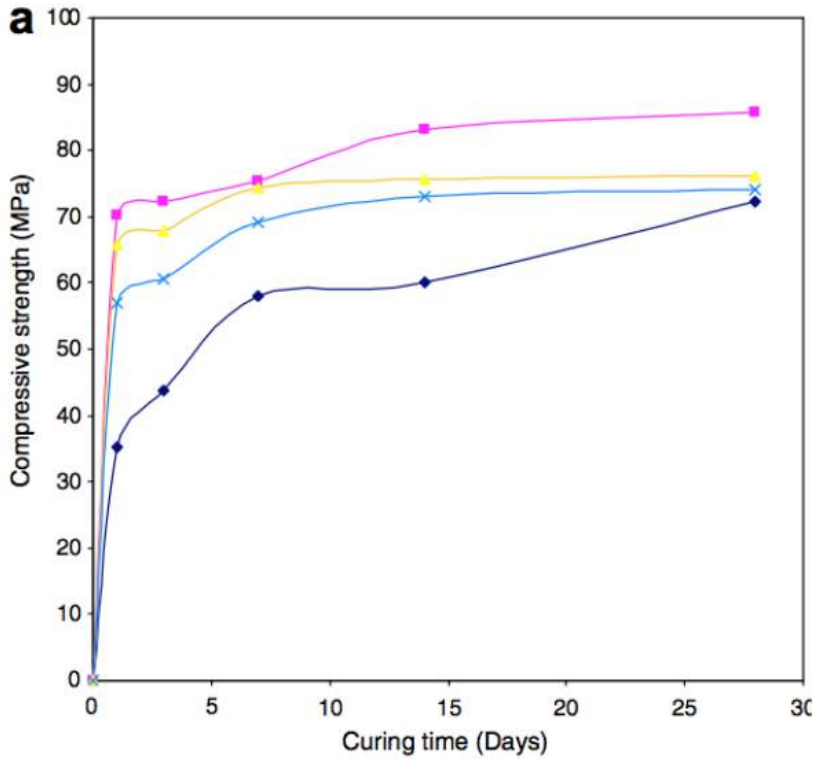
- blended up to 10% Ca(OH)2

- Combined NaOH + Na2SiO3 activators

- Cured at room temperature



hight temperature static calcination



increase of compressive strength along time

PANASQUEIRA mining waste mud (TMWM) :

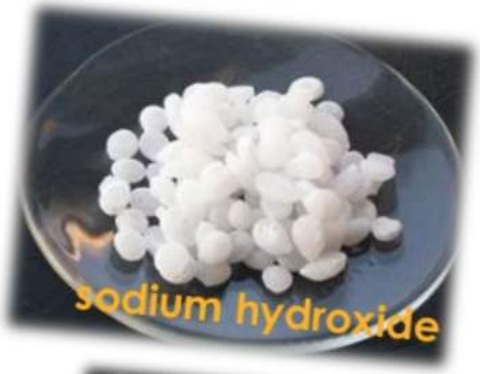
2018 - Current research on alkali-activation

Precursores

TMWM+
Reactive Al+Si rich powder, waste glass, metakaoline, fly ash, GGBS ...

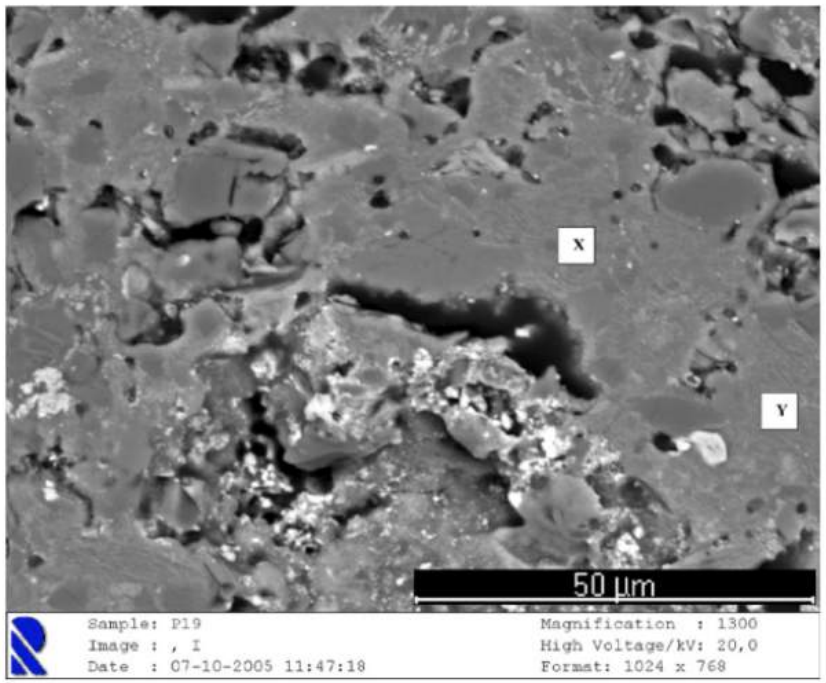
Alkali-activators

Sodium hydroxide;
Sodium silicate;
Potassium Silicate;



alkali-activated binder

disordered alkali aluminosilicate amourphous gel phase



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N-A-S-H

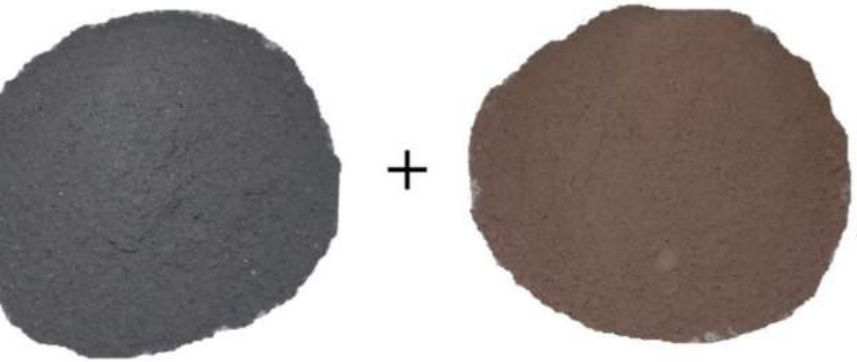
PANASQUEIRA mining mud + brick waste powder
Element composition + Properties

500 µm **250 µm**

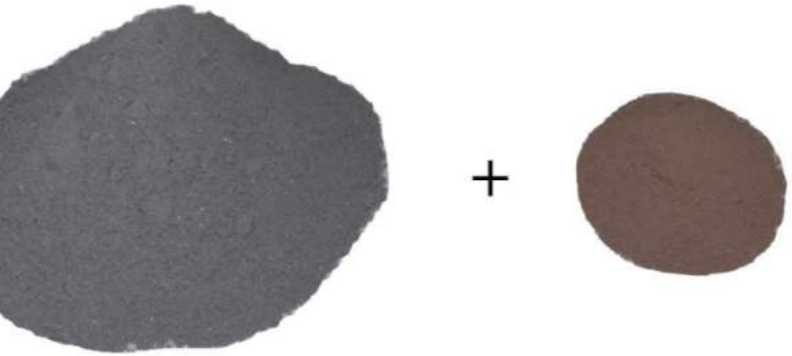
Composition/Properties	Materials	
	BP	TMWM
O	47.32	38.26
Si	27.39	18.2
Al	13.09	7.51
Ti	0.61	0.3
S	0.15	2.64
K	2.40	3.39
Ca	0.57	0.41
Fe	5.52	9.02
Mg	0.87	2.43
Na	0.37	0.80
P	0.06	–
Zn	–	1.09
Other	1.66	15.89
LOI*	3.8	11.6
Density g/cm^3	2.7339	3.0319
Blaine specific area cm^2/g	2954	3339
*LOI, Loss on ignition at 1000 °C		

Different mud collection, different composition
"other" - 9% to 16%
Arsenic (1.5%) Sulfur (4%), Zinc (0.6%), Manganese (0,2%), Wolfram (0.3%)

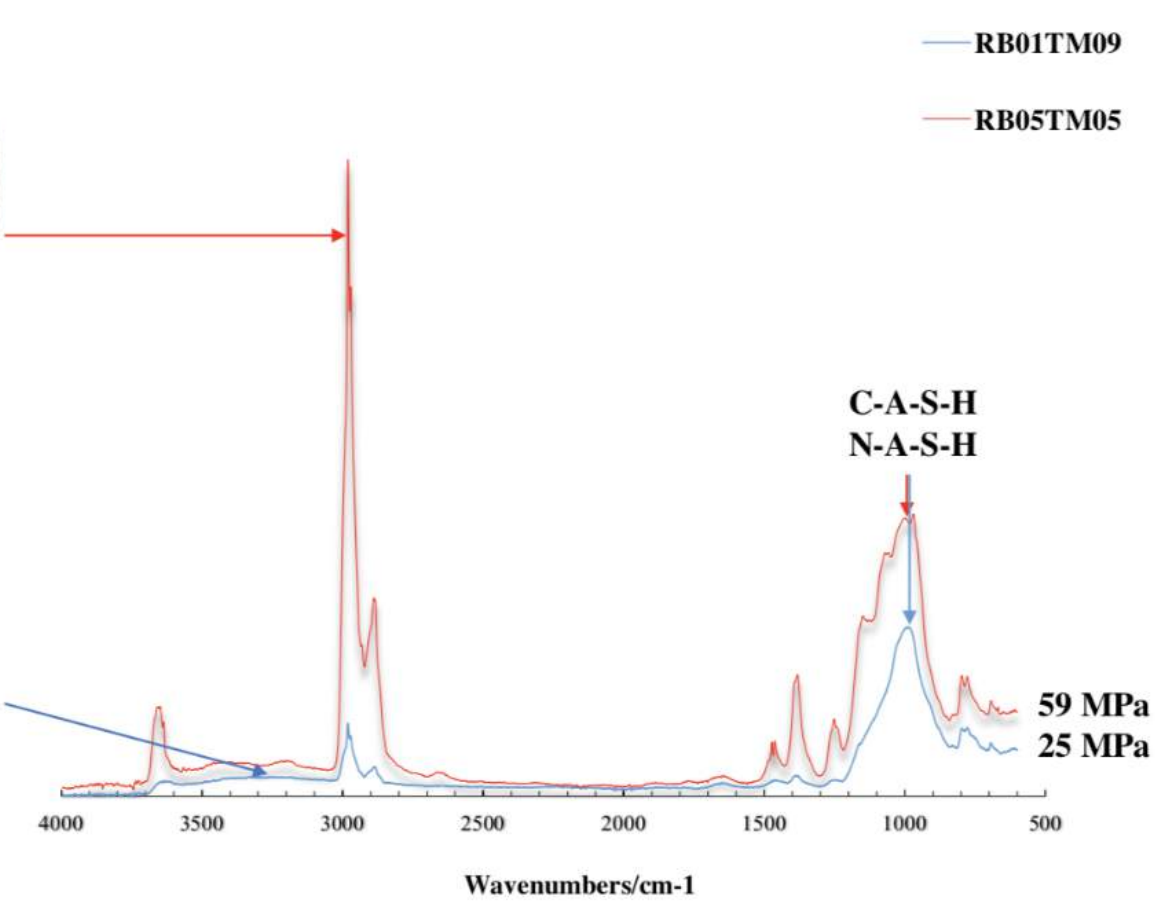
Alkali activation: mining mud + brick waste (RCBW)
FTIR - fourier transform infrared spectroscopy



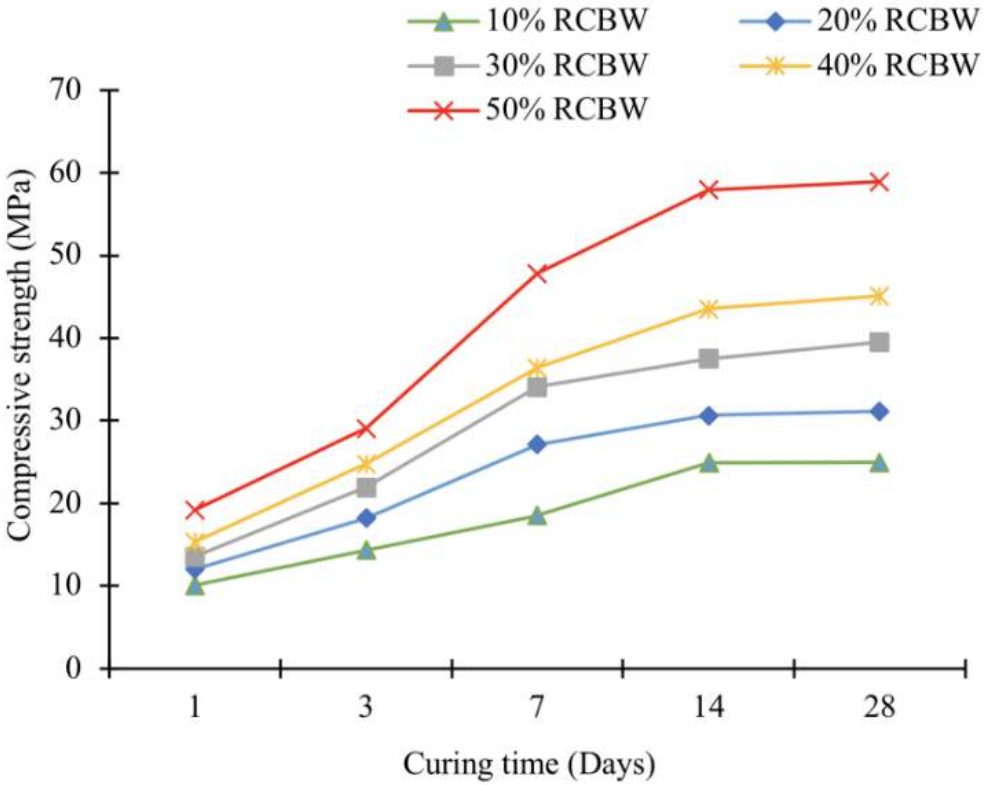
50% TMWM + *50% RCBW*



90%TMWM + *10%RCBW*



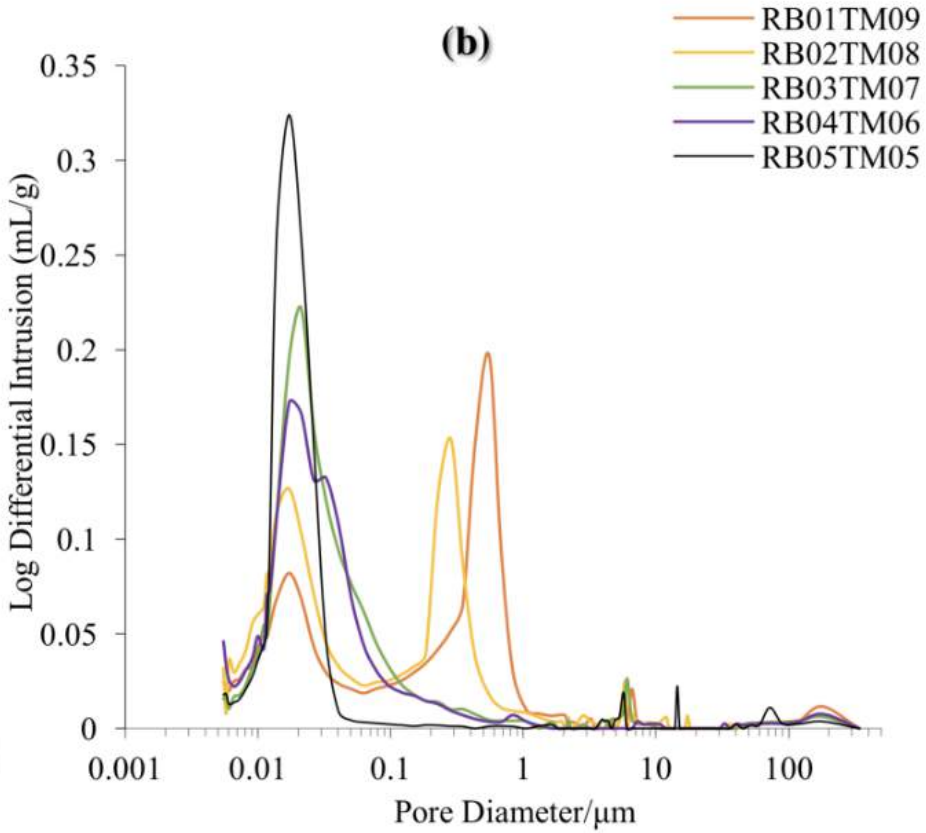
Alkali activation: mining mud + brick waste (RCBW)
Compressive strength + Mercury Intrusion Porosimetry



Compressive strength x RCBW %
28 days

10% 20% 30% 40% 50%

(~ 20MPa ... ~ 60 MPa)



Critical Pore diameter x BPW %
28 days

10% 20% 30% 40% 50%

(0.5534 ; 0.28338 ; 0.0171 ; 0.0170 ; 0.0170 µm)

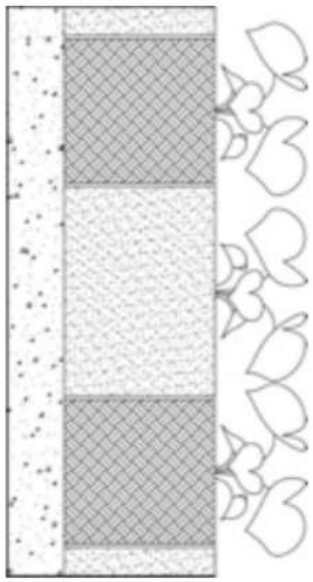
We started a project in 2011 of innovative natural vegetated panels for energy-efficient building green roofs and facades - GEOGREEN Modular System

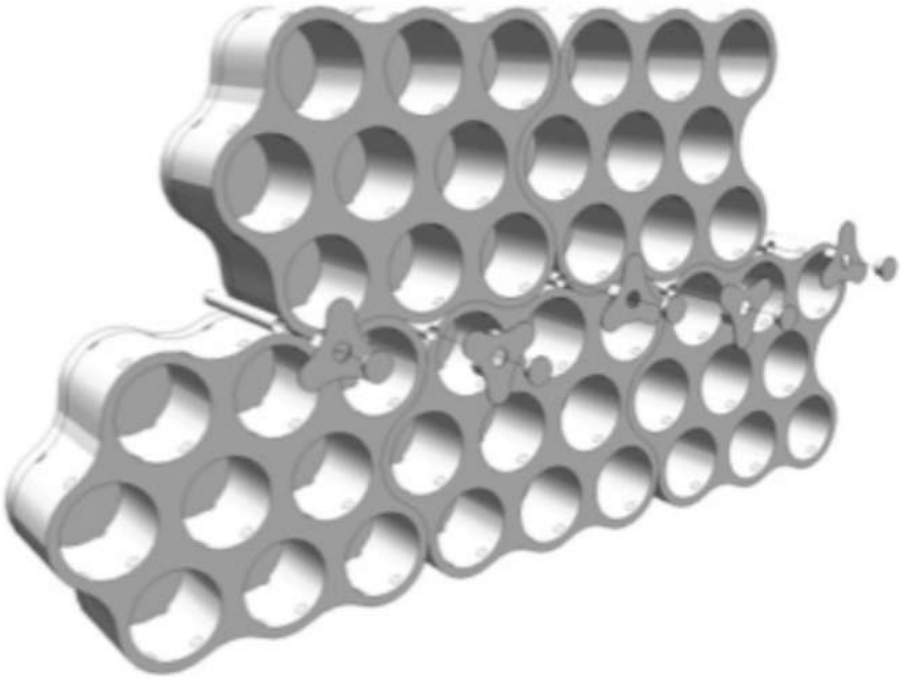
The GEOGREEN modular system is based on pre-fabricated panels incorporating pre-planted vegetation. In vertical or sloped surfaces, each module can be hold by a support structure or fixed directly in the building facade.

GEOGREEN system looks like that

plants are inserted in modules

modules are interlocked





-suitable for new and retrofit/rehabilitation of existing buildings and modernization of urban areas, and easy to modification and maintenance;

so, those are the GEOGREEN modules we did

AAM mortar

blend of mine waste mud and other waste materials.
Density - 1,3g/cm3
Weight 2.4Kg per plate – 26Kg/ m2 Compressive strength
6 MPa (7 days curing at 60°C)
Capillarity absorption coefficient
0,63 - 1,33 Kg.m-2. h0,5

Insulation cork board

Natural eco-friendly material

- Density 105 - 125 Kg/m3
- Weight 0,650Kg per plate
- 7Kg/m2
- Thermal insulator 0.5 W/m2. K
- Thickness 8 cm / 3,15 inches

and GEOGREEN modules with plants

- the panels can include indigenous/endemic vegetation for a particular climate;

some ideias for GEOGREEN system

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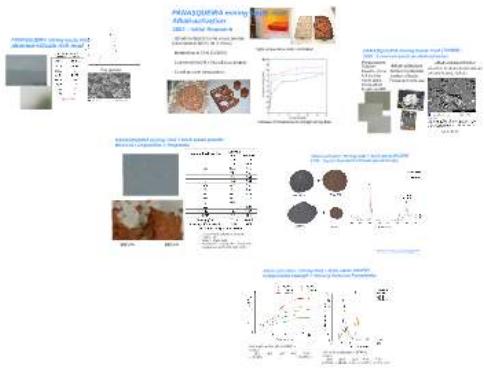

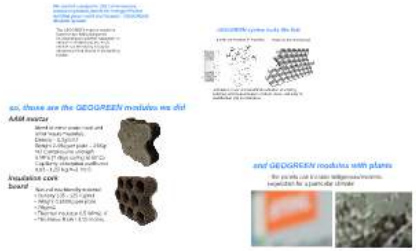

REMINE

REMINE international and inter-sector collaboration through research and innovation **staff exchanges**, share **knowledge** and ideas from research to market (and vice-versa) for the advancement of science and the development of innovation within the **recycling and valorization of mining and quarrying waste + industrial waste + ...**

Aims knowledge development in the fields of materials science, processing engineering, structural engineering, infrastructure systems, arts and design ... to **turn mining waste into valuable materials** for infrastructure and building products .. **with** market perspectives.

Panasqueira mine is one case study for REMINE

Largests Tungsten mine in World
Major production in 1943:
2500 ton of Wolfram;
During 80's, generates about 800 thousand tonnes of coarse residual/year to explore only 2 thousand tones of Wolfram ore.
6,3% of total excavated!
currently, it is still generating 100 to 200 tons per day.
Around 20% is **waste mud.**

Panasqueira tailings (particularly waste mud) also contain **high sulphide (As) concentrations and sulphide-related heavy metals (Cd, Cu, Pd and Zn)**

REMINE has three main objectives:

- Development of a **high energy-efficient alkali-activated-based structural panel** for building facades, and advanced experimental characterization of rheological, mechanical and physical properties;

- Development of **lightweight and fire resistant precast applications**, combining mining waste mud and natural cork for artistic, architectural and historical heritage restoration;

- Improving opportunities for reuse of mining wastes in **pavements infrastructure and as pouring pavement materials** for insitu application.

REMINE research will give solutions to safely reuse the waste mud containing arsenic and hazardous heavy metals.
developing novel eco-friendly geopolymeric (alkali-activated) binders, mortars and concretes (foamed-concretes) that can effectively immobilize arsenic and heavy metals as solidified/stabilized products.

Main valuable materials for infrastructure and building products .. with market perspectives.

macro-encapsulated aggregates (ML-LWA) for a precast panel application; *patented*

artificial aggregates for infrastructures (AA)

lightweight foamed materials, combining mud + waste glass + expanded cork

lightweight foamed materials, perforated blocks + mud waste + brick waste powder *patented*

REMINE technical objectives:

- novel waste-based alkali-activated binders by **combining mining/ quarrying wastes** with other **mineral and non-mineral wastes;** Coal mining waste; Slags, Waste glass, Brick waste ...

- novel materials with novel properties, such as **ceramic and refractory materials**, using **unusual wastes;** waste polymers; ...

Alkali-activation – novel binders

Ceramic materials - thermal insulation

Project WP/Tasks progress - Overview

https://reminemsca.wordpress.com

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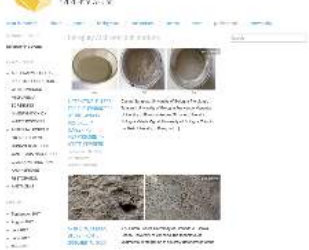
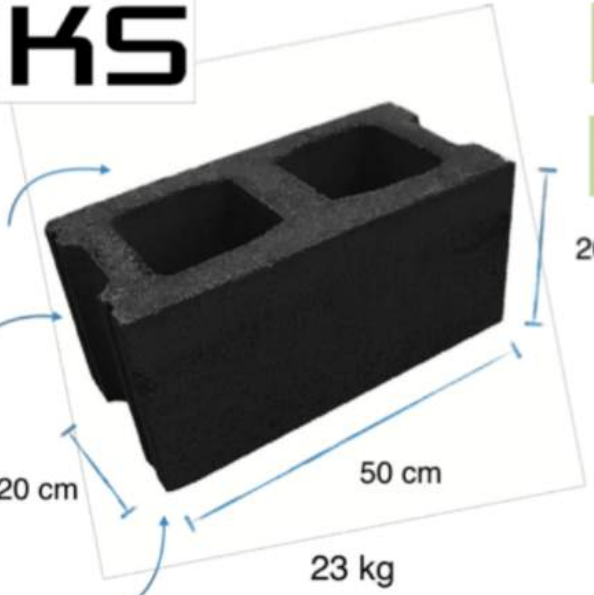


ECO2 BLOCKS

48 hours fast hardening blocks

CO2 stored as Calcium Carbonates



Industrial waste

Non potable water

Carbon dioxide

Recognized International publications

Patented (provisional)

Ongoing industrial prototyping tests


ECO2 BLOCKS
Carbon dioxide absorbent construction blocks
Traditional manufacturing machines
10x manufacturing process
50% cheaper
5x higher mechanical resistance
2x higher fire resistance
Circular Economy product design


ECO2 BLOCKS
50% cheaper
10x faster manufacturing process
Traditional manufacturing machines
PRÉMIO MANUEL ANTÓNIO DA MOTA
First prize
Prémio
Manuel
António da Mota
Climate Launchpad
1
2018
First Prize Winner Climate Launchpad Grand Final
Sustainable Production Systems Winner Climate Launchpad Grand Final

REMIX
Interreg Europe

8th Peer Review Meeting
Fundão
10 de dezembro de 2018

REMINE H2020-MSCA-RISE

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REMINE
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https://reminemsca.wordpress.com

Funding:
This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie sklodowska-Curie agreenment Nº 645696

Brunel University