



EL ROL DEL  
CEMENTO &  
CONCRETO  
DE CARA  
AL **CAMBIO  
CLIMÁTICO**



CONGRESO  
**Cemento & Concreto  
Verde 2050**



**06** AL **09** **2024**  
MAYO



Ciudad de  
Guatemala



**Arcillas  
Calcinadas**

Prof. Fernando Martirena  
Coordinador LC3 TRC LATAM



# The LC3 project

10+ years of collaboration  
Switzerland-India-Cuba  
Technology Resource  
Centers in LATAM and  
Asia  
Close contact with the  
industry



# A SHORT HISTORY OF LC3

# The origins

**2005-2008**

SDC-SNSF Project  
*Calcined clays for  
pozzolans*



**2009-2012**

SDC-SNSF Project  
*Ternary blend cement  
calcined clay-limestone*



**2013-2020**

SDC-Climate Change  
*Low Carbon Cement*



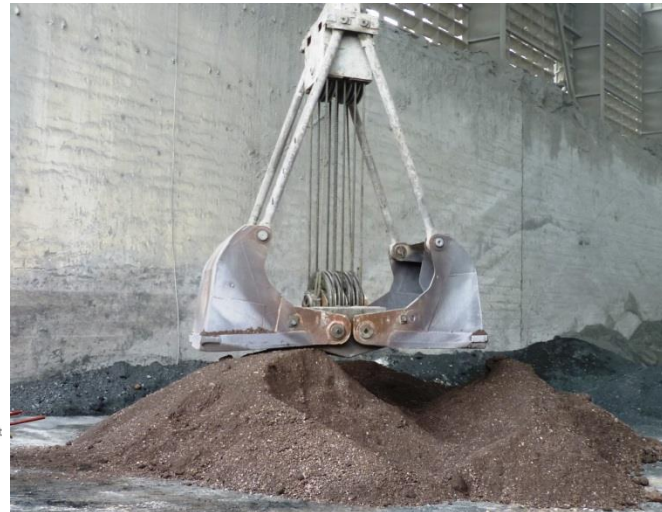
The pursuit of sustainable alternatives to replace Clinker with Supplementary cementitious Materials



Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra



# 2013: first full industrial trial



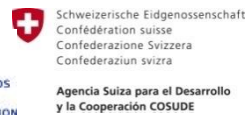
**Jan 2013:** Clay sourcing  
Pontezuela (300 t)

**March 2013:** Clay calcination  
Siguaney (110 t)

**August 2013:** Cement  
grinding (130 t)

**Sept-Dec. 2013:** Cement use in  
construction

**Jan-July 2014:** Evaluation of  
concrete made with LC3



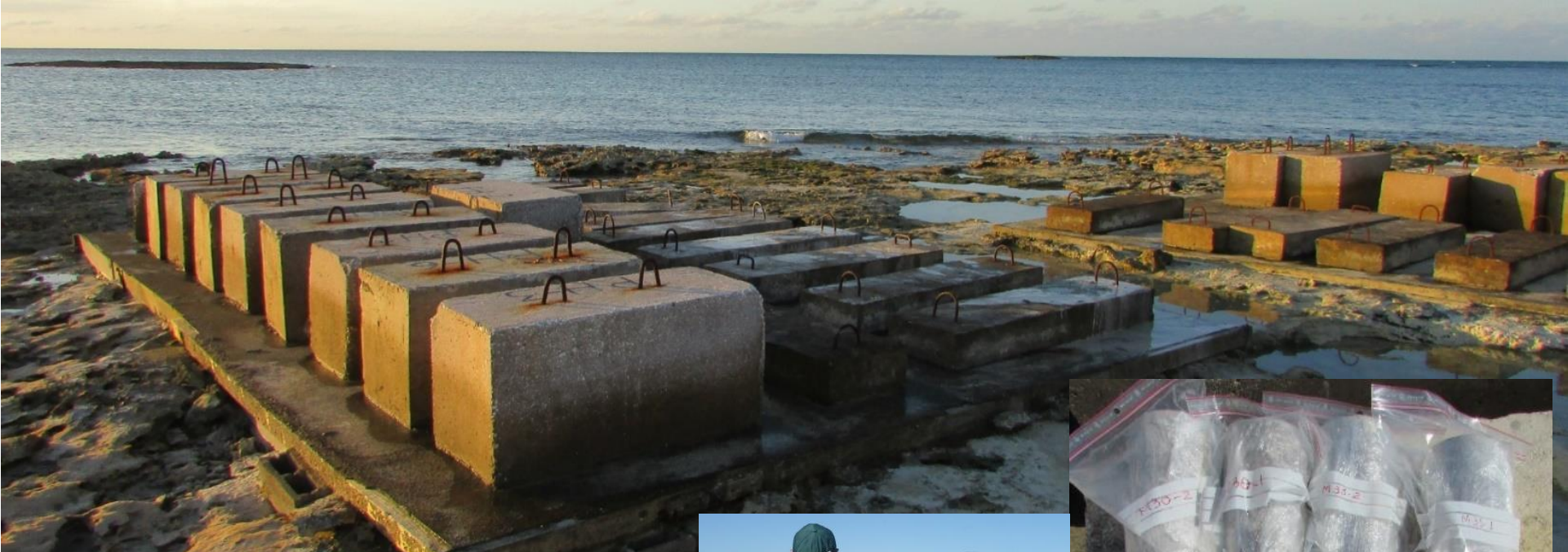


Cement type	Design 28d strength block. MPa	Cement Content (kg/m <sup>3</sup> )	Design Slump (cm)	Slump (cm)	w/c	Comp. Strength MPa	
						7d	28d
Concrete blocks EPM LCC	5 MPa	300	-	-	-	3.6	5.1
Concrete blocks EPM OPC	5 MPa	300	-	-	-	4.2	5.6



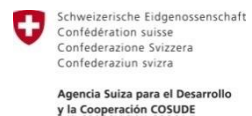
Cement type	Design Strength Mpa	Cement Content (kg)	Design Slump (cm)	Slump (cm)	w/c	Comp. Strength MPa	
						7d	28d
Precast concrete bridge part made with LCC	25 MPa	360	12±3	17.5	0.57	21.0	31.4
Precast concrete bridge part made with OPC	25 MPa	360	12±3	10	0.49	20.4	33.2

# 2014: Exposure site for LC3 concrete

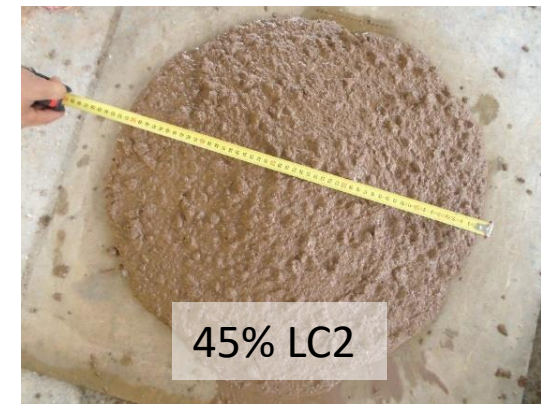
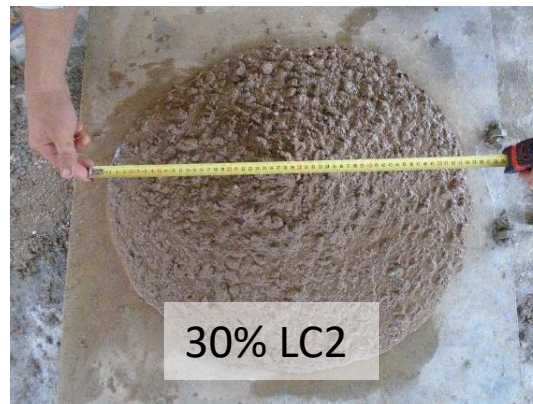
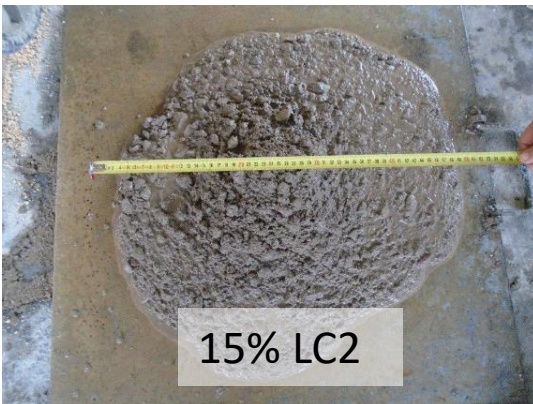
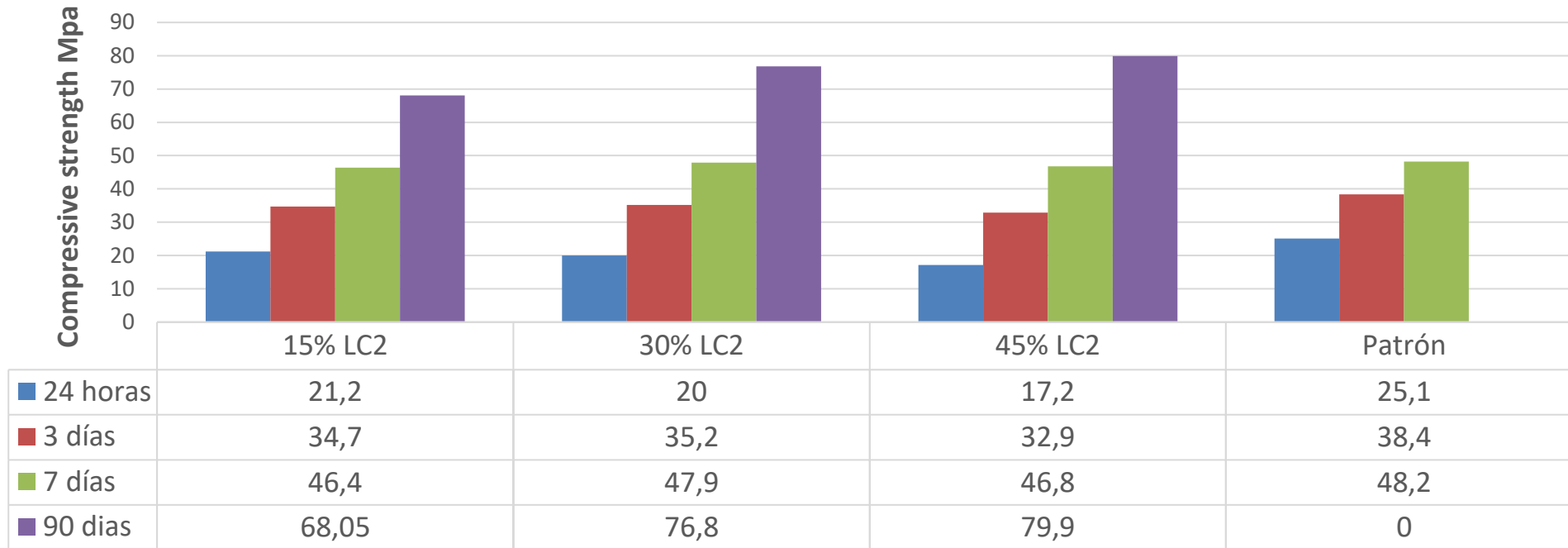




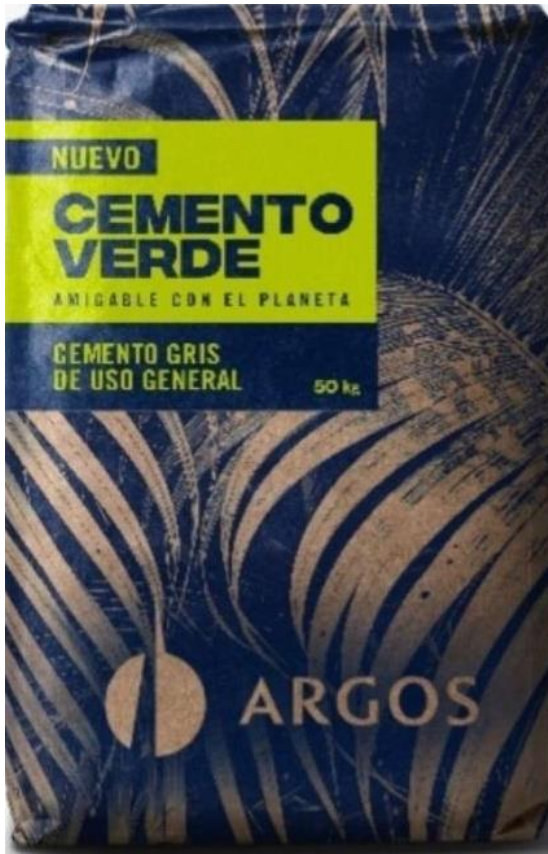
# 2018: Industrial trial (LC2)



# LC2 in concrete



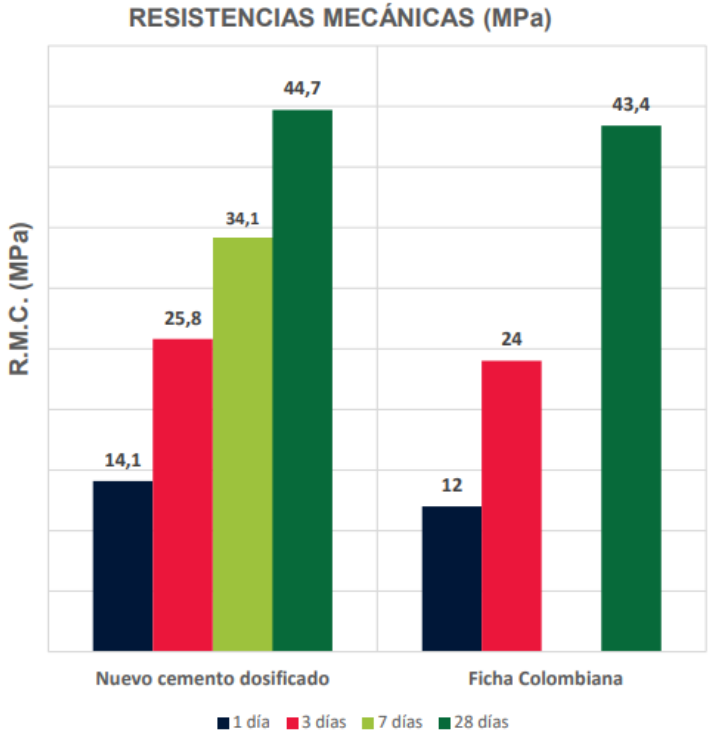
# 2020: Rio Claro plant



# 2023: large scale construction (Colombia)



## Cemento Concretero con AC



Presentation FICEM, 2019

# 2021: CIMPOR Ivory Coast



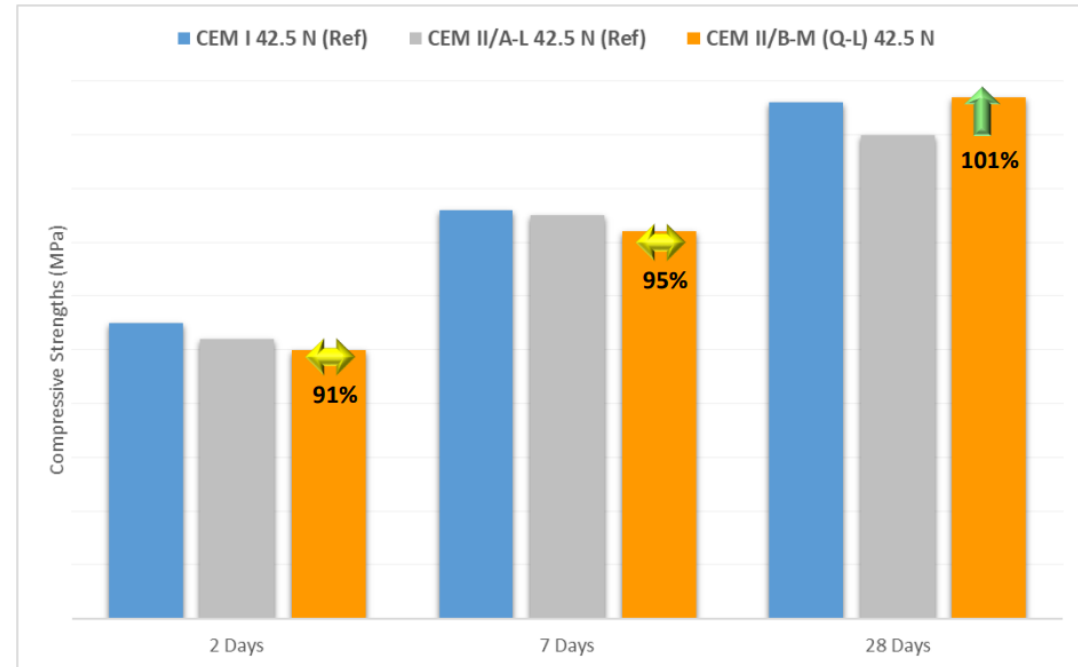
## CIMPOR Côte d'Ivoire

World's first greenfield calcined clay integrated cement plant

Production Capacity:

0.80M tons of cement

0.30M tons of calcined clay



DeOHclay®  
Operational Experiences  
from the Pioneer

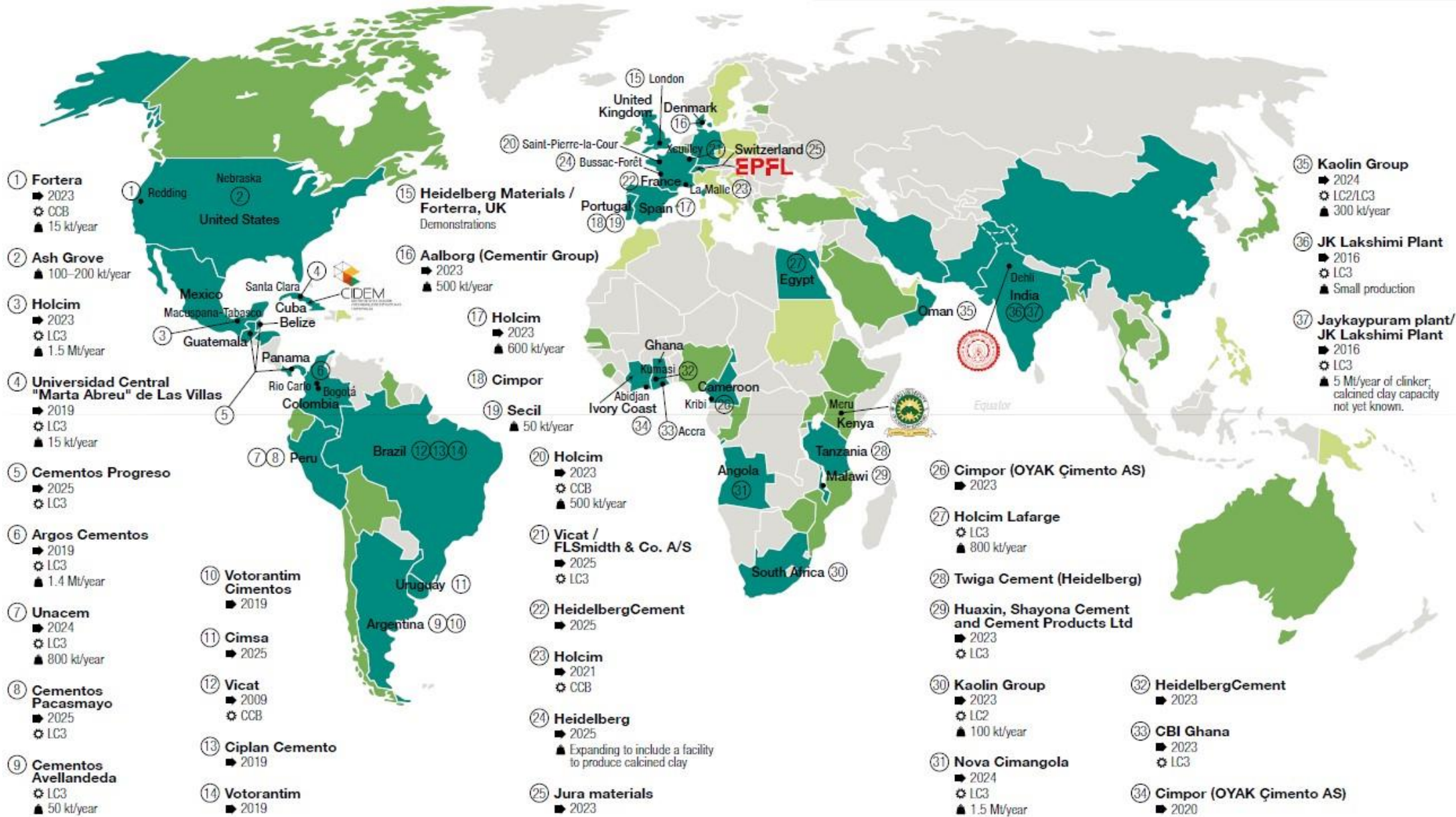
Suat Çalbiyık  
Chairman  
scalbiyik@cimpor.com

Berkan Fidan  
CTO  
bfidan@cimpor.com

11.03.2024  
Lisbon, Portugal

# What do we have after 10+ years?

- Knowledge and experience on how to choose the clays
- Different choices for calcination equipment (flash calciner, rotary kiln, retrofitted kiln, etc.)
- The admixture industry has produced tailor made admixtures for calcined clay (grinding aids, superplasticizers)
- Standards covering LC3-50 (50% clinker)
- Critical mass of LC3 (successful) applications in building of infrastructure.
- Evidence of long term durability
- Reduction of CO2 emissions proven



Where are the  
Stumbling Blocks  
Today?

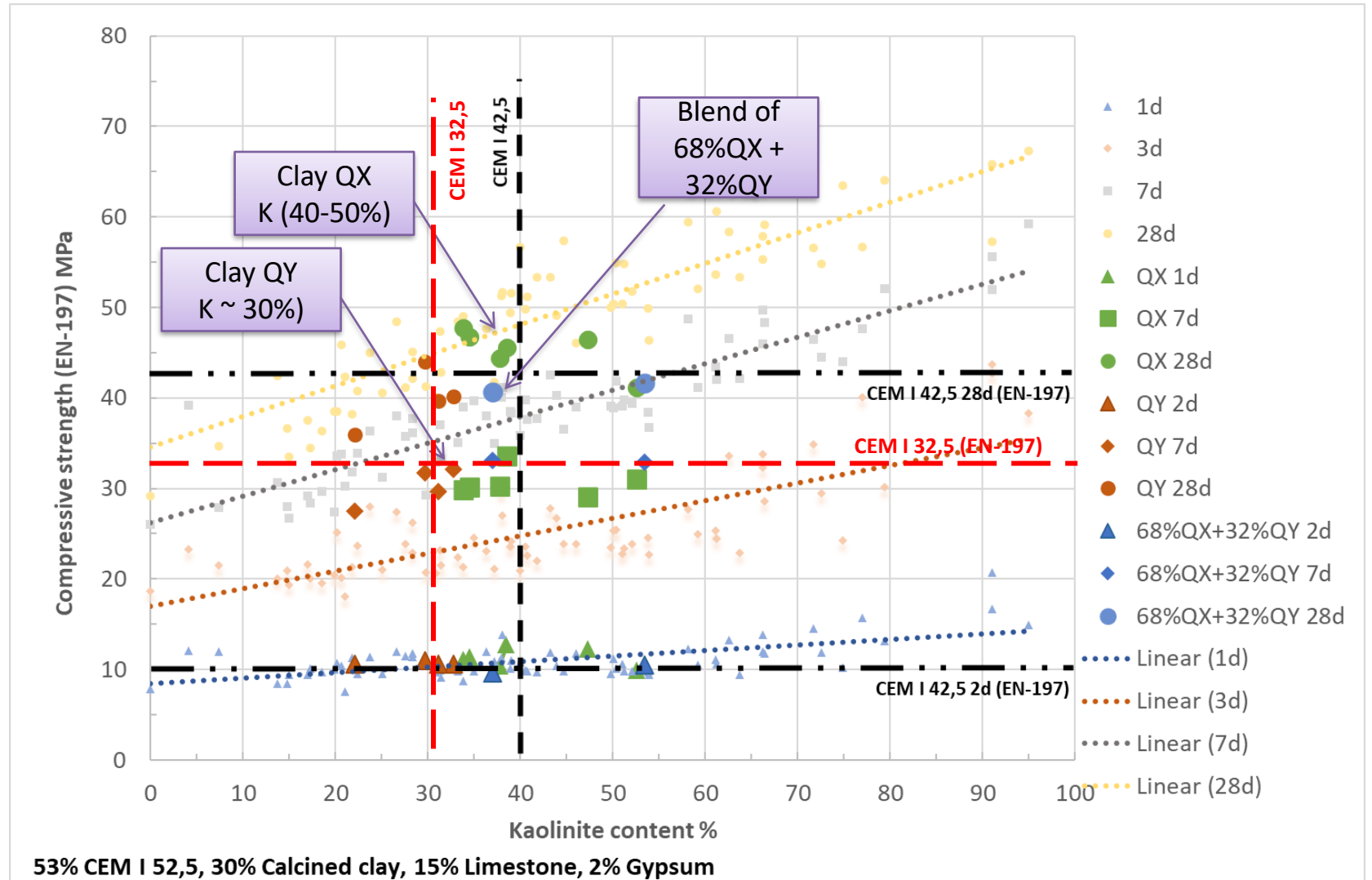


# Clays with $K < 40\%$

Properties of a CEM I 42,5 can be met with a minimum of 40% kaolinite

Properties of a CEM I 32,5 can be met with a minimum of 30% kaolinite

Blending clays could enable a good use of resources, yet fulfilling target properties



# Implementing color control



Exhaustion of oxygen is done by inserting a liquid fuel lance at the cooler. Combustion of the fuel (approximately 0.5% increase in fuel) can do this quickly and safely



# Abidjan / Côte d'Ivoire DeOHclay Integrated Cement Plant

DeOHclay®  
Operational Experiences  
from the Pioneer

Suat Çalbiyık  
Chairman  
scalbiyık@cimpor.com

Berkan Fidan  
CTO  
bfidan@cimpor.com

## Achievements & Experiences

- > Unique process control adaptations with additional sensors and tools
- > Reliability and high accuracy on color control with tailor-made process methodologies

11.03.2024  
Lisbon, Portugal

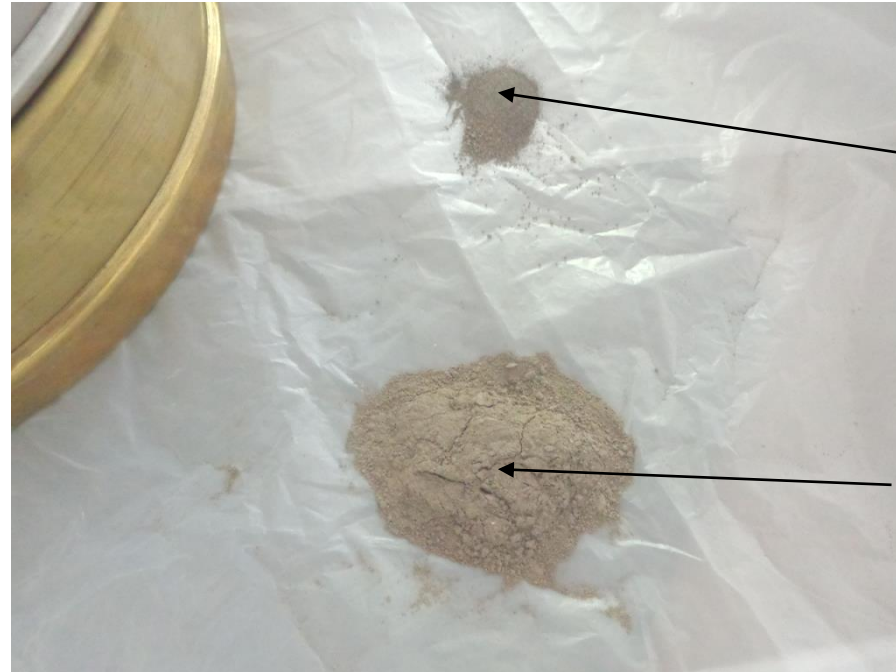
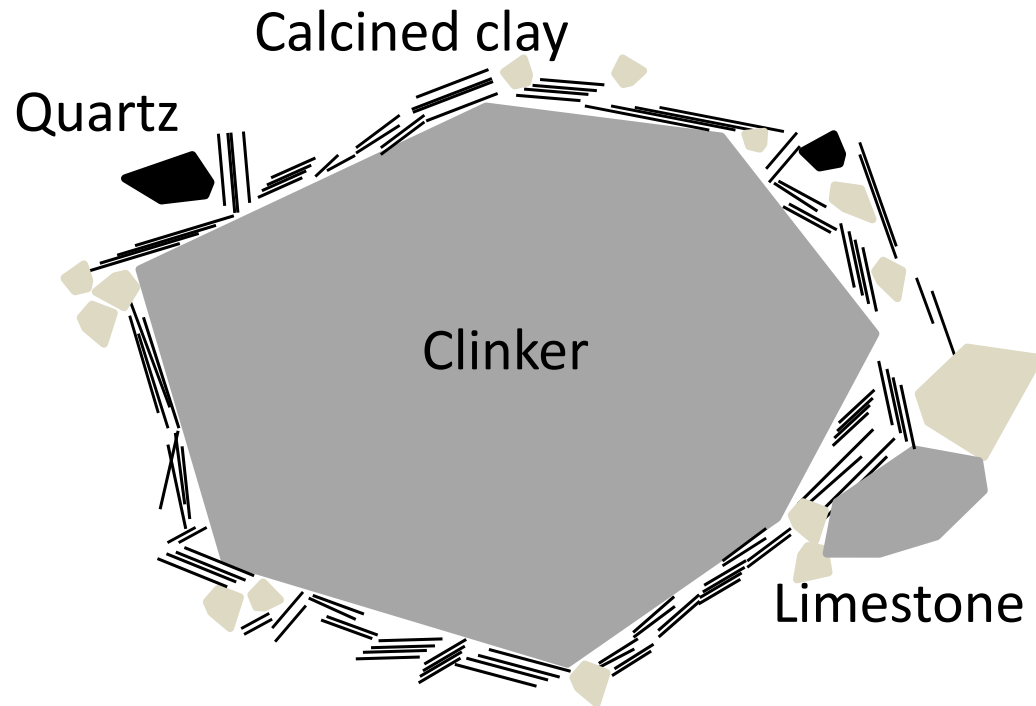


Actual Product (with color control)

2024



# Co-grinding on LC3



Coarser  
Clinker (over  
90  $\mu\text{m}$ )

Finer  
the Rest

- Separator gauge was set for around 10% of cement retained at 90  $\mu\text{m}$  sieve (coarser than normal practice)
- Most material retained at 90  $\mu\text{m}$  (9%) sieve was coarse clinker

# Grinding strategy: co-grinding



**CC 1h no GA**



**CC 1h PCE 1 0.45%**



**CC 1h Amine 0.13%**



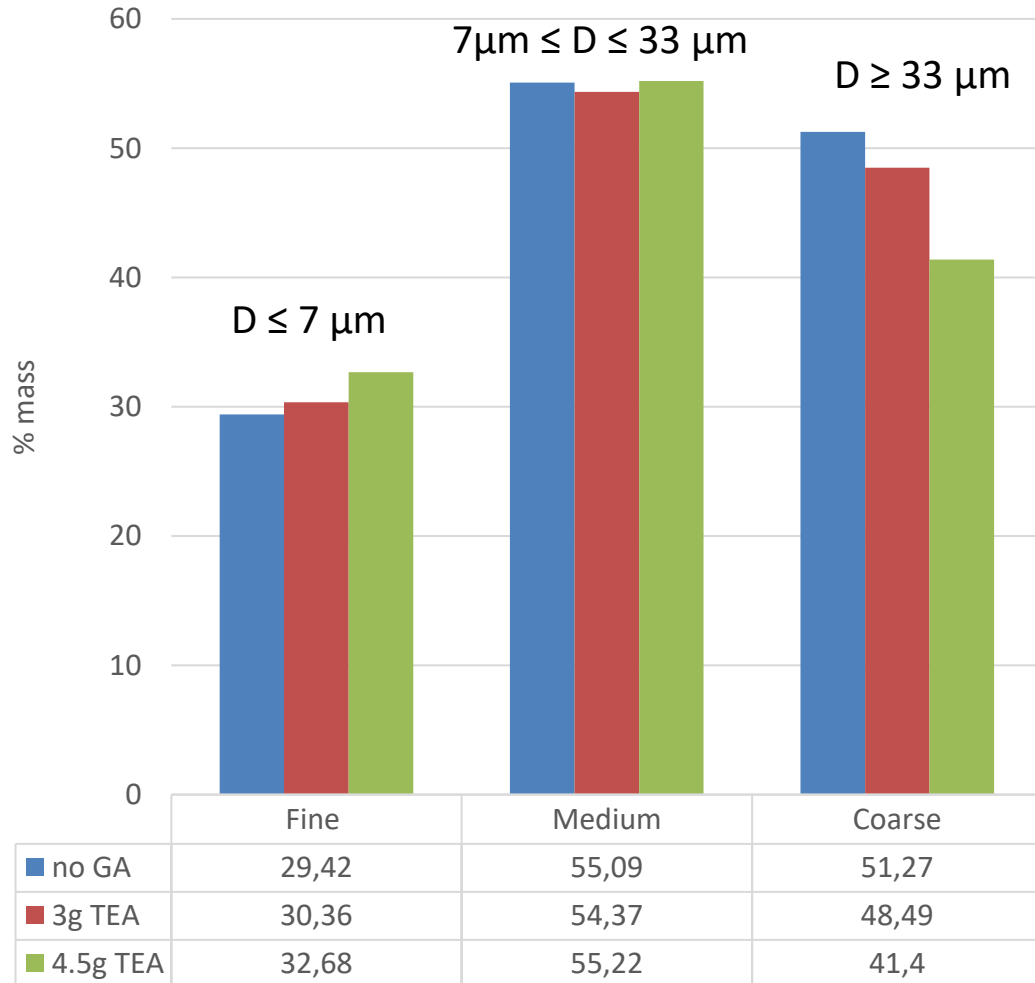
**CC 1h Glycol 0.12%**

Agglomeration during grinding can compromise fineness of clinker.  
Grinding aids would solve the problem

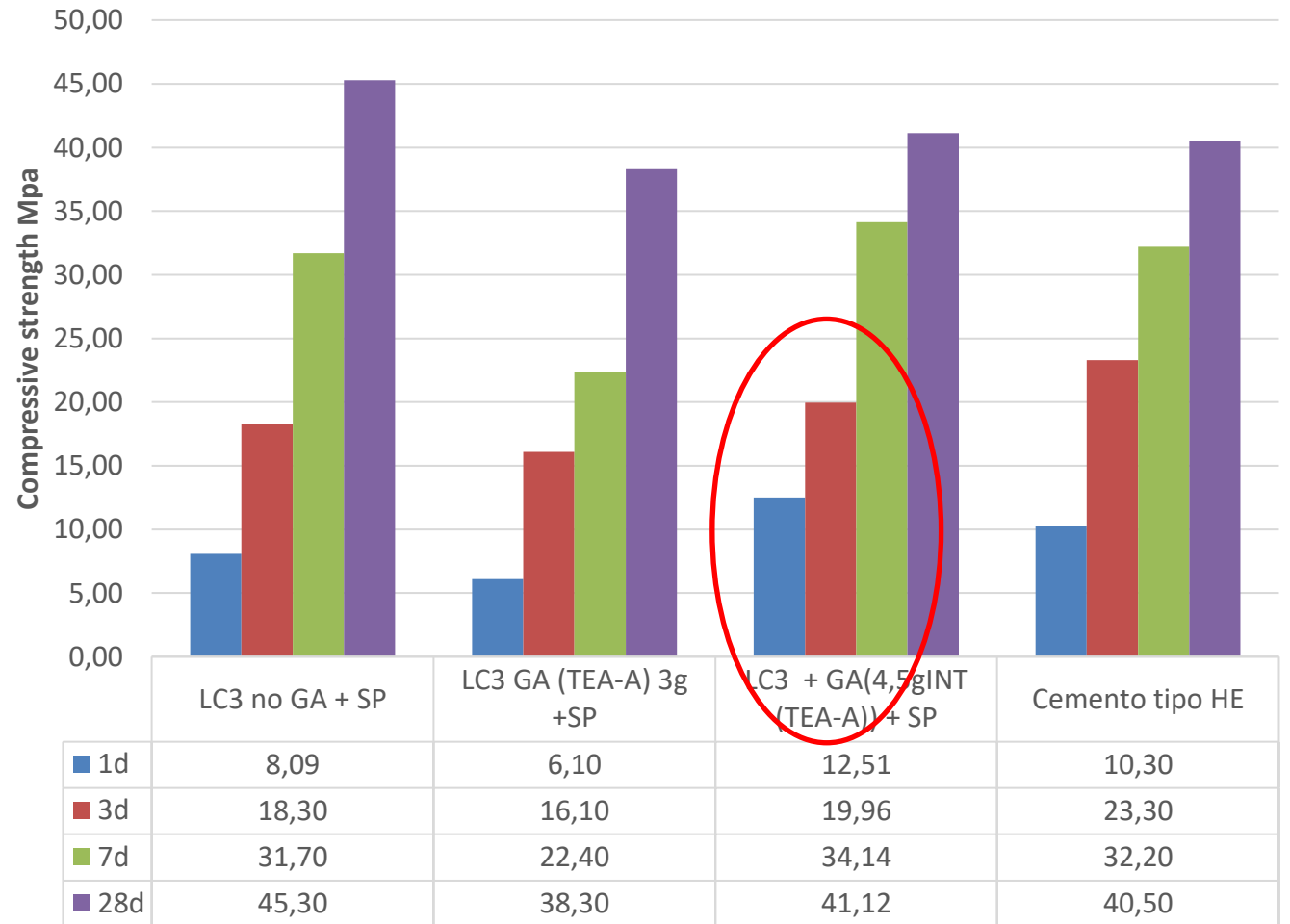
# Impact of grinding aids

NOTE: This test is a modification of the standard ASTM C109/109M which includes addingque incluye añadir SP to achieve a Flow that enables having a wáter to cement ratio similar to that of Portland cement

### Clinker content



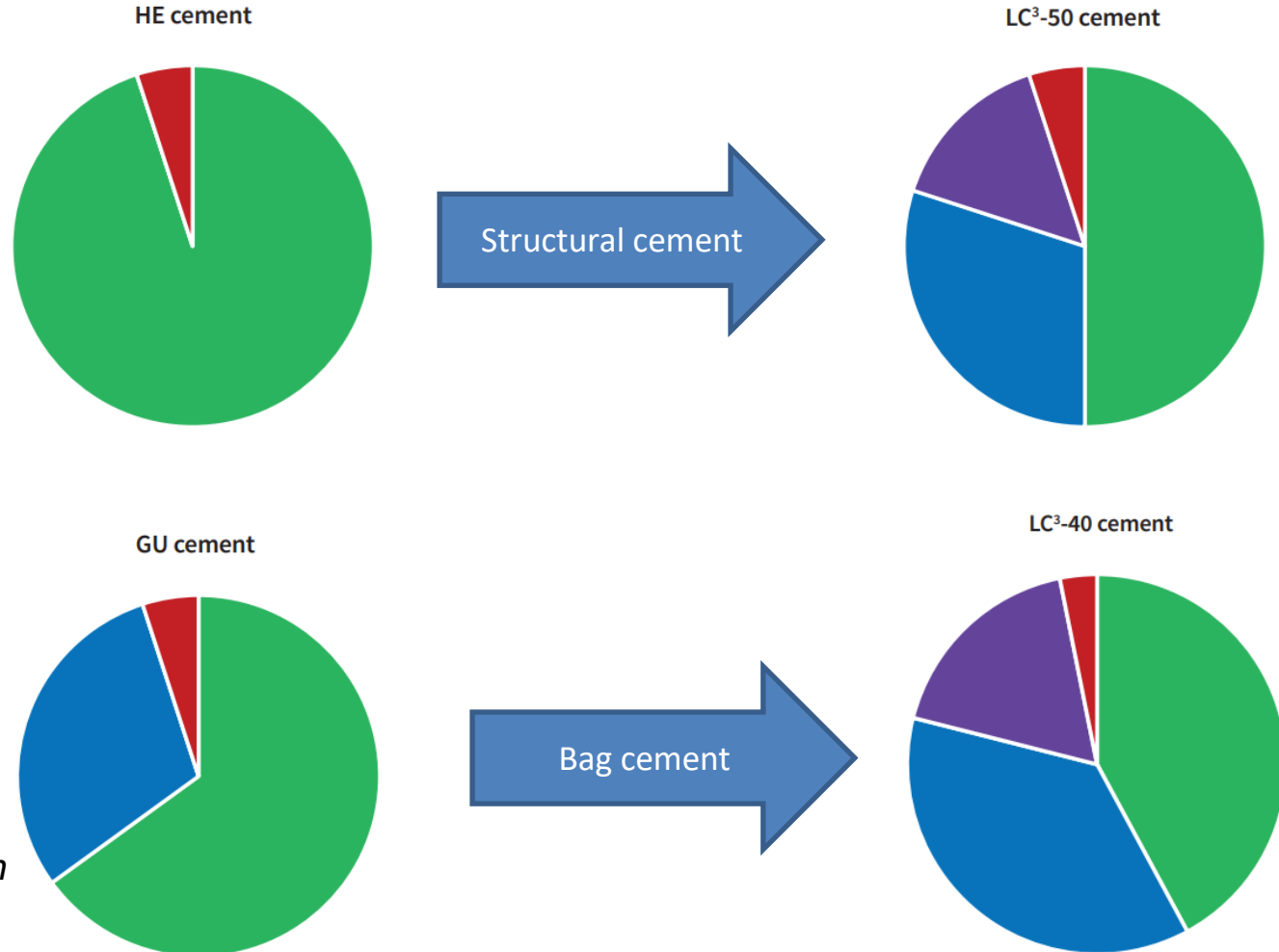
### Co-grinding



# Choices for LC3 formulation & use

# Choices

The comparison is made with real cements produced in Central America





# Potential cement formulations

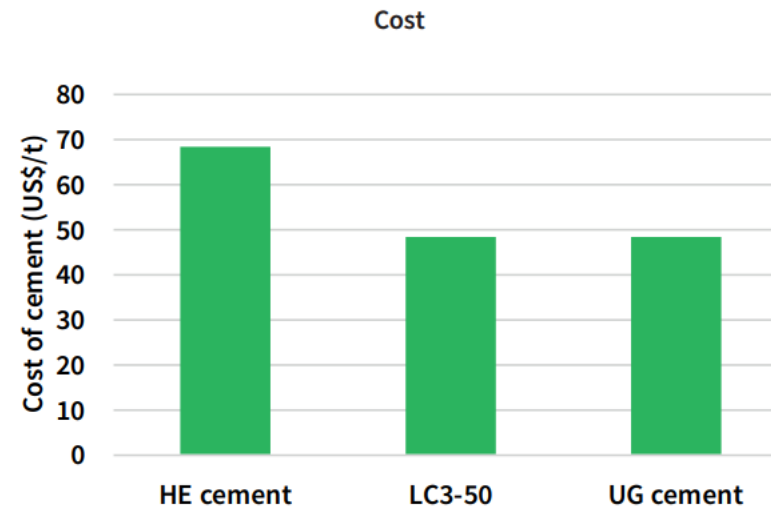
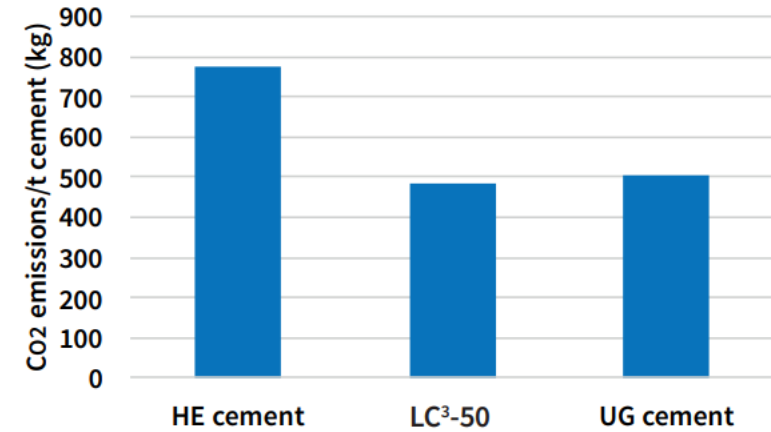
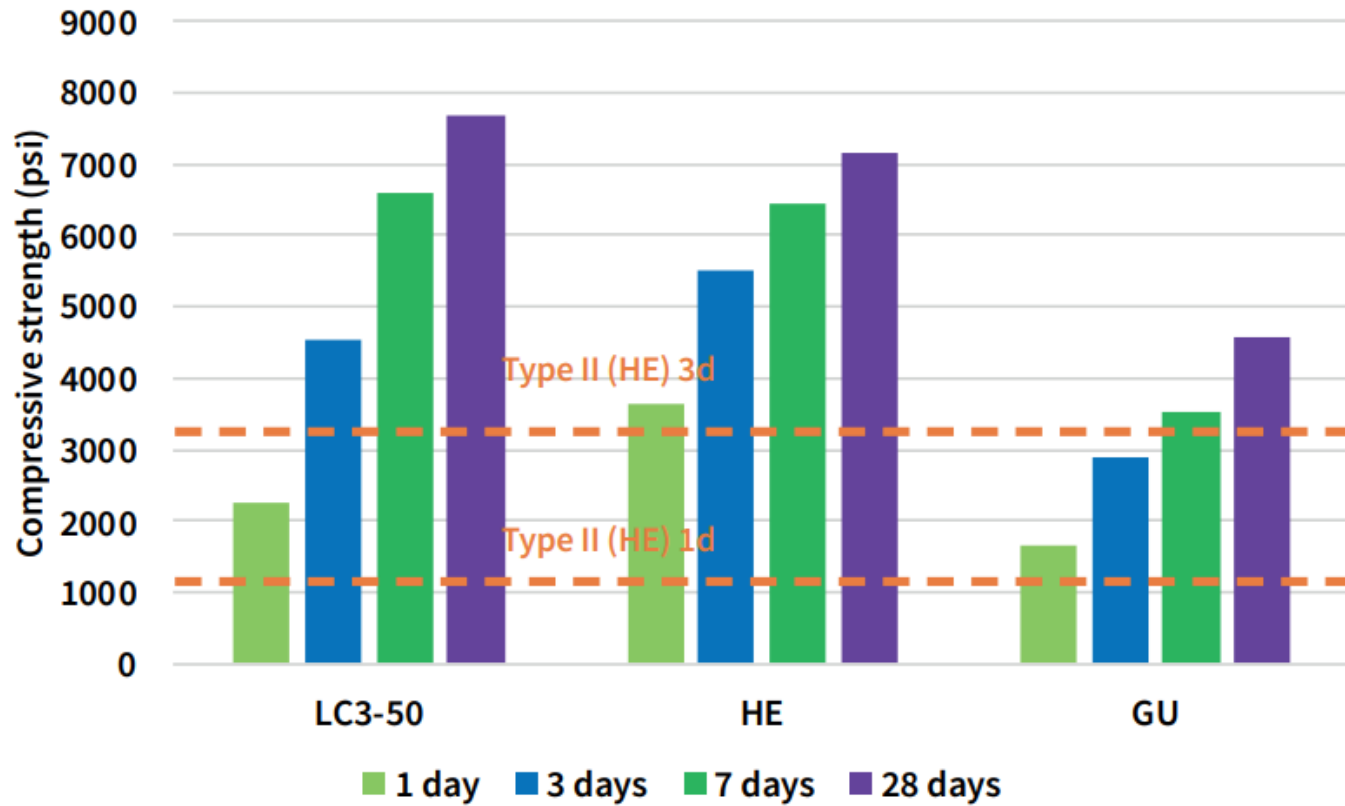
LC3-50 2:1: Structural cement, similar to CEM I 42,5, bulk, 50% Clinker, 30% calcined clay, 15% limestone and 5% gypsum



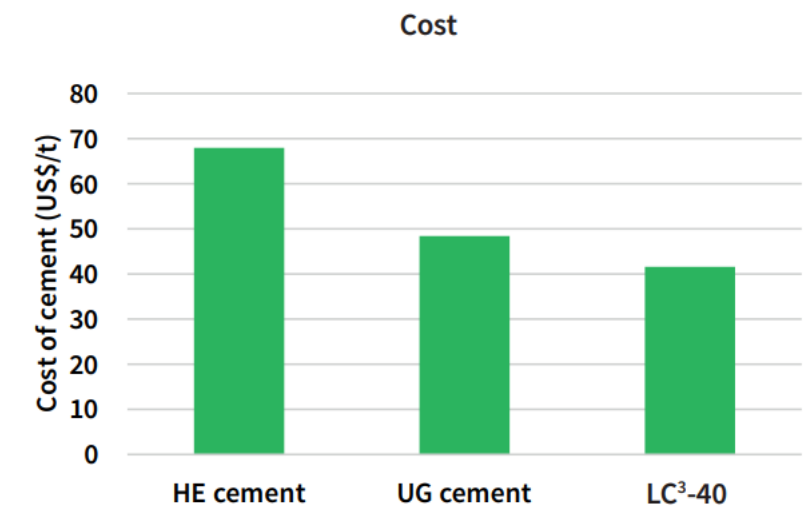
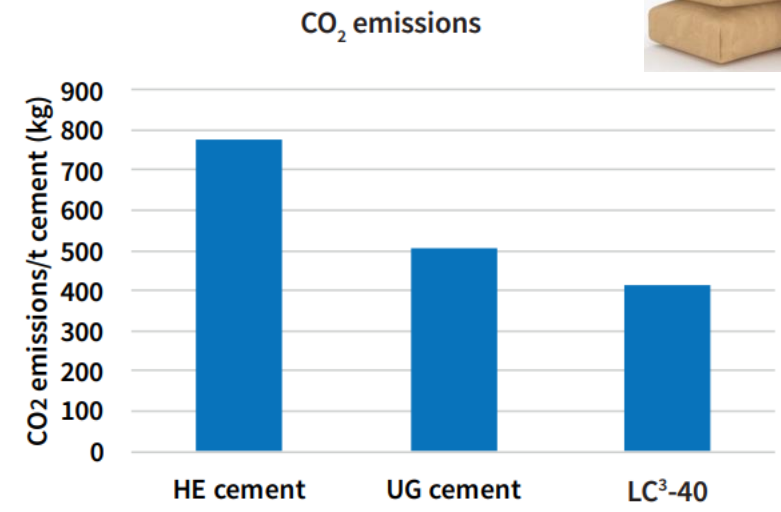
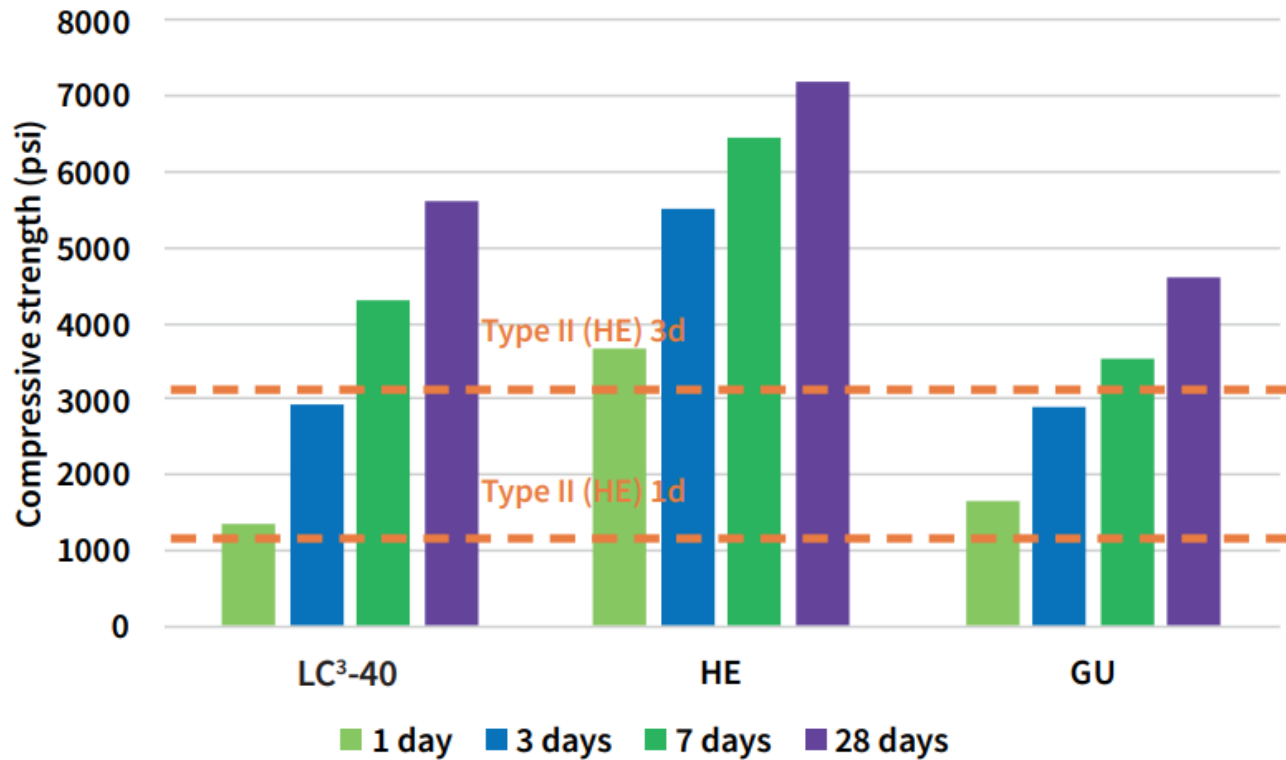
LC3-35 2:1\*: Bag cement of general use, 35% Clinker, 40% calcined clay, 20% limestone and 5% gypsum

*\*not currently approved within EN-197-5*

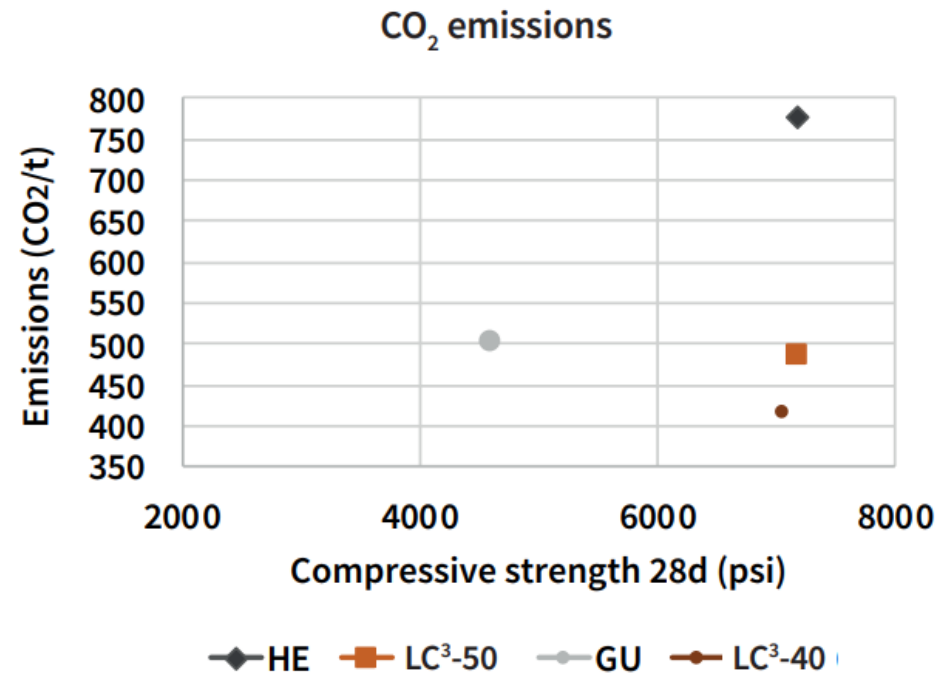
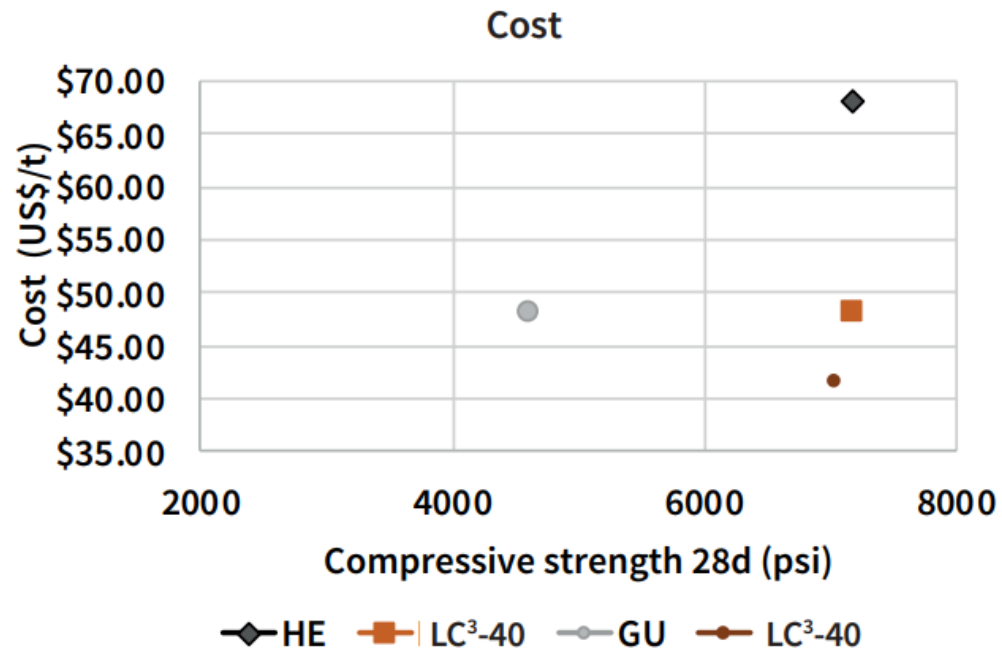
# Choices for LC3-50



# Choices for LC3-40



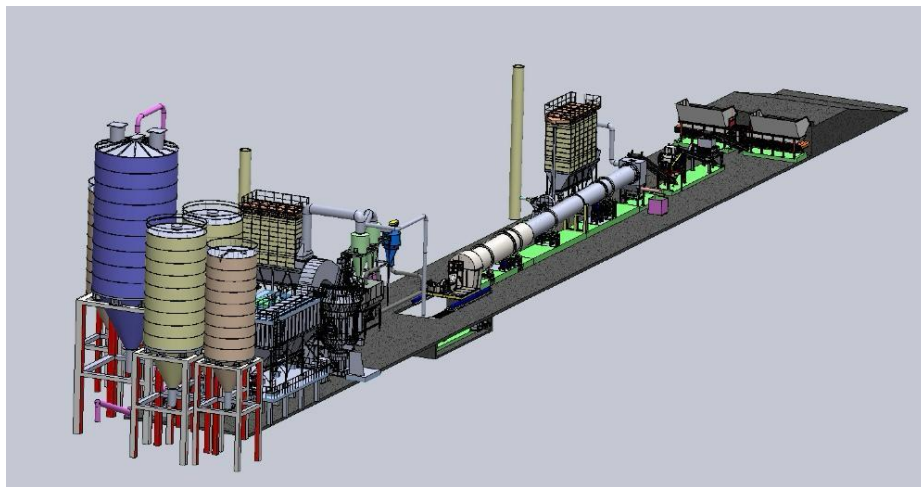
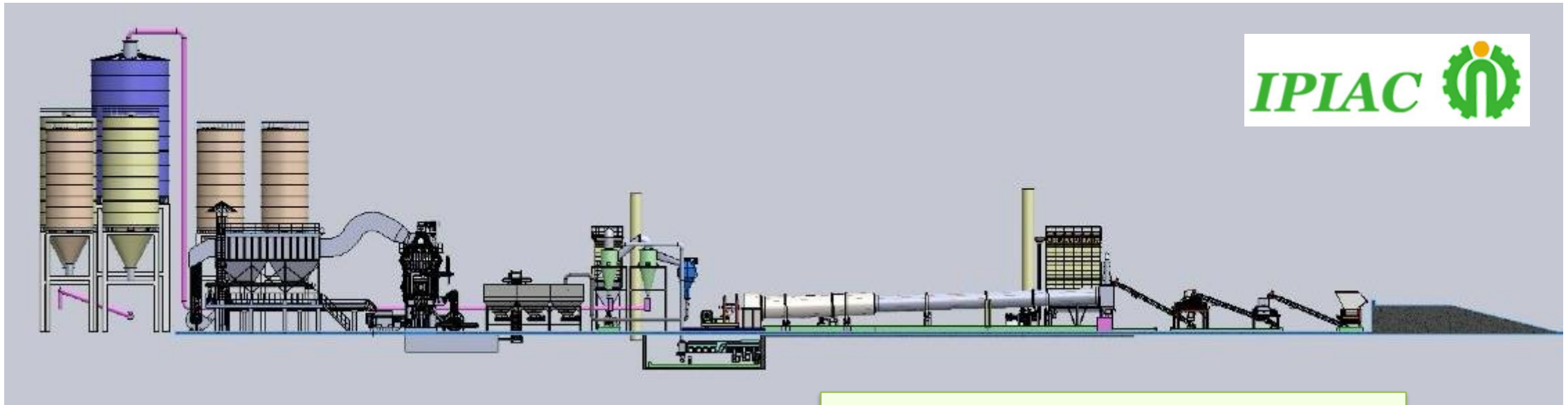
# LC3-50 vs. HE and LC3-40 vs GU



The imposition of a carbon tax could create incentives for the introduction of lower clinker cements

New emerging  
technologies  
*(the future)*

# Compact “Plug & clay” units



## Containerized LC3 plant

- 100 Ktpy calcined clay
- 300 Ktpy LC3 cement
- 520 kcal/kg calcined clay
- 25 kWh/ton calcined clay
- Cost around \$US 7 M

# Scenarios

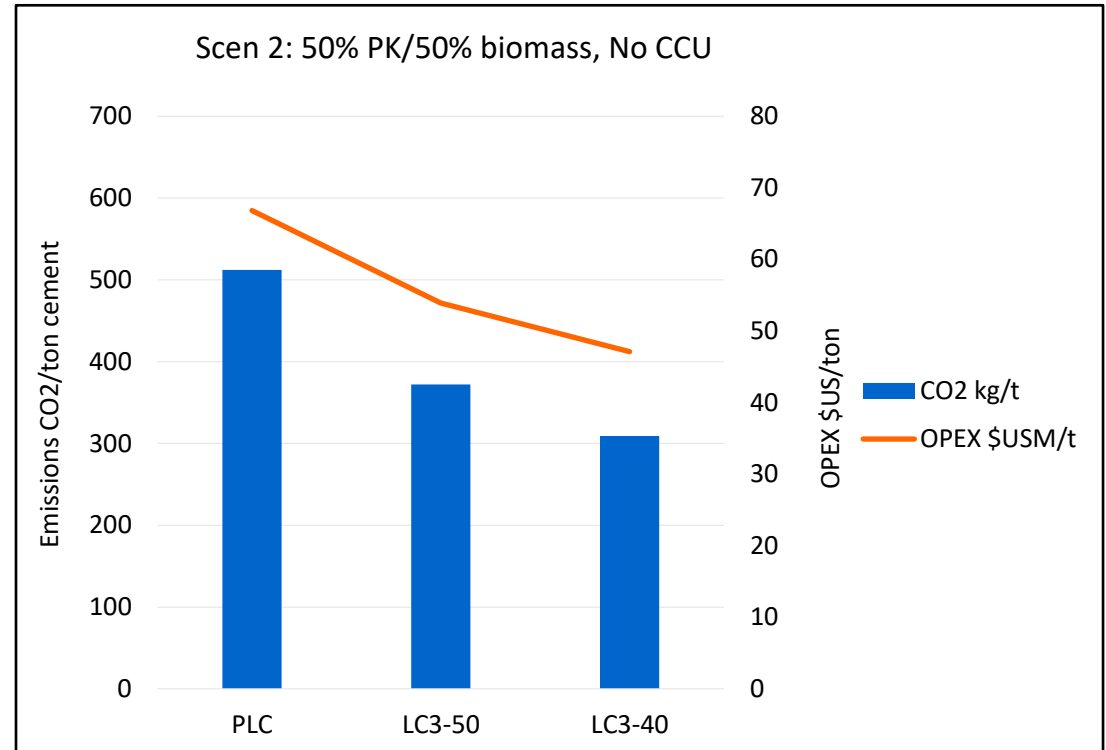
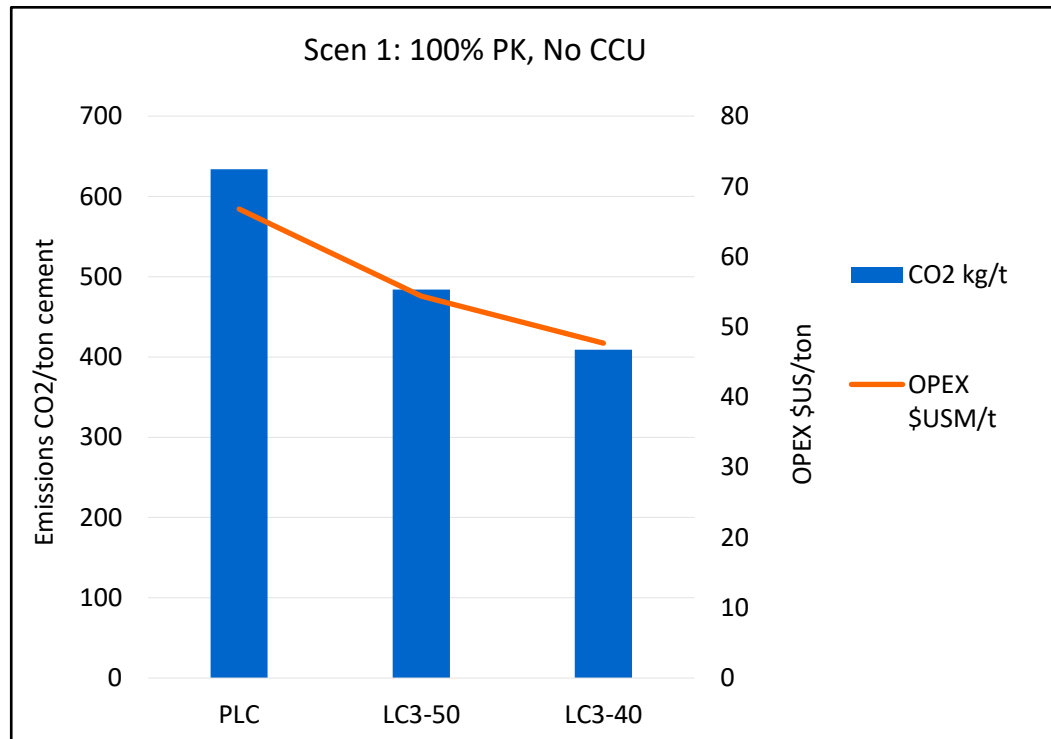
## **SCENARIO 1**

- Fuel: 100% petcoke
- Cement:
  - Portland Limestone (75% CLK)
  - LC3-50 (50% CLK)
  - LC3-40 (40% CLK)

## **SCENARIO 2**

- Fuel: 50% petcoke/50% gasified biomass
- Cement:
  - Portland Limestone (75% CLK)
  - LC3-50 (50% CLK)
  - LC3-40 (40% CLK)

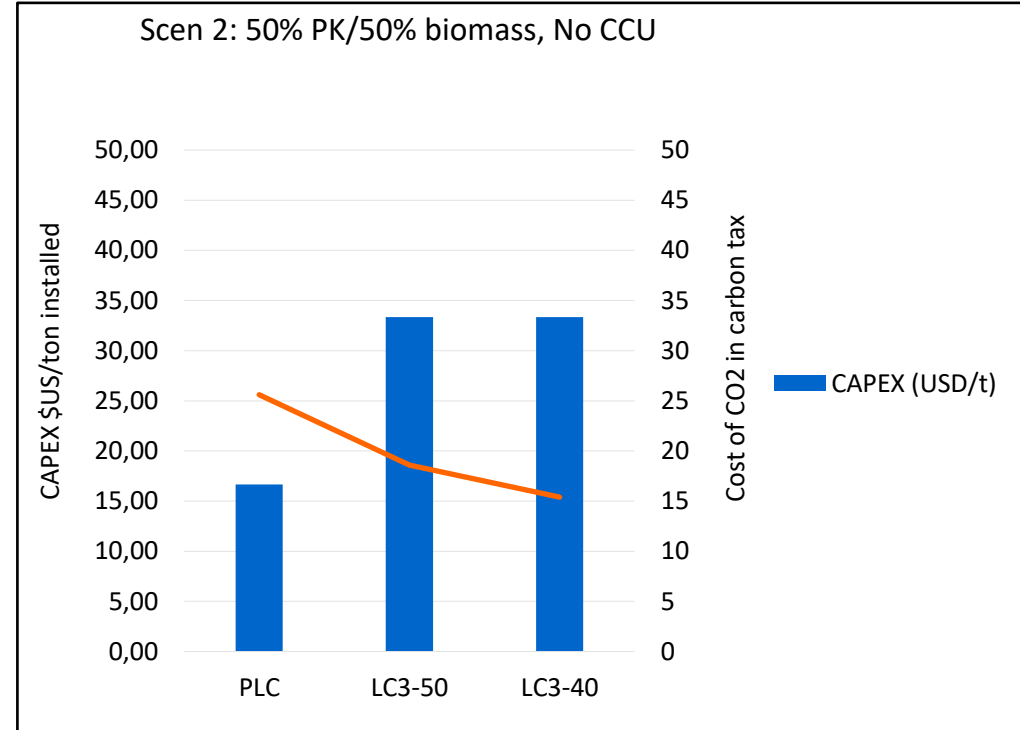
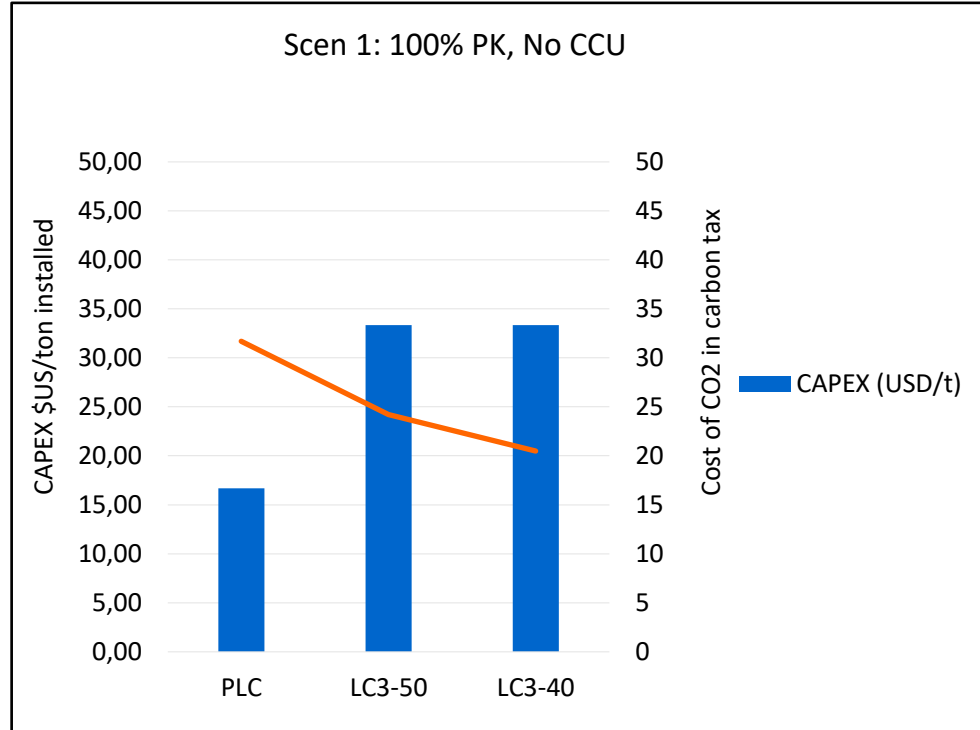
# CO2 emissions vs. OPEX



- LC3-50 reduces 25% CO2 emissions compared to PLC for similar performance (LC3-40 reduces 35% but poorer performance!!) in ALL scenarios
- 50% biomass as alternative fuel brings about decrease in 20-25% of CO2 emissions (for all cements)
- OPEX does not change significantly in all scenarios



# CAPEX vs Cost of CO2 (carbon tax)



- A 30% increase in CAPEX is foreseen if decarbonization measures are to be implemented
- The increase in CAPEX could be compensated by the decrease in the cost of paying carbon tax. This could offset most of the increase in CAPEX!

# Summary

- Combination of calcined clay and limestone is the path to clean cement production
- Very diverse tile of products for different actors
- Sound and cost effective technology available
- More than 40% reduction of CO<sub>2</sub> emissions!
- LC3 is spreading throughout the world!



Sinoma 中材国际



15-18 May 2024

# 4<sup>th</sup> International Conference on Calcined Clays for Sustainable Concrete

## ORGANIZER

The Chinese Ceramic Society

## CO-ORGANIZERS

Southeast University

Sinoma International Engineering Co., Ltd.

University of Jinan

Sobute New Materials Co., Ltd.



Nanjing  
China



# LC<sup>3</sup> Day Portugal

28 May 2024, in LNEC Lisbon

(LNEC - Laboratório Nacional de Engenharia Civil)

Avenida do Brasil 101, Building C 'Manuel Rocha' (Room 1), Lisbon, Portugal

## Objective

Leading experts in academia and industry will present the latest developments of cements containing calcined clays and limestone (LC<sup>3</sup>), with emphasis on the environmental and economic impact of the new material. The program will look closely at the Portuguese, European and West African markets and pinpoint opportunities for use of calcined clays to rapidly decarbonise the sector. You will hear from LC<sup>3</sup> Project experts, 'early adopters' – companies already producing LC<sup>3</sup> at industrial levels across the world – as well as equipment and admixture suppliers with first-hand experience using LC<sup>3</sup>. Register today and be part of the conversation of low-carbon cement LC<sup>3</sup>!

## Free registration

Here →



<https://docs.google.com/forms/> (...)

## More information

Here →



<https://lc3.ch/event/lc3-day-portugal/>

## Contact

lc3day@lneec.pt



# HANDS ON SEMINAR

»»» OCT 6TH-12TH, 2024



## Lectures

Clay survey  
Calcination and grinding  
Cement production  
Durability of LC<sup>3</sup> concrete



## Laboratory

LC<sup>3</sup> cement characterization and Field work at a clay deposit, sample collection and processing



## Calcination trial

Participation on a real clay calcination trial at the LC<sup>3</sup> Pilot Plant Ecosolutions



## Visit

Visit to the natural exposure site at Cayo Santa Maria



Register here  
[WWW.HANDSONREGISTER.COM](http://WWW.HANDSONREGISTER.COM)



# Thank you!!

José Fernando Martirena Hernández (Prof.  
Dr.Sc. Ing.)

Director CIDEM

Faculty of Constructions. Universidad Central  
de las Villas

e-mail:

[martirena@uclv.edu.cu](mailto:martirena@uclv.edu.cu)/[fmartirena@ecosur.org](mailto:fmartirena@ecosur.org)

skype: [@fmartirena@ecosur.org](https://www.skype.com/join/fmartirena)

Whatsup: +53 5 2637716 or +41 7 9710 2146

website: [www.ecosur.org](http://www.ecosur.org) / [www.lc3.ch](http://www.lc3.ch)  
[/www.ecosolutions.gl](http://www.ecosolutions.gl)

