Interreg North-West Europe SeRaMCo

European Regional Development Fund

EUROPEAN UNION

Mid-term conference

Luxembourg

28-29 November 2018

Use of recycled aggregates for cement production

UNIVERSITÉ DE LORRAINE

Romain TRAUCHESSEC
Hichem KROUR
Cécile DILIBERTO
André LECOMTE

VICAT

Laury BARNES-DAVIN
Breffni BOLZE
Arnaud DELHAY

Interreg North-West Europe SeRaMCo

European Regional Development Fund

Outline

Introduction

I. Context and problematics

II. Laboratory experiments

III. Industrial trial

Conclusion

Introduction

Recycled concrete and mixed aggregates can:

- have high porosity (water absorption),

- contain impurities: bricks, plaster, etc. (soluble sulfate, methylene blue value, etc.).

If not used for concrete or road construction, landfilling ?

→ Valorization of these materials as cement raw meal.

Natural materials (limestones, marls, clays)

+

Recycled aggregate (cement paste, sand, bricks, ceramics, etc.)

1450°C →

Portland cement

Interreg North-West Europe SeRaMCo

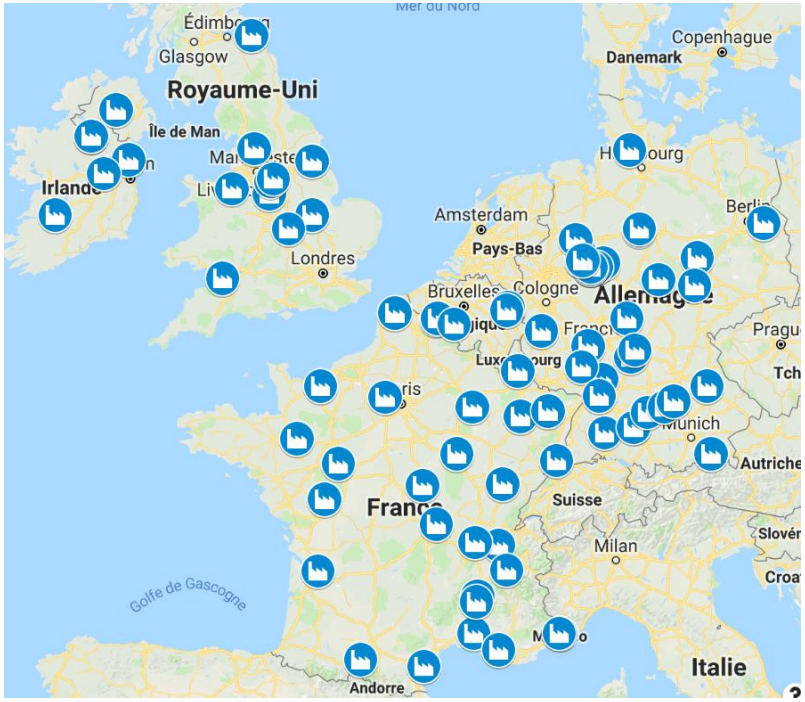
EUROPEAN UNION

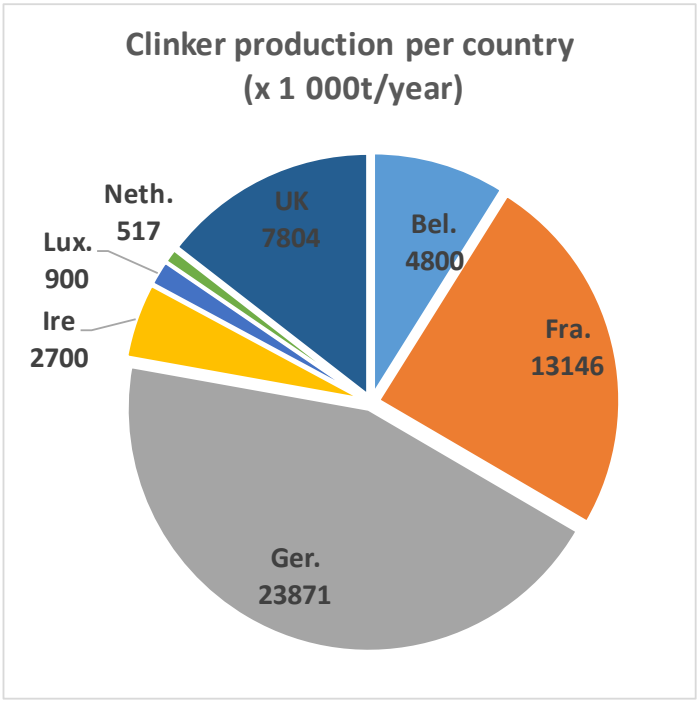
European Regional Development Fund

I. Context and problematics

Cement plants with kiln(s)
(82 plants in the countries of the NEW).

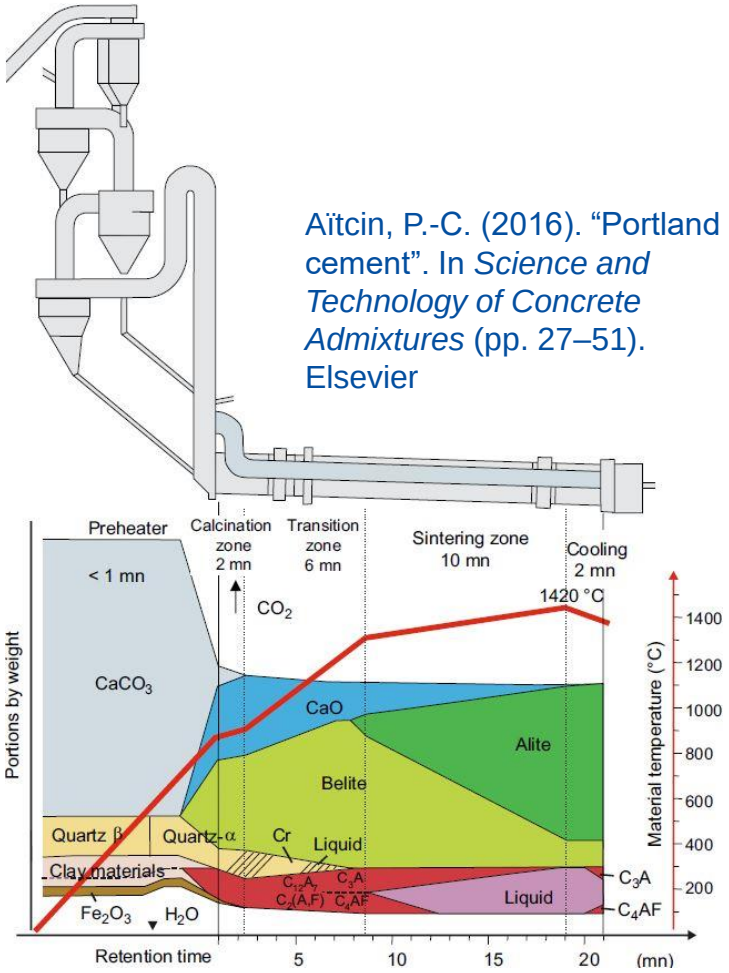
Quantity of clinker produced
(54 millions of tons per year).





I. Context and problematics

- Raw meal (clays-limestone) must be adjusted.
- High temperature process.



Aïtcin, P.-C. (2016). "Portland cement". In *Science and Technology of Concrete Admixtures* (pp. 27–51). Elsevier

- Recycled aggregate addition is possible : first trials during the **French National Projet Recybéton**.

I. Context and problematics

- Recycled aggregates variability (mixed aggregate ?).
- Effect of incorporation on burnability.
- Recycled cement durability.
- Industrial process.

Interreg North-West Europe SeRaMCo

European Regional Development Fund

II. Laboratory experiments (variability)

Interreg
North-West Europe
SeRaMCo
European Regional Development Fund
EUROPEAN UNION

II. Laboratory experiments (variability)

Interreg North-West Europe SeRaMCo
EUROPEAN UNION
European Regional Development Fund

II. Laboratory experiments (variability)

- Recycled aggregates contain mainly calcite and quartz but in variable proportions.

- High silica, magnesium, sulfate or alkalis contents can limit the incorporation rate.

- **Mixed aggregates** are harder to incorporate (more silica).

- For 74% of the 34 RA (analyzed or found in the literature), the maximum incorporation rate can reach 10-20%.

→ These proportions depend on the cement plant quarry, the type of cement produced and the recycled aggregates. In practice, ≈ 5% of incorporation rate is a realistic proportion.

Interreg North-West Europe SeRaMCo

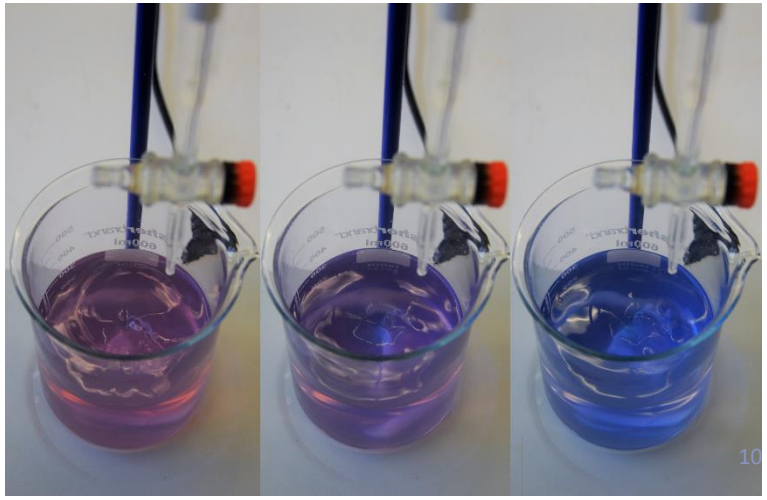
EUROPEAN UNION

European Regional Development Fund

II. Laboratory experiments (burnability)

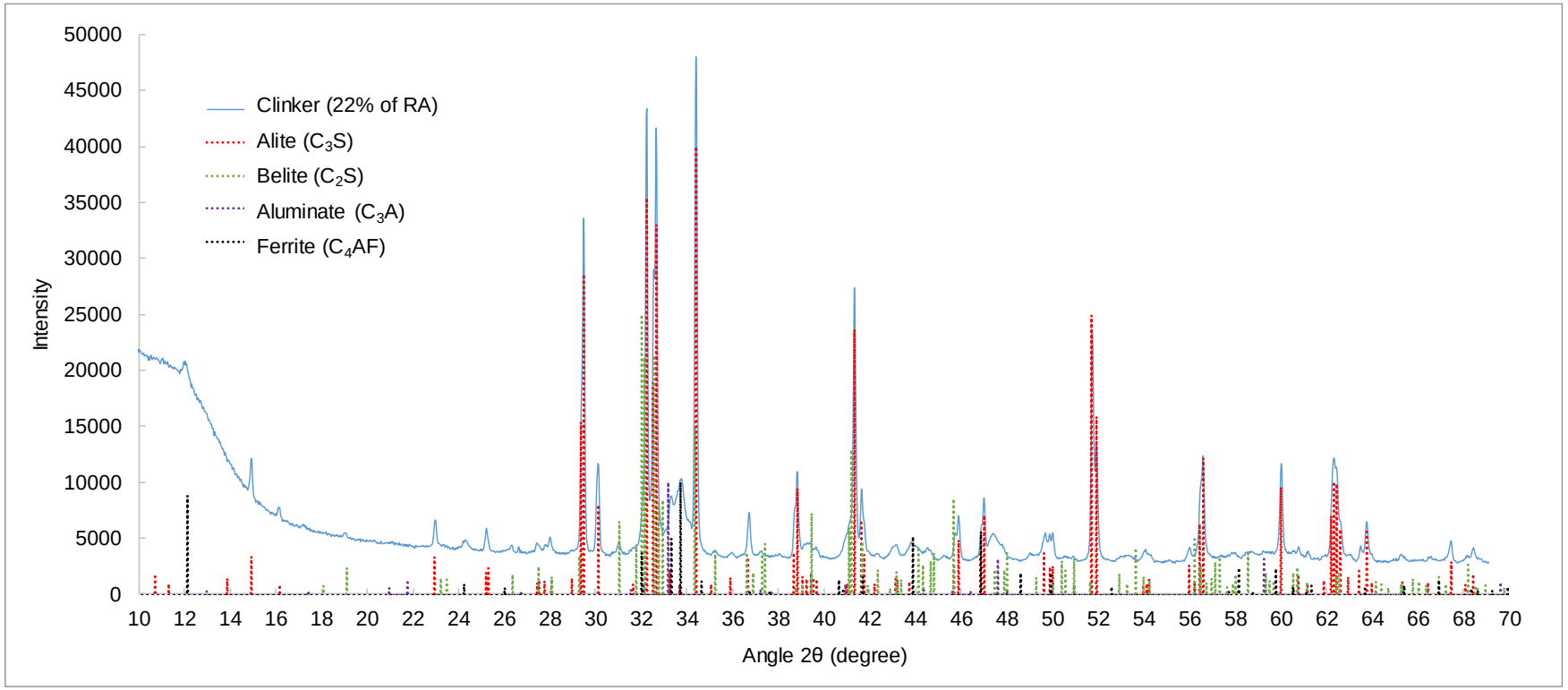
Laboratory synthesis of clinker with 5 different recycled aggregates.

Free lime measurements = raw meal burnability.



II. Laboratory experiments (properties)

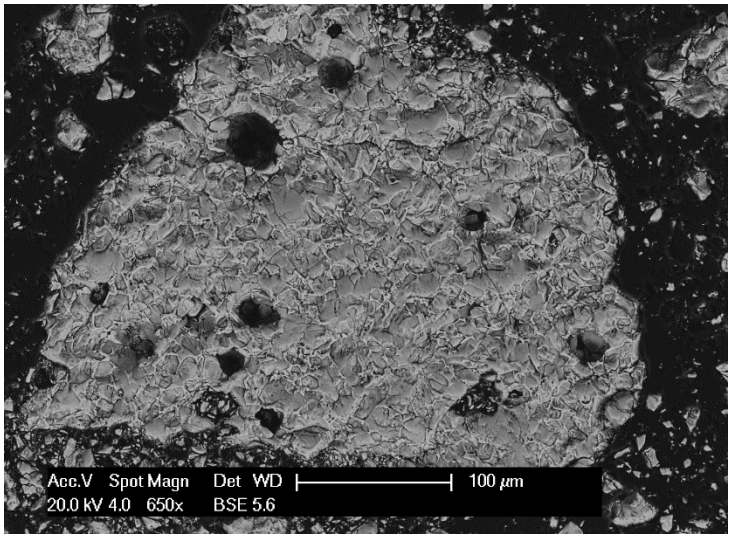
Clinker (22% of RA) mineralogical composition

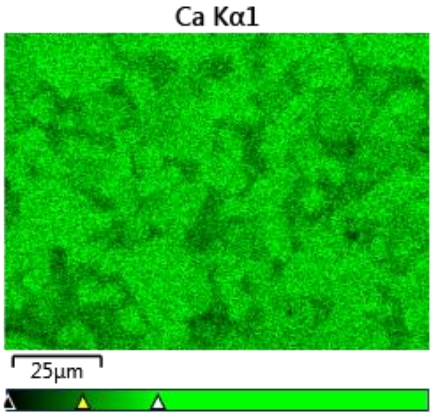


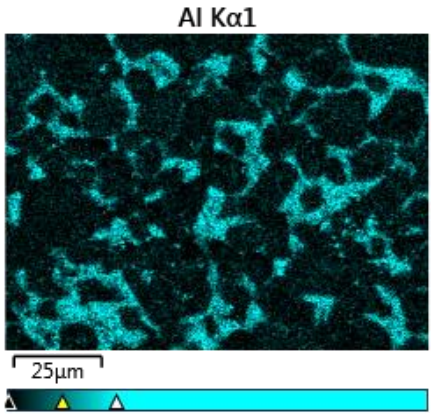
Interreg
North-West Europe
SeRaMCo
European Regional Development Fund

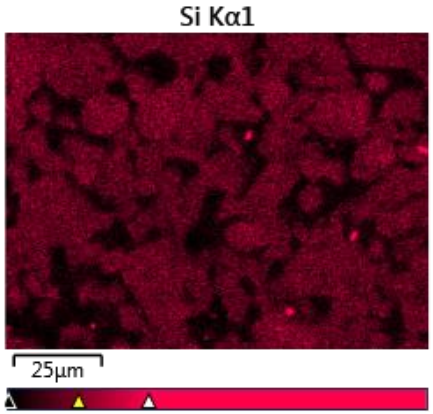
EUROPEAN UNION

II. Laboratory experiments (properties)

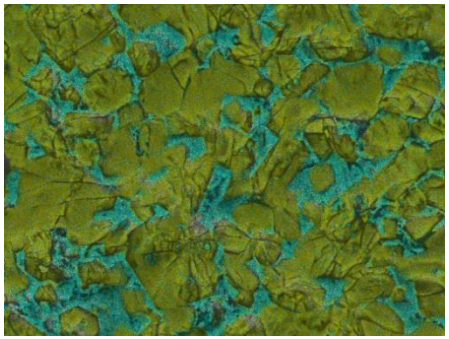


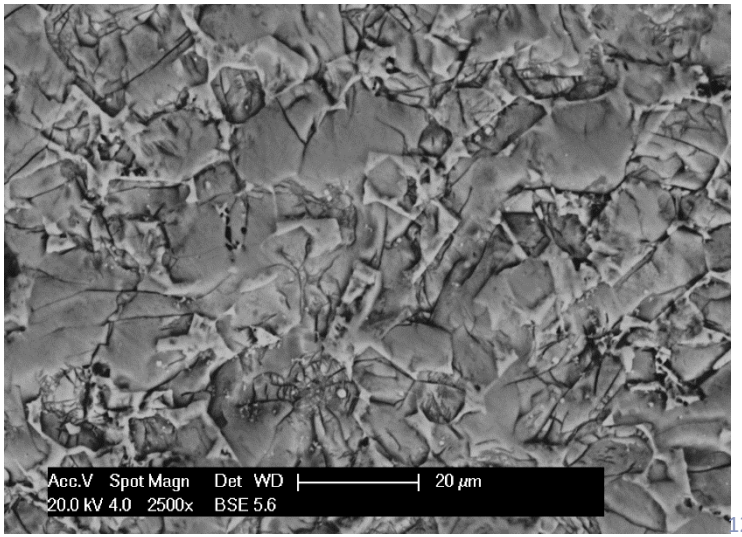






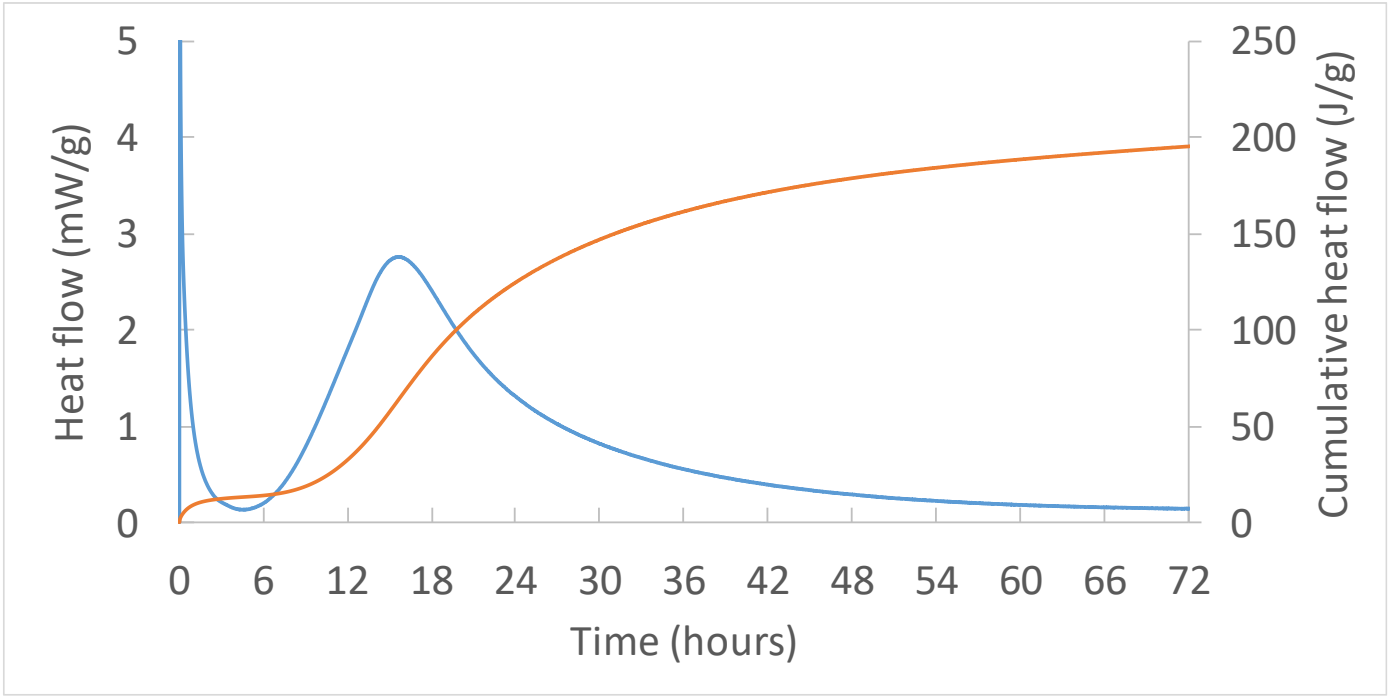
Al (blue) + Si (yellow)





II. Laboratory experiments (reactivity)

Clinker hydration heat (22% of RA)



→ The characterizations of the clinkers (composition and reactivity) are ongoing.

III. Industrial trial

VICAT cement plant in Créchy, France

Interreg North-West Europe
EUROPEAN UNION
SeRaMCo
European Regional Development Fund

III. Industrial trial (Créchy cement plant)

Last cement plant greenfield in France

Built in 1968

Leader in reducing the consumption of fossil fuel

> 80% of the energy needed for the burning is produced thanks to alternative fuel

70 workers

Open 24/7

2018 Innovation
Commisioning of a gasifier

A world first!!!

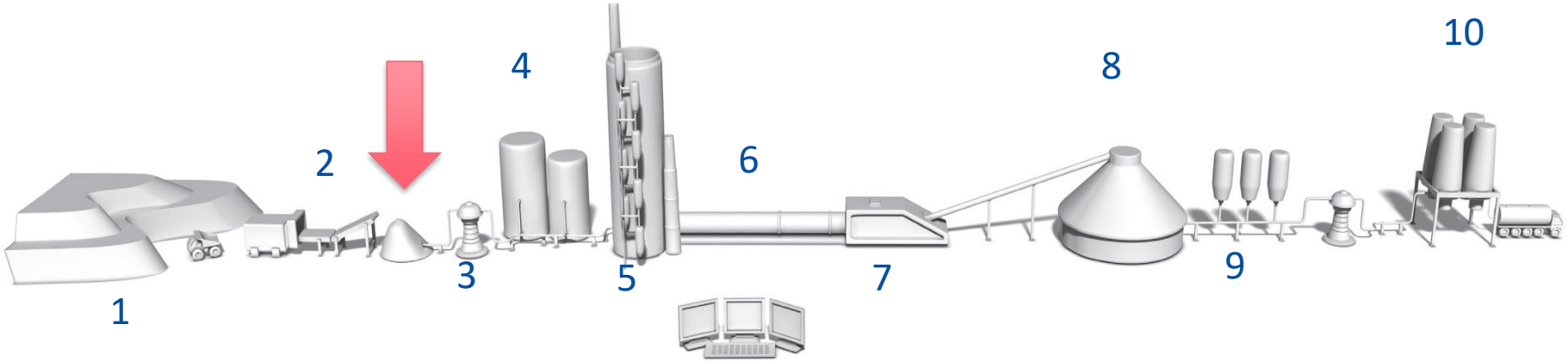
Raw material substitution :

The plant is substituing
10% of natural ressources
(limestone and marl) thanks to the valorisation of mineral by-products coming from other industries

VICAT CIRCULère

Interreg
North-West Europe
SeRaMCo
European Regional Development Fund

EUROPEAN UNION



- 1: Quarry
- 2: Pre-homogenisation pile
- 3: Raw feed mill
- 4: Storage
- 5: Pre-heater Tower
- 6: Kiln
- 7: Cooling
- 8: Storage
- 9: Cement mill
- 10: Storage, packing, loading

Interreg
North-West Europe
EUROPEAN UNION

VICAT cement plant in Créchy, France

Interreg
North-West Europe
SeRaMCo
European Regional Development Fund

- Sampling of crushed concrete
  - Chemical characterization
  - Adjustment of the raw mix to reach production/quality targets
  - 150 t produced by TRADECOWALL (Belgium) and 600 t produced by AGGREGATS DU CENTRE (France)

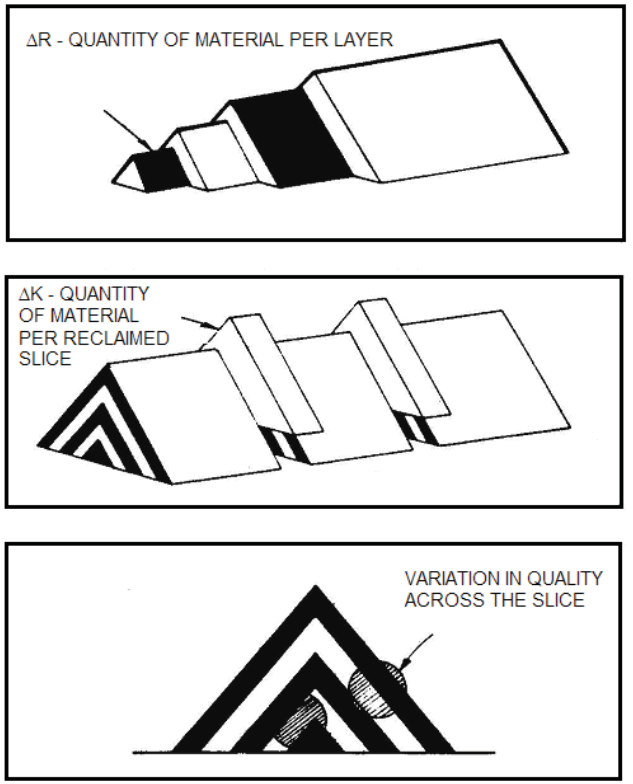
Interreg North-West Europe SeRaMCo

EUROPEAN UNION

European Regional Development Fund

- Stacking of raw material including 15% demolition concrete sand and gravel

➢ Pre-homogenisation



Costa et al, Jan 07 Reserchgate

Interreg North-West Europe SeRaMCo

- Milling of the pre-homogenisation pile
- ➢ Final adjustment of the chemistry by adding bauxite and iron oxide
- ➢ Storage and homogenisation of the raw feed
- Firing of the raw feed

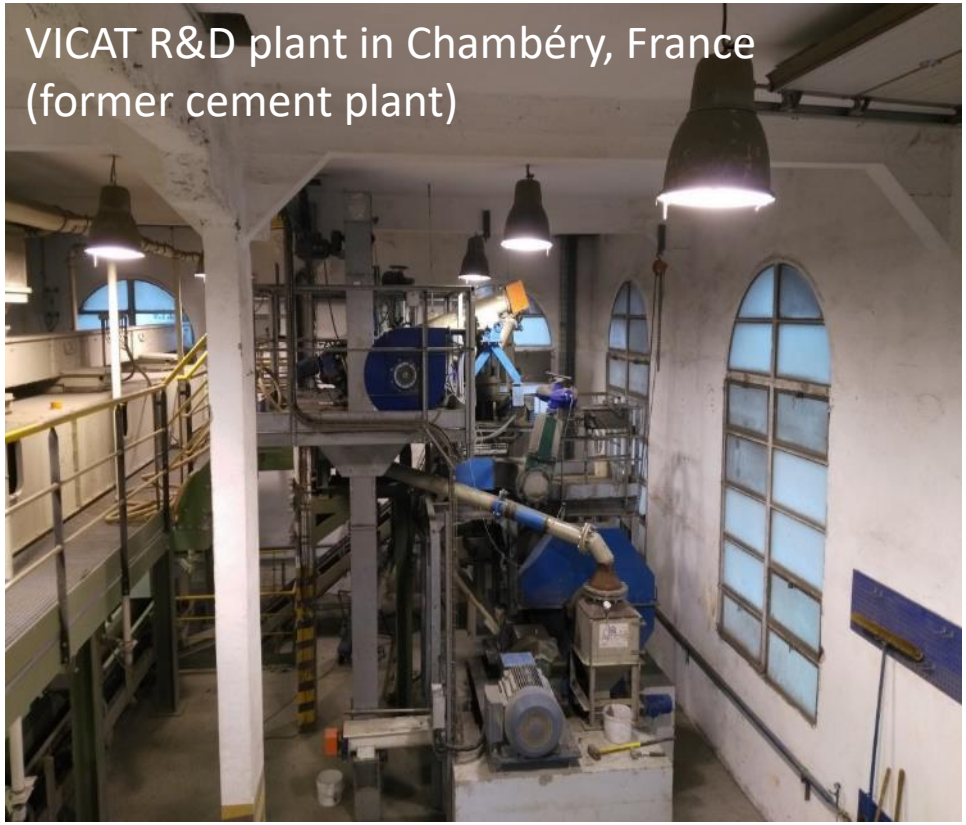
Interreg
North-West Europe
SeRaMCo
European Regional Development Fund

- Production of 3 000t of clinker
- Storage in Créchy before transfer to R&D pilot center in Chambéry

Interreg North-West Europe SeRaMCo

EUROPEAN UNION

European Regional Development Fund



- R&D ball mill pilot
  - 1t/h
  - Same sulfate source and content
  - Comparable fineness: measurement of Blaine fineness and PSD
- Production of 5T of cements :
  - 2 RCA containing cements :
    - CEM I 52,5 N
    - CEM II 42,5 N LL
  - 2 Reference cements :
    - CEM I 52,5 N
    - CEM II 42,5 N LL

Interreg
North-West Europe
SeRaMCo
European Regional Development Fund

- Currently :
  - Chemical, mineralogical and physical characterisation of the cements
  - dispatch to partners who asked for cement samples

Interreg
EUROPEAN UNION
North-West Europe
SeRaMCo

Thanks for your attention!

Questions?