Use of recycled aggregates for cement production
Introduction

I. Context and problematics

II. Laboratory experiments

III. Industrial trial

Conclusion
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) + 1450°C → Portland cement

Recycled aggregate (cement paste, sand, bricks, ceramics, etc.)
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).
Recycled aggregate addition is possible: first trials during the French National Projet Recybéton.

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

- Raw meal (clays-limestone) must be adjusted.
- High temperature process.
- 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.
II. Laboratory experiments (variability)
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.
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
II. Laboratory experiments (properties)

Al (blue) + Si (yellow)
II. Laboratory experiments (reactivity)

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

Clinker hydration heat (22% of RA)
III. Industrial trial

VICAT cement plant in Créchy, France
Interreg North-West Europe SeRaMCo

Leader in reducing the consumption of fossil fuel

70 workers
Open 24/7

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

Built in 1968

Last cement plant greenfield in France

2018 Innovation Commisioning of a gasifier

A world first!!!

III. Industrial trial (Créchy cement plant)

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
• 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
VICAT cement plant in Créchy, France
• 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)
• Stacking of raw material including 15% demolition concrete sand and gravel

➢ Pre-homogenisation

Costa et al, Jan 07 Researchgate
• 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
• Production of 3 000t of clinker
• Storage in Créchy before transfer to R&D pilot center in Chambéry
• 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
• Currently:
  ➢ Chemical, mineralogical and physical characterisation of the cements
  ➢ dispatch to partners who asked for cement samples
Thanks for your attention!