Valorization of construction, demolition and industrial waste, a route to circular economy

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Building and construction sector:
- more than 1/3 of global resource consumption
- generation of solid waste: 40% of the total waste volume
- EU: CDW = largest waste stream (1/3 of all EU waste)

CDW (Construction & Demolition Waste): mostly not recycled

Causes:
- heterogeneity
- dispersion
- economic viability
- (policy / inconsistencies, discrepancies)

Necessity to improve resource efficiency and management, and waste valorization

⇒ Research projects: Ecoliser, Valdem
ECOLISER

► ÉCOliants pour traitement de Sols, Etanchéité et Routes
  ► Start 01.01.2016
  ► Duration 6 years (2016-2022)

Programme FEDER 2014 - 2020

Budget total: 5,018,944 €
- FEDER: 40%
- WALLONIE: 39%
- OPÉRATEURS PUBLICS: 21%

4th FNRS-LCA Meeting
Mechanical reinforcement of soils implies the addition of lime or hydraulic binders (large amounts of energy and resources).

The ECOLISER project aims to develop eco-friendly binders based on industrial by-products or secondary materials (slag, bottom ash, blast furnace ash, glass fine, fly ash from thermal power plant and biomass, ...).

The ECOLISER project thus aims:

- to minimize the impact of human activity on the environment in the Walloon region (industrial sector)
- to meet the needs of rehabilitation and development of brownfield sites into zonings for new industries
- to contribute to the sustainable management of natural resources (and limit the landfill of industrial by-products)

Three types of alternative ecoliants are targeted:

- for the improvement and mechanical stabilization of (non polluted) soils
- for soil sealing and tightness, and in particular the installation of reactive waterproofing barriers to fix heavy metals and micropollutants from percolating water (reduction of the risks of pollutant remobilization)
- for the production of cohesive materials for road infrastructure
VALDEM project aims to improve demolition waste treatment to reach a circular economy in North of France and Wallonia (BE)

http://www.valdem-interreg.eu/
Life Cycle Management - scope

- **Residential buildings**
  - Dismantling then demolishing
  - Sorting on site
  - Storage platform

- **Commercial and industrial buildings**
  - Demolishing quality +
  - Demolishing quality -

**Types of buildings (upstream)**

**Demolishing/dismantling practices**

**Downstream**

<table>
<thead>
<tr>
<th>Flow</th>
<th>Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete + brick</td>
<td>Mixing</td>
</tr>
<tr>
<td>Concrete + plaster</td>
<td>Plaster</td>
</tr>
<tr>
<td>Concrete fines + brick</td>
<td>Fines + mixing</td>
</tr>
<tr>
<td>Concrete fines + brick + soil</td>
<td>Fines + mixing + soil</td>
</tr>
</tbody>
</table>

⇒ sorting, separation (density, jig)

⇒ brick, reexcavable self-compacting materials (MAR)
Life Cycle Management: co-supervised thesis (ULiège – IMT)

Charlotte COLEMAN:
Gypsum residues in recycled materials: effects on microstructural and mechanical properties of cementitious mixes

Mohamed El Karim BOUARROUDJ:
Design and properties of self-compacting concrete based on fine recycled particles

Adèle GRELLIER:
Valorization of recycled fine particles of silicates materials: development of hydraulic binders
Recycling of production waste of concrete blocks

CONREPAD – BEWARE fellowships

- Pr Luc Courard, Dr Ir Zengfeng Zhao (ULiège – GeMMe)
- PREFER company (Flémalle/Engis, BE)
- Production of concrete blocks with recycled concrete aggregates (RCA) from production waste
- Block BD14292: 29 x 14 x 19 cm, with 2 holes
- 30% RCA: properties ok → feasibility validated
- Comparative LCA: concrete blocks without and with 30% RCA
- cradle to gate, FU = 1 m³ of blocks
System boundaries

1. Natural aggregate only (B_RCA0)

2. 30% RCA (B_RCA30)

Mobile crusher Metso LT12113
250 t/h - 115 m³/h ; 1x /year
(on-site storage of waste)
Inventory

1. Composition of blocks (kg for 1 m³ ≈ 2,170 kg)

<table>
<thead>
<tr>
<th>Material</th>
<th>B_RCA0 (0%)</th>
<th>B_RCA30 (30%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural aggregate CC 2/7</td>
<td>1010</td>
<td>707</td>
</tr>
<tr>
<td><strong>Recycled concrete aggregate 2/7</strong></td>
<td>0</td>
<td>282</td>
</tr>
<tr>
<td>Natural river sand NA 0/2</td>
<td>822</td>
<td>822</td>
</tr>
<tr>
<td>Yellow sand</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>Cement CEM III/A</td>
<td>175</td>
<td>175</td>
</tr>
<tr>
<td>Water</td>
<td>41.3</td>
<td>55</td>
</tr>
</tbody>
</table>

2. Production

- 101,500 m³/year
- Waste: 1% → 1,015 m³/year (2,202,550 kg)
- RCA 2/6.3 availability: 805,015 kg/year → 2,855 m³ of B_RCA30 ~ 3 % of the annual production of blocks only
- To be completed with B_RCA0 (98,645 m³): ⇒ "mixed" production of RCA0 (97%) and RCA30 (3%)
LCA Results – B_RCA0 vs Mixed prod.

Simapro 8.5; Ecoinvent 3.4; ILCD 2011 Midpoint+ (1.10)
LCA Results – B_RCA0

Impact of each step expressed as % of the total impact in each category

(No CF for "Gravel")
LCA Results – B_RCA0 vs B_RCA30

Valdem: valorization of CDW

CDW sorting site of Eloy Construction (Sprimont) → RCA
⇒ Import of RCA 2/6.3 from Richopré quarry (Chanxhe, 25 km)
⇒ 100% B_RCA30 (instead of mixed production)

Impact of each scenario expressed as % of the "worst" result (=100%)
Conclusions

• Very little waste blocks (1%) \(\Rightarrow\) B_RCA30 can represent only 3% of the annual production of PREFER

• Impacts (in all categories) due mainly to cement, not to (natural) aggregates

\[\Rightarrow\] Very limited benefits (not significant) from the internal recycling of waste blocks

• But higher benefits (land use) if import of RCA from a nearby CDW sorting site (external recycling) \(\Rightarrow\) B_RCA30

• To confirm from a financial (and a technical) point of view

• RECYBETON (FR): use of "sand" (0/2 mm) in clinker ? (up to 15%)
Take home message

- Globally, and in a circular economy perspective, internal recycling of waste blocks at PREFER is a good idea!

- Especially if internal recycling is completed with RCA from a local external source of CDW
Thank You!