VALDEM PROJECT: FROM LCA OF DEMOLITION WASTE TO CIRCULAR ECONOMY OF BUILDINGS

Sylvie Groslambert (ULiège, Chemical Engineering, BE) with the cooperation of the cd2e
s.groslambert@uliege.be
Context:

- 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)
VALDEM project: objectives

VALDEM aims to improve demolition waste treatment to reach a circular economy in North of France and Wallonia (BE):

- Identify waste flow and create new recycling sector
  - Optimize building EoL management: new deconstruction, sorting and recycling processes
  - Increase recycling
  - Generate high quality secondary materials (up-cycling)

- Validate the approach by using Life Cycle Assessment

- Demonstrate the transferability of the results to industries

- Conduct a monitoring of regulations and highlight opportunities
VALDEM project: scope

General information:
http://www.valdem-interreg.eu/

Co-founders:

[Diagram showing geographical area and budget details]
VALDEM project: partnership

Life Cycle Assessment (MT3 – A4)

Coordination & legislative survey

Mineral Processing applied to C&DW

Valorization in materials with technical, economical, environmental validation

member of EMRA

member of EMRA

member of EMRA

member of EMRA
Life Cycle Management: detailed scope

- **Types of buildings (upstream)**
  - Residential buildings
  - Commercial and industrial buildings

- **Demolishing/dismantling practices**
  - Dismantling then demolishing
    - Demolishing quality +
    - Storage platform
  - Sorting on site

- **Downstream**
  - Concrete + brick
    - Mixing
  - Concrete + plaster
    - Plaster
  - Concrete fines + brick
    - Fines + mixing
  - Concrete fines + brick + soil
    - Fines + mixing + soil
  - …
  - …

⇒ 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
Life Cycle Management: concrete actions

Identify hot spots and key aspects → meta-analysis
- waste inventory (recycling parks)
- potential waste flows (regional data)

Comparative LCA:
- technical information from consortium partners
- evaluation of benefits and impacts of proposed solutions
- limit impact transfer to generate the maximum value for the stakeholders

Transfer of results to the main actors (recycling operators, building contractors, product manufacturers, policy ...) in the 3 regions
Life Cycle Management: outputs

Bring scientific and concrete elements (based on data from the ground and at macro-level) on how recycling of CDW can improve environmental impact of buildings along their life (current and future) and move forward to a circular economy in construction sector
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 RCA
Goal and Scope

Goal:
- To study the influence of the recycling of production waste in substitution of natural aggregates in the production of concrete blocks

Scope:
- Cradle-to-gate (comparative) LCA
- Substitution of 30% of natural aggregates with recycled concrete aggregates (RCA) from production waste
- FU: 1 m³ of concrete blocks, on the basis of a 1 year production
System boundaries

1. Natural aggregate only (B_RCA0)

2. 30% RCA (B_RCA30)
1. Composition of blocks (kg for 1 m³)

<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>Recycled concrete aggregate 2/7</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

- 1 m³ ≈ 2,170 kg
- 101,500 m³/year (total for the 2 production sites – 65.5% and 34.5%)
- Waste: 1% → 1,015 m³/year (2,202,550 kg) → on-site storage
- Mobile crusher Metso LT12113 (250 t/h - 115 m³/h) : 1x /year
Inventory

• Recycling: after crushing and sorting:
  ▪ RCA 0/2: 38% → landfill
  ▪ RCA 2/6.3: 36.6% → concrete blocks
  ▪ RCA 6.3/14 + 14/20: 25.4% → other internal recycling (avoided burden)

• RCA 2/6.3 availability: 805,015 kg/year
  ⇒ 2,855 m³ of B_RCA30
  ~ 3 % of the annual production of blocks
• ⇒ To be completed with B_RCA0 (98,645 m³)
• "Mixed" production of RCA0 and RCA30

• Inventory for 1 year: B_RCA0 vs mixed production of
  B_RCA0 and B_RCA30 (incl. mobile crusher etc.)
• Normalized by annual production to have 1 m³ (FU)
LCA Results – B_RCA0 vs Mixed prod.

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

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

Valdem: valorization of CDW
Eloy Construction: CDW sorting site → RCA
⇒ Import of RCA 2/6.3 from Richopré quarry (Chanxhe, 25 km)

(No CF for "Gravel")
Conclusions

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

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

• ⇒ Very limited benefits (not significant) from the internal recycling of waste blocks compared to the impacts of the whole process

• But higher benefits (land use) if import of RCA from CDW sorting site (external recycling) ⇒ B_RCA30

• To confirm from a financial (and a technical) point of view
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
Acknowledgment:
This work is part of the research project VALDEM (Convention n° 1.1.57 of Interreg France – Wallonie - Vlaanderen 2014-2020) partly financed by the European Regional Development Funds, and Wallonia.

Contact:
Dr Hervé BREQUEL
R&D Manager
herve.brequel@ctp.be
Phone: 0032.69.88.42.66

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