Smart Construction and Demolition Wastes

L. Courard

*Urban and Environmental Engineering, University of Liège*

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Global context

What to do?
Global context

- 2050: 75% population living in cities
- We produce wastes
  - In EU28 countries, the total waste production by economic activities and households accounted for 2.50 billion tons (4931 kg per capita) in 2014. CDW is estimated to 34.7% of the total wastes.

Source: Eurostat (online data code: enu_waspen)
Global context

We need construction materials (aggregates)

- For the EU28 plus EFTA countries, the total 2015 aggregates production is estimated just on 2.66 billion tons. The primary materials came from 26,000 quarries and pits, operated by 15,000 companies (UEPG, 2018, http://www.uepg.eu/statistics/current-trends)
Figure 1: Aggregates Production (in millions of tonnes by country and type)
Objectives

► 3R: Reduce, Reuse and Recycle
► Using CD&W as sub-base and base material in road construction (“less noble”)
► Meeting Sustainable Development Goals: recovery targets to 70% of construction and demolition wastes (CD&W) by 2020 in European Union (Directive 2008/98/EC)
► Reducing use of natural aggregates (preservation of natural resources)
Brakes and obstacles

- Strong legal framework enabling a good level of C&DW management leading to higher recovery rates of C&DW
- Tracimat in Flanders:
  - from selective demolition to production of recycled aggregates with higher quality;
  - certification system to guarantee the quality of RA and RS
- Sorting requirement for C&DW (e.g. ban for polluted soils, asbestos…) and upcycling!
- Green public procurements in construction and recycling quotas in materials used for construction
- Banishment for landfilling of CDW in Wallonia
Brakes and obstacles

- (2013) Obligation to establish a plan for recycling (NOM-161-SEMARNAT-2011)
- Plan de Manejo de Residuos de la Construcción y la Demolición (Camera Mexicana de la Industria de la Construcción)
- Good quality materials (Concretos Reciclados S. A.)
- Increasing number of recycling plants (only 1 for 9 million inhabitants ↔ > 80/11 million inhabitants)
- Developing adapted products
Material processing

1. Reception of waste from construction and demolition
2. Stockpile
3. Initial processing (crushing, separation, etc.)
4. Mechanical grinder
5. Primary crushing (Impact crusher)
6. Magnetic classification
7. Manual separation of impurities
6. Mechanical grinder
7. Recycled materials with different maximum size
Innovative techniques: cleaning aggregates

For **crushing and cleaning** aggregates from concrete

**Attached mortar**

**Natural aggregate**

**How to clean aggregates?**

Bonifazi et al., 2018

Different techniques:
Microwaves, thermal heating, sonic impulses, **electro-dynamic fragmentation (EDF)**

EDF: high liberation rate of **clean aggregates up to 80%** of the fraction 2-20 mm
Innovative techniques: sorting aggregates

For **sorting** the different components of a mixed source

Mixed aggregates

**How to sort?**

Sorted aggregates

- Concrete, mortar
- Glass
- Wood, paper, plastic...

Natural aggregates

Bricks, tiles, ceramics

Different techniques:

Jigging (**density sorting**)

Hyperspectral imaging sensing devices (**optical sorting**)

In the near-infrared range

Stratification by density decreasing upwards
From block wastes to new blocks

- RCA manufactured in laboratory
  - Old concrete from block wastes (C8/10 from Prefer Company)
  - Crushing (jaw crusher in laboratory, opening ≈10mm)
  - Separation of RCA by sieving (0/20mm)
    - Four granular classes: 0/2 - 2/6.3 - 6.3/14 - 14/20
Properties

- Compressive strength

- Compressive strengths of concretes with RCA are slightly lower than those of concrete with natural aggregate
- Compressive strength of concrete made with 100% RCA at 28 days is 8 MPa (14.4% decrease)
Municipal solid waste incineration

1000 kg waste → 200 kg
Municipal Solid Waste
bottom ash residues

Burning at 900-1000°C

After cooling operations

Supply → Cribbling → Magnetic separator → Storage (10-20 weeks)

Municipal solid waste incineration

Industrial process – 10% MSW slags

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
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<tbody>
<tr>
<td>Splitting resistance (N/mm²)</td>
<td>4.05 ± 0.53</td>
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<tr>
<td>Water absorption (%)</td>
<td>6.61 - 6.29</td>
</tr>
<tr>
<td>Abrasion (mm)</td>
<td>0.98 - 1.36</td>
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</tbody>
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Conclusions

► Smart approach for constructions
  ▪ Reduce: new design codes (reduce materials and wastes)
  ▪ Reuse: dismantling and deconstruction
  ▪ Recycle: deposit ↔ market
    ➢ Reduce transportation

► Cradle to cradle
Acknowledgement

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