Cement and Clean Aggregates from CDW: The C2CA Project

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Francesco Di Maio
Outline:

- Introduction and project description
- Overview of objectives
- Overview of project main technologies
- Project organization
- Project flow chart
- Main results achieved so far
- Project impact
# Introduction and Project Description

**Title:** Advanced Technologies for the Production of Cement and Aggregates from Construction and Demolition Waste (C2CA)

**Starting date and Duration:** January the 1st 2011, 48 months

## Partnership

<table>
<thead>
<tr>
<th>Participant no.</th>
<th>Participant organisation name</th>
<th>Country</th>
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<tbody>
<tr>
<td>1</td>
<td>Delft University of Technology</td>
<td>The Netherlands</td>
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<tr>
<td>2</td>
<td>Sapienza Universita’ di Roma Italy</td>
<td>Italy</td>
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<tr>
<td>3</td>
<td>AGH-University of Science and Technology</td>
<td>Poland</td>
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<td>4</td>
<td>Institute of Chemical Engineering and High Temperature Chemical Processes</td>
<td>Greece</td>
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<tr>
<td>5</td>
<td>Barcelona Supercomputing Centre Centro National de Supercomputación</td>
<td>Spain</td>
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<td>6</td>
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<td>8</td>
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<td>9</td>
<td>Theo Pouw</td>
<td>The Netherlands</td>
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<td>Heidelberg Cement</td>
<td>Germany</td>
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<td>13</td>
<td>Laser 2000</td>
<td>The Netherlands</td>
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<tr>
<td>14</td>
<td>Inashco R&amp;D</td>
<td>The Netherlands</td>
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</table>
Introduction and Project Description

[Bar chart showing billion EUR in current prices for years 2004 to 2009. The chart is segmented by materials: Other metals, Precious metals, Iron and steel, Copper, aluminium and nickel, Plastic, Paper and cardboard, Glass.]

TU Delft
Introduction and Project Description

How much can recycling contribute to consumption?

% waste material

- Iron and steel
- Paper and cardboard
- Other metals
- Glass
- Aluminium
- Copper
- Concrete
- WEEE
- Plastics

Current contribution vs. Potential contribution
Introduction and Project Description

Economic importance: Status and progress

Recycled materials value [% of all non-energy raw materials]
Introduction and Project Description

**Motivation**

**Construction and Demolition Wastes**
- Concrete

**Advanced Dry Recovery**
- Dry (and mobile) separation process
- High separation efficiency
- Lower energy consumption compared to wet processes
- Environmental friendly

*A fundamental change*
landfilled or reused in low-grade applications ➔ resources for high-grade recycle concrete

*Improve EU waste & resource management*
*Strengthen EU position in world markets for environmental technologies*
Overview of objectives

Technological Objectives

• To **identify** all important factors and materials constituents related to the economic value and ecologic impact of C&DW concrete streams

• To **quantify** limits and **set standards** for dismantling operations

• To **optimize** breaker and separation processes (models, theory and experiment), for the removal of contaminants from broken concrete and to separate the **fine cement paste** fraction from coarse aggregate fraction

• To improve understanding and provide **numerical predictions** (based on models and experiments), of the effects of the kiln feed subject to partial replacement with the fine ADR stream, on the kiln performance and the exit clinker composition

• To **develop** sensing technologies to characterize feed and product streams in terms of the relevant composition parameters
Overview of objectives

Economic & Ecologic Objectives

• To understand the economy and ecology of C&DW recycling to such an extent that policies can be developed that facilitate an efficient transition towards a combination of optimal value recovery from C&DW and sustainable building;

• To increase the quality of secondary raw materials → higher market value;

• To reduce depletion of resources and increase environmental quality (few C&DW to be landfilled or incinerated, reduction of CO₂ emission);
Overview of objectives

Separating C-S-H from silica
Overview of objectives

**Three routes**

1. Innovation: ADR, Thermal process, Process and quality control (WP1, WP2, WP3, WP4, WP6, WP7)

2. Demonstration: Strukton case study (WP5)

3. Dissemination: Policies that enlarge project impact to optimize value recovery from C&DW and to promote sustainable building. (WP8, WP9)
Overview of objectives

Three routes

C2CA

Policy
- Systems analysis
- Policy recommendations

Case Studies
- Demonstration case studies

Technology
- ADR
- Sensor

Expected impact:
Increase of the recycling/reuse rate of high-volume C&DW streams. Policy recommendations at European, national and local level.

Aim:
To develop and promote innovative technologies and solutions for high grade construction materials manufactured from high-volume C&DW
Project main technologies: ADR

Crushing 32 mm

Autogenous milling

Screening 16 mm

ADR

+16 mm aggregate

+0.5 mm aggregate

-0.5 mm Mix
Project main technologies: ADR
Project main technologies: Laser and Hyperspectral Sensors
Project organization

**Interdependencies of WPs**

- **WP 10**
  - Management

- **WP 9**
  - Workshops, Training & dissemination

  - **WP 4 (route 1)**
    - Cement production

  - **WP 2 (route 1)**
    - Green concrete production and analysis

  - **WP 6 (route 1)**
    - Physical-chemical modelling

  - **WP 3 (route 1)**
    - Advanced liberation & coarse fraction processing

  - **WP 7 (route 1)**
    - Sensors & quality inspection

  - **WP 5 (route 2)**
    - Case studies

  - **WP 1 (route 1)**
    - Improved strategy for smart dismantling and demolition

- **WP 9 (route 3)**
  - Analysis of sustainability performance & recommendations for improvement
Project flow chart
Main results achieved so far
Main results achieved so far

ADR input

Rotor fraction

Airknife fraction

Coarse fraction

0-20 mm fraction

Coarse +20mm
Computing the mass percentage of output and comparing with input of mill

<table>
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<tr>
<th>mass variation before and after milling</th>
<th>unit</th>
<th>mill input</th>
<th>mill output</th>
<th>differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>gr/gr</td>
<td>15.86%</td>
<td>16.24%</td>
<td>0.39%</td>
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<tr>
<td>2</td>
<td>gr/gr</td>
<td>22.59%</td>
<td>25.72%</td>
<td>3.13%</td>
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<tr>
<td>4</td>
<td>gr/gr</td>
<td>31.22%</td>
<td>36.46%</td>
<td>5.25%</td>
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<tr>
<td>8</td>
<td>gr/gr</td>
<td>46.29%</td>
<td>52.74%</td>
<td>6.45%</td>
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<tr>
<td>11.2</td>
<td>gr/gr</td>
<td>57.37%</td>
<td>62.64%</td>
<td>5.26%</td>
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<tr>
<td>16</td>
<td>gr/gr</td>
<td>70.87%</td>
<td>73.61%</td>
<td>2.74%</td>
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<tr>
<td>22.4</td>
<td>gr/gr</td>
<td>81.75%</td>
<td>82.30%</td>
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<tr>
<td>32</td>
<td>gr/gr</td>
<td>90.22%</td>
<td>90.27%</td>
<td>0.06%</td>
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<tr>
<td>64</td>
<td>gr/gr</td>
<td>100.00%</td>
<td>100.00%</td>
<td>0.00%</td>
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</tbody>
</table>
Interpretation:

- milling produced 1-4 mm fragments from particle surface
- fragment size is too large (>1 mm)
- degree of milling is OK
Main results achieved so far
Main results achieved so far

C2S profile at solid phase
Main results achieved so far

ADR Samples used

<table>
<thead>
<tr>
<th>ADR Theo Pouw: Air Knife product</th>
<th>ADR Theo Pouw: Rotor Product</th>
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<tbody>
<tr>
<td>Mar-11 Concrete HTC AC</td>
<td>Mar-11 Concrete HTC AC</td>
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</tbody>
</table>
Project impact

• Strategic impact

• Economic impact

• Social and Environmental impacts
Thank you for attention

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Acknowledgements
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