Treatment and recycling of wind generator foundations

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SNBPE
RMC in France:
40 millions m³ in 2019
1 900 production sites
520 Companies
15 000 Workers

SNBPE represents 80% of French RMC production
Foundation for wind generator

Most wind generator foundations are built in concrete. The volume depends on the size of the mast, but is generally in the range of 250 to 600 m$^3$. The steel reinforcement ratio is around 100 kg per m$^3$. Concrete pumps are often used for placing the concrete.
Volume of future foundation recycling

- The number of wind generator reaching end of life will strongly increase during the future years, the concrete foundations to recycle will grow accordingly

<table>
<thead>
<tr>
<th>Year</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
<th>2028</th>
<th>2029</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>kTons of concrete to be recycled</td>
<td>15</td>
<td>12</td>
<td>26</td>
<td>35</td>
<td>69</td>
<td>167</td>
<td>294</td>
<td>363</td>
<td>459</td>
<td>607</td>
<td>713</td>
</tr>
</tbody>
</table>

- This concrete can be recycled as aggregates for new concretes
Recycling the concrete

• The high steel density may lead to two different operations, a first mechanical one to break the foundation and take out the major part of the steel, then, another operation, with more “human action” to sort the concrete and the remaining steel.

• The crushed concrete may then be used in new concrete.

- A 5M-€ R&D program supported by the Ministry of Ecology
- Objectives: to promote the complete recycling of concrete into concrete
- 47 partners (industry + academia)
- Comprehensive coverage of the topic, from material science to demonstration sites and proposals for standard evolutions
- More than 100 researchers involved – about 40 research reports produced to date
**Concrete applications**

- **Main Constituents of Cements**
  - Lab Study

- **Mineral Addition to Concrete**

- **ARM for Cement Raw Mix**
  - Lab study / Industr. Prod

- **FINES = Sand Fractions**
  - (0/4 or 0/6mm)

**DEMOLITION SCHEME AND RE USE OF MATERIALS**

- Coarse fractions
- Fine fractions
Experimental construction sites

5 experimental constructions using concrete with recycled aggregates:

• **Slab-on-grade**: an outdoor car-park in Chaponost, Lyon region
• **Civil engineering structure**: a bicycle bridge in the Nîmes-Montpellier rail bypass site
• **Administrative archives building**: an archive room for a library in Mitry-Mory, Paris region
• **Industrial applications**: sidewalk and low walls in a ready-mix concrete plant, Gennevilliers, Paris region
• **Office building - Compression slab**: an internal slab of an office building, Villeneuve-la-Garenne, Paris region

• And also 2 sites using cement with recycled fines:
  • **Slab with concrete** in Chaponost car-park
  • **Precast elements in concrete**
Experimental construction sites (continuation)

Construction date: December 2013
No damage observed until today

Slab-on-grade
Outdoor car-park
Recycled aggregate rates: 0, 30 and 100% sand and/or gravel
Experimental construction sites (continuation)

Construction date: June – July 2014
No damage observed until today

Civil engineering structure
Bicycle bridge
Recycled aggregate rate: 20 % gravel
(40% also tested in lab)

Core sampling in testing wall
Experimental construction sites (continuation)

Administrative archives building
Archive room
Recycled aggregate rate: 30%
Sand and 50% gravel

Construction date: October 2015
No damage observed until today
Experimental construction sites (continuation)

**Industrial applications**
Sidewalk and low walls in a ready-mix concrete plant
Recycled aggregate rate: 30% Sand and 30% gravel

Construction date: February 2015
No damage observed until today

**Office building - Compression slab**
Recycled aggregate rate: 20%

Construction date: May 2016
No damage observed until today
Deliverables

- **52 scientific and technical reports**: Almost all of them accessible to public via www.pnrecybeton.fr
- A scientific book in French: Le béton recyclé
- A scientific book in English: Concrete Recycling: Research & Practice
- A Recommendations guidance: Comment recycler le béton dans le béton
- Proposals for Standards evolution and Incentive measures
Conclusions

- After 7 years of collective work, the French construction community has increased its awareness about complete recycling of concrete.

- Most technical problems to recycle concrete into concrete were addressed, but none of them appears to be a roadblock. Only some adjustments to be done when using recycled concrete aggregates.

- The National Project RECYBETON has produced all the necessary tools allowing the use of this potential resource into concrete.

- A gradual change in the current practices must happen to reach this important goal, requiring efforts from all stakeholders (owners, specifiers, material industry) and decision-makers.

- The French concrete community is now ready to satisfy the objectives of the circular economy rules just adopted.
• Thank you for your attention