RE-USE OF MATERIALS IN ASPHALT PAVEMENT

Prof. Antonio D’Andrea
The Road Material Lab in Sapienza University deals with recovery of waste materials in road pavement for many years.

- Granulate rubber
- Bottom ashes
- C&D
- Industrial sludge

At the moment we are approaching the recovery of harbour sediments in asphalt.

Prof. Antonio D’Andrea
In the last decade we carried out two national project and another one is still on progress:

(PRIN 2000 – 2003 – 2006, co-funded by individual and public authorities)

PRIN 2000: Ottimizzazione dell'impiego dei materiali riciclati nelle costruzioni stradali
   (Improvement of using recycling materials in asphalt pavement)

PRIN 2003: Prestazioni e durabilità di strade ed elementi strutturali realizzati con materiali riciclati
   (Performances and durability of roads and structural elements made of recycled materials)

PRIN 2006: Recupero degli scarti destinati a discarica: dalla ricerca tecnologica innovativa all'impiego su larga scala e all'inquadramento normativo.
   (Recovering of waste materials: from the research to the large scale use and to the standardization of specifications)

Prof. Antonio D’Andrea
The recent European effort about Testing Standardization help us to switch our investigation to the final product, because:

Artificial and recycled materials can be characterized in the same way as natural ones

Performance-based test methods allow to evaluate, without prejudice, the effect of waste materials in asphalt concrete

In our laboratory we can carry on the following tests, according to the European specifications:

- EN 12697-26 annex D (stiffness)
- EN 12697-24 annex D (4PB fatigue)
- EN 12697-25 method B (TCC)
**ENVIRONMENTAL PROPERTIES**

We know that they are as important as mechanical ones for a large scale use of the final product

Leaching test for the some absolute industrial sludges, compared with asphalt concrete

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Klopman Sludge</th>
<th>Mix with Klopman Sludge</th>
<th>Ramoil Sludge</th>
<th>Mix with Ramoil Sludge</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>μg/l As</td>
<td>&lt;0.1</td>
<td>n.r.</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>50</td>
</tr>
<tr>
<td>Cadmium</td>
<td>μg/l Cd</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>5</td>
</tr>
<tr>
<td>Chrome</td>
<td>tot μg/l Cr</td>
<td>&lt;2</td>
<td>0.3</td>
<td>&lt;2</td>
<td>0.3</td>
<td>50</td>
</tr>
<tr>
<td>Cobalt</td>
<td>μg/l Co</td>
<td></td>
<td>n.r.</td>
<td>-</td>
<td>n.r.</td>
<td>250</td>
</tr>
<tr>
<td>Copper</td>
<td>mg/l Cu</td>
<td>1.5</td>
<td>n.r.</td>
<td>40</td>
<td>0.1</td>
<td>0.05</td>
</tr>
<tr>
<td>Iron</td>
<td>mg/l Fe</td>
<td></td>
<td>0.06</td>
<td>-</td>
<td>0.08</td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>μg/l Pb</td>
<td>18</td>
<td>n.r.</td>
<td>150</td>
<td>n.r.</td>
<td>50</td>
</tr>
<tr>
<td>Manganese</td>
<td>μg/l Mn</td>
<td></td>
<td>n.r.</td>
<td>-</td>
<td>n.r.</td>
<td></td>
</tr>
<tr>
<td>Mercury</td>
<td>μg/l Hg</td>
<td>&lt;0.1</td>
<td>n.r.</td>
<td>&lt;0.1</td>
<td>n.r.</td>
<td>1</td>
</tr>
<tr>
<td>Nichel</td>
<td>μg/l Ni</td>
<td></td>
<td>0.08</td>
<td>-</td>
<td>0.06</td>
<td>10</td>
</tr>
<tr>
<td>Zinc</td>
<td>μg/l Zn</td>
<td></td>
<td>0.1</td>
<td>-</td>
<td>n.r.</td>
<td>3</td>
</tr>
</tbody>
</table>
ENVIRONMENTAL PROPERTIES

We know that they are as important as mechanical ones for a large scale use of the final product

Leaching test for absolute hospital bottom ash and asphalt concrete incorporating them

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Hospital Bottom ash</th>
<th>HMA</th>
<th>HAC with 43 % bottom ash</th>
<th>HAC with 53 % bottom ash</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>μg/l As</td>
<td>2.2</td>
<td>1.9</td>
<td>2.5</td>
<td>&lt;0.1</td>
<td>50</td>
</tr>
<tr>
<td>Cadmium</td>
<td>μg/l Cd</td>
<td>&lt;0.2</td>
<td>1.5</td>
<td>1.5</td>
<td>0.8</td>
<td>5</td>
</tr>
<tr>
<td>Chrome</td>
<td>tot μg/l Cr</td>
<td>25.5</td>
<td>2.1</td>
<td>11.3</td>
<td>11</td>
<td>50</td>
</tr>
<tr>
<td>Cobalt</td>
<td>μg/l Co</td>
<td>2.1</td>
<td>&lt;2</td>
<td>&lt;2</td>
<td>2.1</td>
<td>250</td>
</tr>
<tr>
<td>Copper</td>
<td>mg/l Cu</td>
<td>0.063</td>
<td>&lt;0.002</td>
<td>&lt;0.002</td>
<td>0.009</td>
<td>0.05</td>
</tr>
<tr>
<td>Lead</td>
<td>μg/l Pb</td>
<td>&lt;1</td>
<td>11.2</td>
<td>6.4</td>
<td>1.3</td>
<td>50</td>
</tr>
<tr>
<td>Mercury</td>
<td>μg/l Hg</td>
<td>&lt;0.25</td>
<td>&lt;0.25</td>
<td>&lt;0.25</td>
<td>0.5</td>
<td>1</td>
</tr>
<tr>
<td>Nichel</td>
<td>μg/l Ni</td>
<td>13.8</td>
<td>&lt;2</td>
<td>5.9</td>
<td>&lt;2</td>
<td>10</td>
</tr>
<tr>
<td>Zinc</td>
<td>mg/l Zn</td>
<td>&lt;0.025</td>
<td>&lt;0.025</td>
<td>&lt;0.025</td>
<td>0.066</td>
<td>3</td>
</tr>
</tbody>
</table>
the laboratory results confirm that techniques and design methods can overwhelm both mechanical and environmental issues, but to complete our progress toward the large scale use ...

PRIN 2006: Recupero degli scarti destinati a discarica: dalla ricerca tecnologica innovativa all'impiego su larga scala e all'inquadramento normativo.

(Recovering of waste materials: from the research to the large scale use and to the standardization of specifications)

they are very important and useful:

- plant production test
- field validation

Prof. Antonio D’Andrea
At this level the research is subject to public authorities permissions and here, often, the research project will suffer a setback.

A short example:

- our Laboratory studied a new asphalt concrete coming from cold recycling of hospital bottom ashes
- the project got public and independent funds
- we designed both mixing plant and trial test stretches and asked authorization;
- we’ve been waiting for that authorization to realize the trial pavement since 2003;
- we’re still waiting for it.

Prof. Antonio D’Andrea
FINAL OBSERVATIONS

It is not impossible to have public or independent fundings; public authorities encourage recycling of waste materials even when they are classified as "hazardous". And very good words are in Italian laws (1997, 2003, 2006).

But, specially in Italy, R&D projects about waste materials slow down when they face environmental agencies and need permissions.

Maybe it is not only a question of governmental red tape, but also a question of roles, regulations and personal responsibility, or personal reading of rules.

This means that the same authority (i.e. the Regional one) that gave you the money to carry out the project, then refuses the permissions to complete the job or simply ignores your formal applications and the project can hang in the air for years.

Prof. Antonio D’Andrea
MY QUESTIONS FOR THE WORK GROUP

Should Universities and research institutes play an authoritative role based on the independence of their research activity?

Should Authorities “believe” much more in R&D projects and give more faith and specific roles to universities and public research centers?

Should the environmental laws recognize this particular role of the universities, i.e. the link between research and exploitation, and let them more freedom, at least in the experimental phase of the project?

Can we improve the excellence in R&D projects to dispel the suspicion that rounds these topics?

In this view, should universities form more tight relationship with contractors to reach enough critical mass?

Prof. Antonio D’Andrea
What researchers and technicians can do?

We probably have to fight the “refusal of refuses”:
The experience we had with C&D is typical of this wrong approach against recovering of waste materials.

We are supposed to explode some false prudence:
Not always it is better to dispense with waste materials, because the global environmental balance could be negative.

We have to make politics aware of the slowness of permissions that are often in conflict with knowledge transfer and exploitation of the research results.

We probably should help politics in making less complex execution of a project, or at least the experimental phase of it.
Under fixed condition could be sufficient a “silenzio assenso” (silence-assent) procedure.

Prof. Antonio D’Andrea