Promoting circular economy for a greener road construction

CIRCULAR ECONOMY STRATEGIES APPLIED TO ROAD CONSTRUCTION: ACCIONA EXPERIENCE
1. Waste valorization
2. Circular Economy concept
3. Road construction examples
4. Conclusions
Waste valorization at ACCIONA
C&DW

- Zero waste in construction sector
- Waste valorization in construction procedures, tenders,…
- Multiple applications of C&DW and participation in R&D projects
- Reference projects

- Innovative strategies for high-grade material recovery from construction and demolition waste
- Cost effective recycling of CDW in high added value energy efficient prefabricated concrete components for massive retrofitting of our built environment
- REycling of CDW materials and structures in energy efficient pREfabricated elements for building REfurbishment and construction
- Holistic Innovative Solutions for an Efficient Recycling and Recovery of Valuable Raw Materials from Complex Construction and Demolition Waste
INDUSTRIAL WASTE

- Ecodesign strategies (LCA, LCC)
- Business needs
- Waste Management plan
INDUSTRIAL WASTE

EARTHWORKS STRUCTURES: TDA AS EMBANKMENT FILL

- Duplicación de la M-111 y Variante de Fuente el Saz (Madrid)

- Enlace S. Isidro - Aeropuerto Sur (Tenerife)

- Autovía A7, tramo Motril – Carchuna (Granada)

- Conexión entre la Nacional 19 y la Estación de Ferrocarriles (Czuprynowo – Polonia)
INDUSTRIAL WASTE

ECO SANDFILL: S expendy foundry sand valorisation in construction sector through the validation of high-performance applications.
LIFE15 ENV/ES/612
Circular economy concept at ACCIONA
Circular economy concept at ACCIONA

Methodology

- Evaluation of waste and fluxes from other industries
- Application of waste with construction purposes
- Industrial simbiosis and circular economy regional models
- Collaboration and exploitation agreements
Valorization of C&D Wastes. Objetives:

C&D Waste minimization:

- To increase recovery rates, moving from low grade applications to high grade application, with a special focus on Cleaning and Sorting technologies for on site valorization.

Valorization based on properties and requirements of applications:
- High grade applications:
  - Coarse recycled concrete aggregates structural and non- structural concrete
  - Suitable applications for fine aggregate and mixed recycled aggregates

DEMONSTRATION EXPERIENCES

Extension of a penitentiary center in Teruel (Spain)
  - Recycled structural concrete: Slab
  - Recycled non-structural concrete: Lean Concrete.

Recycled concrete during landfill work at the Lai Chi Kok Viaduct (LCKV) in Hong Kong.

Alicante Airport terminal (Spain). Use of recycled aggregate from construction and demolition as backfilling
The overall objective of FISSAC project is to develop and demonstrate a new paradigm built on an innovative industrial symbiosis model towards a zero waste approach in the resource intensive industries of the construction value chain, tackling harmonized technological and non technological requirements, leading to material closed-loop processes and moving to a circular economy.

PROJECT OBJECTIVES:

- New Industrial Symbiosis Model definition
- Innovative technological and non-technological processes to transform waste into valuable secondary raw materials
- Development and optimization of new cost-effective construction products through the total or partial replacement of virgin raw materials by higher amounts of secondary high-purity raw materials from industrial waste.
- Demonstration of processes and products at pre-industrial scale
- Demonstration at industrial scale and real application
- Development of an integrated Industrial Symbiosis Management Software Tool able to address a Life Cycle and a GIS based approach

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FISSAC

FOSTERING INDUSTRIAL SYMBIOSIS FOR A SUSTAINABLE RESOURCE INTENSIVE INDUSTRY ACROSS THE EXTENDED CONSTRUCTION VALUE CHAIN
PAPERCHAIN
NEW MARKET NICHES FOR THE PULP AND PAPER INDUSTRY WASTE BASED ON CIRCULAR ECONOMY APPROACHES

The overall objective of PAPERCHAIN is to deploy five novel circular economy models centred in the valorisation of the waste streams generated by the Pulp and Paper Industry (PPI) as secondary raw material for a number of resource intensive sectors: construction sector, mining sector and chemical industry. PAPERCHAIN aims to unlock the potential of a resource efficient model based on industrial symbiosis which will demonstrate the potential of the major non-hazardous waste streams generated by the PPI (i.e. green liquor dregs, grits, lime mud, paper sludge fly ash, deinking paper and fibre sludge) as valuable secondary raw materials.

The technical objectives of PAPERCHAIN are:

- To design the baseline for the circular economy models surrounding the Paper and Pulp Industry
- To design the circular models schemes for the industrial symbiosis.
- To implement the valorization processes at industrial scale
- To demonstrate the circular models at real scale in four EU countries.
- To validate the sustainability of the circular economy models
- To carry out the certification processes, training and guidelines for the recycled solutions
- To develop a market strategy, exploitation routes and ensure replication

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 730305.

<table>
<thead>
<tr>
<th>WASTE</th>
<th>CHARACTERISTICS</th>
<th>CURRENT FATE</th>
<th>PAPERCHAIN ALTERNATIVE</th>
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</thead>
<tbody>
<tr>
<td>GREEN LIQUOR DREGS</td>
<td>Composed of nonreactive and insoluble materials recovered from the furnace including bentonite, calcium, sodium and magnesium carbonates and silicates</td>
<td>GLDs are mainly disposed to landfill (95%)1</td>
<td>- Upgrading their quality for being used as asphalt fillers</td>
</tr>
<tr>
<td>LIME MUD</td>
<td>It precipitates along the causticizing reaction and consists of calcium carbonate and water</td>
<td>Generally burned in the lime kiln. Excess of production is usually landfilled</td>
<td>Valorisation as concrete filler</td>
</tr>
<tr>
<td>SLAKER GRTS</td>
<td>Rejects from the lime kiln and limestone fragments precipitated during the causticizing reactions. Contains sodium and aluminium salts</td>
<td>91% is currently landfilled2</td>
<td>Once washed they can be used as aggregates in asphalt pavements</td>
</tr>
<tr>
<td>FIBRE SLUDGE</td>
<td>Produced by the wastewater treatment plants. Includes wood fibres and mineral such as kaolin, CaCO3 and TiO2</td>
<td>Landfilled (50%), burnt for energy recovery (25 %) or applied to land.</td>
<td>Production of renewable ethanol for secondary chemicals for different applications such as paint</td>
</tr>
<tr>
<td>DEINKING PAPER SLUDGE</td>
<td>Composed of short fibres, coatings, fillers, ink particles and chemical additives</td>
<td>Landfilled (40%) and energy recovery (35 %)2</td>
<td>New composite for slope stabilisation</td>
</tr>
<tr>
<td>WASTE PAPER ASH</td>
<td>Produced from the burning of different waste in the recycling-based mills</td>
<td>Most of it is landfilled</td>
<td>Binder in soil stabilisation</td>
</tr>
</tbody>
</table>

Circular economy concept at ACCIONA
PAPERCHAIN
NEW MARKET NICHEs FOR THE PULP AND PAPER INDUSTRY WASTE BASED ON CIRCULAR ECONOMY APPROACHES
Road construction examples
OBJECTIVE: Use of alkaline by-products for neutralizing and inerting reactive soils, allowing the reuse of soil/rock with low sulphide content as borrow material or providing low-priced neutralization reagents for excavated soils with high sulphide content destined to landfill.

ADVANTAGES AND IMPACT:
- Low cost solutions
- Complementary mechanical properties
Liaison with relevant potential local partners / clients
Examples of technical success:
- Ladle furnace slag from several steel-making plants as neutralizing reagent
- Marble slurries as agricultural lime (carbonate filler) replacement
- Fly ashes as potential heavy metal adsorbent.
- Waste paper boiler ash from pulp & paper industry.
- Collaboration with relevant alumina producers to test neutralizing and metal adsorbent capabilities of bauxite residues.
USE OF WPA
AS HYDRAULIC ROAD BINDER

OBJECTIVE: Soil improvement and soil stabilization with the use of WPA as hydraulic road binder.

ADVANTAGES AND IMPACT:
- WPA adequate for soil stabilization
- Accomplishment of requirements for Spanish regulation
- Durability similar to soil-cement
- Good workability and performances
- Good Surface finishing

Close collaboration among industries and public authorities to demonstrate the feasibility of the solution

Application of waste paper ash as soil stabilizer in A-14 Road (Spain)
Conclusions
- Need of innovative business models to maintain the resources as much as possible within the economy
- Social, economic and environmental barriers for industrial symbiosis-circular economy
- Innovation and business
- Construction sector as mobilizing agent
- Overcome non-technical barriers such as:
  - Internal reluctance (workability, productivity, performance, motivation)
  - Environmental regulation (categorisation, REACH inscription, waste management requirements)
  - Regulatory framework in Civil Works (Not-foreseen binder)
  - Client’s reluctance (lack of approval by the construction manager)
  - Lack of standardization regarding some waste (such as WPA not clear or not defined in on-going standards related to HRB)
  - Lack of trust among partners. Difficulties to set-up the win-win agreement