Evaluation of the environmental benefits of biochar addition into concrete-based composites

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EVALUATION OF THE ENVIRONMENTAL BENEFITS OF BIOCHAR ADDITION INTO CONCRETE-BASED COMPOSITES

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Students > 30,000

Biochar: Production, Characterization and Applications
LCA group @ Polito

Expert Team with years of experience (http://areeweb.polito.it/ricerca/LCA/)
coordinated by

Prof. Blengini: Associate professor at Politecnico di Torino
and
Senior Researcher at Joint Research Centre of European Commission - European Platform on Life Cycle Assessment (EPLCA)

Biochar: Production, Characterization and Applications
Outline

1. LCA definition
2. LCA crucial aspects
3. LCA for innovative products
4. LCA «case study»: Concrete vs Concrete&Biochar
5. Conclusions
LCA definition

• LCA: Life Cycle Assessment
• UNI EN ISO14040-44: LCA is the « compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle »
• A Foundamental Tool for Assessing Environmental Performance
La definizione di Ica l'hai presa dalla norma?
Utente sconosciuto, 7/25/2017
LCA Crucial aspects

Aspects not included/evaluated in LCA:
- Materials Cost
- Visual Impact on the Landscape
LCA for innovative products

Biochar: Production, Characterization and Applications

LCA «case study»
Concrete vs Concrete with Biochar

The aim of this work:

Concrete (100% Cement)

Concrete with Biochar (70% Cement, 30% Biochar)

Functional Unit: $1 \text{ dm}^3$

Biochar: Production, Characterization and Applications
## LCA «case study»
Concrete vs Concrete with Biochar

<table>
<thead>
<tr>
<th>Material</th>
<th>Unit</th>
<th>Standard Concrete*</th>
<th>Concrete with Biochar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>kg</td>
<td>0.45</td>
<td>0.29</td>
</tr>
<tr>
<td>Biochar</td>
<td>kg</td>
<td>0.00</td>
<td><strong>0.12</strong></td>
</tr>
<tr>
<td>Fine aggregated (Sand)</td>
<td>kg</td>
<td>0.66</td>
<td>0.60</td>
</tr>
<tr>
<td>Coarse aggregated (Gravel)</td>
<td>kg</td>
<td>1.23</td>
<td>1.12</td>
</tr>
<tr>
<td>Water</td>
<td>kg</td>
<td>0.21</td>
<td>0.16</td>
</tr>
<tr>
<td>Water/Cement ratio</td>
<td>-</td>
<td>0.47</td>
<td>0.55</td>
</tr>
<tr>
<td>Oil</td>
<td>MJ</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Electricity</td>
<td>MJ</td>
<td>0.015</td>
<td><strong>0.015</strong></td>
</tr>
<tr>
<td>Weight</td>
<td>kg</td>
<td>2.2</td>
<td><strong>1.7</strong></td>
</tr>
</tbody>
</table>

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LCA «case study»
Concrete vs Concrete with Biochar

Biochar concrete; at construction yard

Raw materials
- Portland cement
- Sand
- Gravel
- Biochar

Plant
- Biochar concrete; at plant

Construction yard
- Biochar block; at construction yard

Biochar «waste material»
Zero burden approach: waste has no impacts/benefits

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LCA «case study»
Concrete vs Concrete with Biochar

Biochar concrete; at construction yard

Raw materials

Biochar «waste material»
Zero burden approach: waste has no impacts/benefits

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LCA «case study»
Concrete vs Concrete & Biochar

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LCA «case study»
Concrete vs Concrete with Biochar

**Biochar: Production, Characterization and Applications**

![Graph showing climate change impact of block production and transportation to yard for Biochar concrete block and Standard concrete block.]

- **Climate Change [kg CO2 eq.]:**
  - **Block production:**
    - Biochar concrete block: 0.28 kg CO2 eq.
    - Standard concrete block: 0.43 kg CO2 eq.
  - **Transportation to yard:**
    - Biochar concrete block: 0.05 kg CO2 eq.
    - Standard concrete block: 0.05 kg CO2 eq.

**Notes:**
- 1 dm³
LCA «case study»
Concrete vs Concrete with Biochar

CONTRIBUTION ANALYSIS of a standard concrete block [1 dm³]

ReCiPe 1.08 Midpoint (H) - Climate change, incl biogenic carbon [kg CO2-Equiv.]

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Conclusions
• Preliminary LCA study on Concrete VS Concrete with Biochar
• The major environmental benefits come from the reduction of cement
  • kg of CO₂ equiv. saved ~35%
  • kg CFC-11 equiv. saved ~35%
• Primary energy demand -30%

1% substitution of Cement with Biochar

~1% benefit for impact categories of Climate change, Ozone depletion and primary energy

??? Economic point of view
??? Landscape point of view

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Thank you for your attention... to our Earth
The concept of global warming was created by and for the Chinese in order to make U.S. manufacturing non-competitive.