Are Recycled Building Materials more Sustainable than the Traditional Ones?

Bozhilova-Kisheva, Kossara Petrova; Olsen, Stig Irving

Publication date: 2011

Are Recycled Building Materials more Sustainable than the Traditional Ones?
Kossara Bozhilova-Kisheva, Stig Irving Olsen

Quantitative Sustainability Assessment Section, Department of Management Engineering, Technical University of Denmark, kpbo@man.dtu.dk, +45 4525 4413

Introduction
The manufacturing and use stages in the life cycle of buildings contribute significantly to the CO₂ emissions in the world. Most of the CO₂-reduction initiatives for buildings have focused on the energy efficiency of buildings during the use stage. As the environmental performance of this stage improves, the environmental impacts (e.g. CO₂ emissions and natural resource use) and the energy efficiency of the material and production stages gain more importance. Therefore, it is very important to research the possibilities for and potential environmental benefits of using recycled materials in the construction of new buildings as well as the possibilities for eco-design.

The Advanced Technologies for the Production of Cement and Clean Aggregates from Construction and Demolition Waste project (implemented under the 7th Framework Program of the EU) was initiated by companies and universities with the objective of steering the construction sector towards sustainable production and decision-making for sustainability. The project involves the development of innovative technologies for recycling of end-of-life concrete into new concrete in order to fulfill the objectives of the Dutch Waste Management Plan (2009-2021) for reduction of the environmental impacts within the life cycle of construction and demolition waste (CDW). In the project, the use of innovative technologies generating recycled concrete will be compared with the existing concrete production technologies within the framework of life cycle sustainability assessment (LCSA).

Aim of the Study
In the course of the project, the life cycle sustainability assessment approach will be applied to three new technologies for production of concrete from recycled CDW: 1) smart dismantling; 2) advanced dry recovery separation and 3) sensor for quality control. The technologies are expected to separate the CDW into fractions, which can replace some of the virgin raw materials for the production of concrete. A possible shift in the use of recycled aggregates from road construction to buildings and constructions as a result of realization of the new recycling technologies in the Netherlands is presented in Fig. 1 (existing situation) and Fig. 2 (possible future scenario with 50% substitution of the dry CDW separation technology with the advanced dry separation technology). The figures are based on the total amount of CDW in the Netherlands in 2008 and the CDW composition from 1994.
Materials and Methods

The study is based on an analysis of the scientific literature on life cycle sustainability assessment (LCSA), on statistical data and on the results from a workshop with academic and industrial project partners. The industrial project partners are representatives of the following industries: construction and demolition operations and management, cement, aggregates and concrete production, CDW recycling. The purpose of the project workshop was to determine the goal, scope, and reference product system for the LCSA study and to choose the categories of indicators and impacts to be assessed by the study.

Results and Discussion

In addition to the concept of life cycle assessment, the concept of life cycle sustainability assessment was recently introduced. Generally, the following formula, first suggested by Kloepffer (2008) is used to mathematically represent the LCSA: LCSA = ELCA + ELCC + SLCA, where ELCA stands for environmental LCA, ELCC stands for environmental life cycle costing and SLCA stands for social (socio-economic) life cycle assessment. In the course of the literature review, two approaches are identified possible when conducting LCSA: 1) to perform the three assessments separately and 2) to incorporate the ELCC and the SLCA in the ELCA. In the former case, the...
assessments will most probably make use of different inventories, while the latter they will be based on a common inventory. The LCSA approach applied within the framework of the project is based on combining the results of the ELCA, ELCC and SLCA and most probably giving them equal importance in the decision-making process. Furthermore, the ELCA and the ELCC are based as much as possible on a common life cycle inventory, while the SLCA is based on the performance of the companies that implement the processes, which are within the system boundaries.

The application of ELCA in the construction sector is a little bit controversial, since there are many combinations of building materials and components and different lifetimes of the different constructions. According to the Kotaji et al. (2003), the ELCA of buildings and constructions is broken down to a cradle-to-gate ELCA of their building materials and components. According to the same authors, the life cycle of a building is divided into different number of life cycle stages and not all of these stages are always included in the assessments (e.g. construction and demolition). A probable reason for the exclusion of the demolition stage is that the environmental impact of a building is mostly based on its energy performance, thus excluding stages of the life cycle with comparably lower energy demand. The new technologies, developed in the framework of the project, are located at the EoL stage of the building life cycle, including dismantling and demolition and CDW recycling for material production. In the scientific literature it is recognized that the material production and demolition stages of buildings with good energy performance have higher share in their life cycle energy demand. Thus, it is a good idea to take into account the impact of all of a building’s life cycle stages.

Furthermore, in a LCSA performed in the project also social and economic aspects have to be included. The SLCA for the project follows the UNEP-SETAC Guidelines for Social Life Cycle Assessment of Products (2009). The guidelines present indicators for assessment of social impacts to 5 categories of stakeholders and 6 categories of impacts. The impact categories include human rights, health and safety, working conditions, cultural heritage, governance and socio-economic repercussions. The stakeholder categories include society, local community, workers, value chain actors and consumers. The guidelines provide a broad range of both generic and specific indicators for the stakeholder categories, but when applied to a specific case and industry, a selection of suitable indicators needs to be made. At a project workshop, several indicators for each stakeholder group were selected as a preliminary set of categories of indicators for the project and a questionnaire form was developed in order to collect data for the SLCA. The specific indicator value from the survey results will be compared to a reference indicator value.
Conclusions and Recommendations

At the beginning of the project it is early to say, but it is possible that some trade-offs between the environmental, social and economic impacts of the assessed technologies for production of recycled construction materials might be observed at the different life cycle stages of buildings and constructions. Therefore, when implementing LCSA for buildings and constructions, it is recommended to include all life cycle stages, even the ones with expected comparatively low energy consumption, which have not always been included in the ELCAs of buildings and constructions.

Bibliography


Acknowledgements:

This extended abstract is realized through the financial support of the European Commission in the framework of the FP7 Collaborative project "Advanced Technologies for the Production of Cement and Clean Aggregates from Construction and Demolition Waste (C2CA)". Grant Agreement No 265189.