

## **LIFE CYCLE ASSESSMENT OF AN ADHESIVE FOR THE LAYING OF CERAMIC TILES**

*R. Spinelli, \* M. Pini, P. Neri, A.M. Ferrari*

*University of Modena and Reggio Emilia, Department of Science and Engineering Methods,  
Reggio Emilia, Italy,  
martina.pini@unimore.it,*

*Keywords: Life cycle assessment; adhesive; recycling; co-product.*

### **ABSTRACT**

The aim of the study is a comparative assessment of the environmental damage of an adhesive for the laying of ceramic tiles, obtained by the manufacturing of waste ceramic tiles and natural aggregates. The LCA analysis basically shows that the production of the sand by the recycling process is more impactful because of the energy consumptions required to reprocess the waste ceramic tiles.

### **1 INTRODUCTION**

The building sector is still largely dominated by recourse to natural resources with growing consumes: the necessary request of natural aggregates generate a strong impact on the territory because of extractive activities.

The growing attention and interest towards the environment led to a wider interest in reusing and recycling building materials. Consequently it is necessary to pay attention on the contribution that the secondary aggregates may lead to the satisfaction of the building society needs. For this reason it is necessary evaluate the environmental burdens associated to the needed industrial operations to obtain the secondary raw materials, with respect the natural aggregates, obtained from extractive activities. To investigate the environmental performance of both secondary raw materials and natural aggregates it is important to adopt the life cycle approach. A product is usually defined as eco-friendly when it is solely composed by recycled materials, since the consumption of raw materials and the production of waste are limited. However, in this way, it cannot taken into account of the energy consumption during the reprocessing, that often reduces the advantage of the raw material savings.

### **2 MATERIALS AND METHODS**

#### *2.1 Goal definition*

The scope of the present study is to assess the environmental impacts of an adhesive for the laying of ceramic tiles obtained by the manufacturing of waste ceramic tiles and natural aggregates.

#### *2.2 System, functional unit and function of the system*

The studied system is the manufacture of an adhesive for the laying of ceramic tiles produced by a company of the Sassuolo ceramic district (Italy). The functional unit is the hourly production of the adhesive: 200t/h. The function of the system is the laying of the ceramic tiles.

### *2.3 System boundaries*

The system boundaries for the analysis ranging from raw material extraction to the final packaging, thus obtaining “a cradle to the gate” overview. Plants, devices and equipment, and therefore the energy consumptions have been considered in the study.

### *2.4 Impact assessment methodology*

The analysis is conducted using the SimaPro 7.3.3 software and the IMPACT 2002+ evaluation method to assess the environmental impacts. In order to give more representativeness of the studied system, the following modifications have been implemented: the *transformation to forest intensive, normal, to forest intensive and to arable* have been introduced in the land use impact category; *silver, gravel, sand, lithium, bromine and water in ground* have been introduced with the same characterization factors considered in the Mineral impact category of Eco-indicator99 method; it has been evaluated the *volume occupied by the radioactive wastes* considering the same characterization and normalization factors of EPID 2003 method; the *depletion of water* has been added and a new indicator (*Soil*) has been introduced to assess the damage on the ground generated by the sand extraction and to consider the depletion of a natural resources.

### *2.5 Life cycle inventory*

The inventory analysis has been conducted using primary and secondary data. The data relating to the plants, the energy consumptions, the recycling of waste ceramic tiles and the emissions in air have been directly provided by a company of the Sassuolo ceramic district. The remaining data have been obtained from the EcoInvent database (Life Cycle Inventories, 2009). Regarding the production process of an adhesive obtain by the recycling of waste ceramic tile, two different scenario have been hypothesised. In the first scenario (A) it has been considered only the damage associated to the transportation of the secondary materials. In the second one (B), the waste ceramic tiles have been considered as a co-product to which is attributed a portion of damage belonging to the production of ceramic tiles. Product and co-product has been allocated on an economic basis: a market price has been assigned to the product and co-product and their percentage of the total cost has been calculated.

## **3 IMPACT ASSESSMENT AND CONCLUDING REMARKS**

The analysis of the results shows that the production of sand by the manufacturing of waste ceramic tiles produce a higher environmental impact. In particular, considering the two different recycling scenario (transport A and co-product B) the A perspective shows a considerable damage increase with the respect to the B one (Fig. 2).

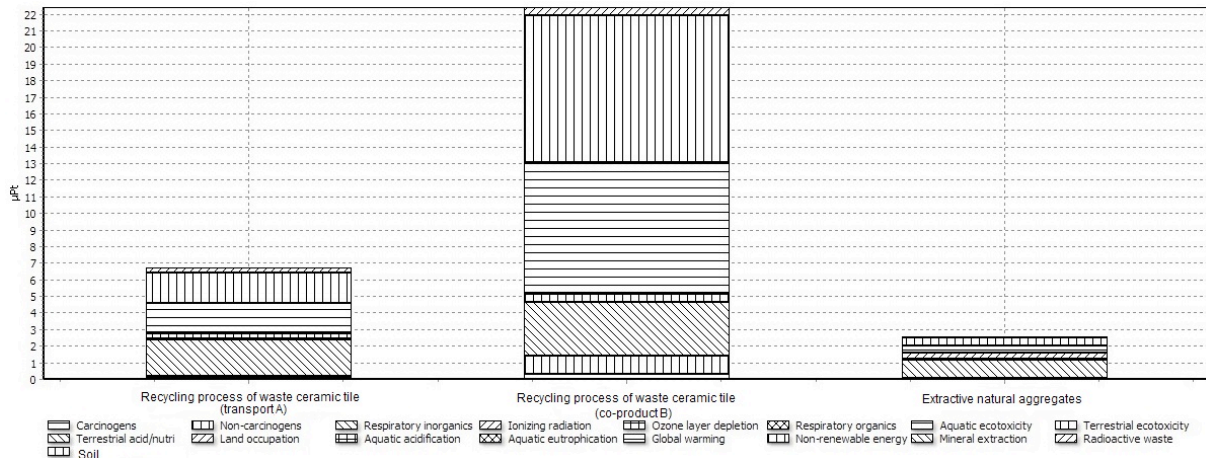


Figure 1 Comparison by impact categories of 1 kg of adhesive produced by recycling process of waste ceramic tiles (A and B scenarios) and the extractive natural aggregates

According to Ecoinvent procedure the A scenario has been adopted in the present study to compare the environmental impacts of an adhesive for the laying of ceramic tiles obtained by the manufacturing of waste ceramic tiles and natural aggregates. Analysis of the results shows that the process of recycling produces a significant increase of the damage for each of the environmental impact categories with the exception of the categories Land occupation and Land (Fig. 2). The damage is mainly caused by Respiratory inorganics, Non-Radioactive waste and renewable energy impacts categories. The damage in Respiratory inorganics is due to the emissions generated during the grinding of waste materials. In Non-renewable energy, Radioactive waste and Global Warming impact categories the damage is due to the energy derived from the electricity grind necessary to the reprocessing of waste ceramic tiles. In Land Occupation the damage is mainly caused by (47.14%) *Occupation, industrial area* in particular for the the recycling process of sand, while the extraction process of sand the damage in the same impact category is mainly due to *Occupation, mineral extraction site* (54.09%). To improve the Life Cycle Impact Assessment it is ongoing studies to evaluate in depth the new indicator (Soil) which assesses the damage on the ground generated by the sand extraction and the depletion of a natural resources. The recycling process, compared with the production of natural sand, causes an increase of environmental impact due to the energy consumption in the reprocessing step. In this way the advantage obtained by the raw materials saving is nullify. For this reason it is not always possible to express a positive opinion on the environmental sustainability of recycling processes.

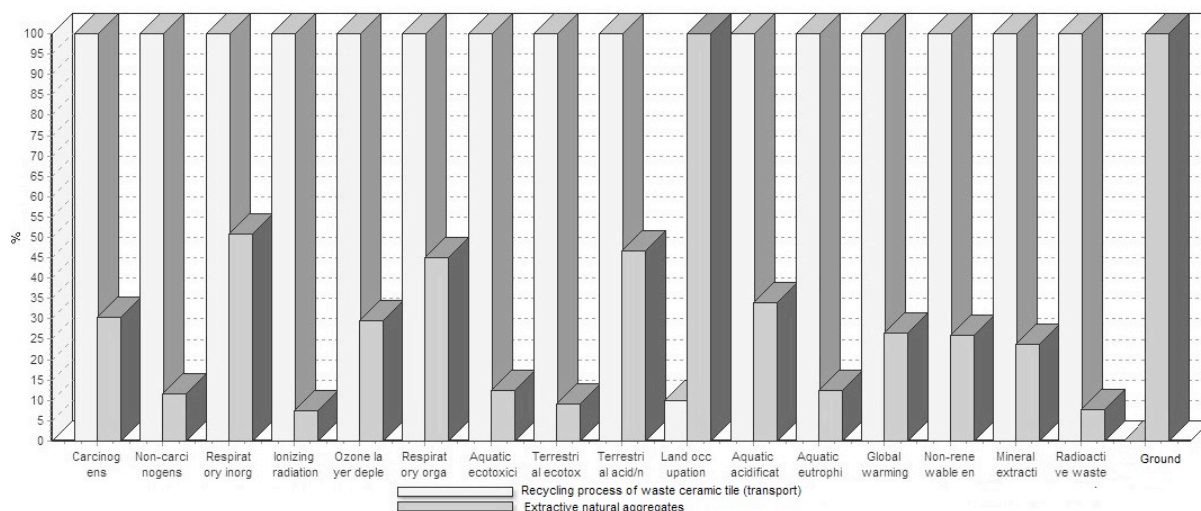


Figure 2 Comparison by impact categories of 1 kg of adhesive produced by recycling process of waste tile (A scenario) and the extractive aggregates

**ACKNOWLEDGEMENTS** The authors would like to thank Adesital S.p.A., for its contribution to data collection.

## REFERENCES

ANPAR, 2005, The production of recycled aggregates in Italy in 2004, [www.anpar.org](http://www.anpar.org)

European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. First edition March 2010. EUR 24708 EN. Luxembourg. Publications Office of the European Union; 2010

Joliet O, Margni M, Charles R et al. (2003) IMPACT 2002+: A new life cycle impact assessment methodology. International Journal of Life Cycle Assessment 8 (6): 324-330

Life Cycle Inventories (2009) Ecoinvent Database. Version 2.0. December 2010. <http://www.ecoinvent.ch/>

Neri P., Falconi F., Olivieri G., Ferrari Am., Barbieri L., Lancelotti I., Pozzi P., Cervino M., Gallimbeni R.(2009), Analisi Ambientale della gestione dei rifiuti con il metodo LCA, Pubblicazione elettronica. ISBN, 978-88-900772-2-7, Edizione: Cnr Area Ricerca Bologna [www.lcarifiuti.it](http://www.lcarifiuti.it)