ECO Innovative methodologies for the valorization of construction and urban waste into high grade TILES (ECOTILES, EU-LIFE project)

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Presented at the 5th Scientific day of School of Science and Technology in Camerino on the 8/6/2016

ABSTRACT: The ECOTILES project aims at studying the possibility to produce high-grade cement-based tiles using glass and ceramic waste. The project, financed under the EU-LIFE ENVIRONMENT/WASTE program will contribute to the achievement of EU 2020 goal on waste and resource efficiency, reducing emissions, waste, impacts on human health and the environment. Specific objectives are to: 1) demonstrate an innovative methodology that integrates promising research results to produce a new generation of tiles made almost entirely (up to 70%) with recycled materials and with substantially lower environmental impacts compared to current best-in-market products; 2) demonstrate the improved environmental performance in the production process of precast products, through the re-use and recycling of several streams of urban waste as well as lower energy consumption.

CHARACTERIZATION OF URBAN AND INDUSTRIAL GLASSES IN THE SUSTAINABLE PRODUCTION OF RAW MATERIALS

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Presented at the European Mineralogical Conference EMC 2016, held in Rimini 11-15 September 2016.

ABSTRACT: A set of 35 industrial glass wastes with different colour have been characterized for chemical composition and water content by means of optical microscope and FTIR spectroscopy.

Glasses are made with a combination of various oxides commonly referred to as “soda-lime” glass. Among alumina, magnesia, soda, lime, iron oxide, silica oxide or sand (SiO_2) is the most abundant raw material in glass composition. As alkalis, Na is predominant in all the glasses.

It must be taken into consideration that although the chemical analysis of all the coloured glasses seems to be similar there are great differences in the structure depending on the role of each element as network former, modifier or intermediate. Moreover, all the glass compositions investigated result to be anhydrous that is essential to the re-use of the waste since water content influences different glass physical properties (e.g. viscosity, density).

Thus, understanding the chemical composition of container glass is critical to recycling because has significant implications for managing the behaviour of molten glass in any remelt application.

The goal of this study is to reduce the impact on environment by using recycled glass from urban and industrial waste for the production of fully recycled (up to nearly 70%) pre-casted cement-based products (Terrazzo tiles). This work aims to demonstrate the possibility to reduce the environmental impact up to -20 % than for traditional tiles and achieve the manufacture of high-grade pre-casted products. All the products resulted from the re-use of glass wastes will contribute to the achievement of EU 2020 goals on Waste and Resource Efficiency, by reducing emissions, resource waste, impacts on human health and the environment.

Construction and Demolition Waste (CDW) for eco-innovative building product

Authors: E. Paris, F. Radica, P. Stabile, P. Maddala, F. Ansaloni, G. Giuli, M.R. Carroll

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ABSTRACT: A recent review (Jamshidi et al. 2016) explored the effect of adding waste glass (WG) in the manufacture of urban stepping surfaces concluding that the use of WG can improve various phases of pavement life and structure by enhancing the structural performance, durability, environmental friendliness, and aesthetic features. In this study we extend this knowledge also to interior cement-based interior design tiles.

In detail this work aims to evaluate the technical performances of aesthetically pleasant fully recycled (over 70%) pre-casted cement based products (Terrazzo tiles) manufactured by using GW and construction and demolition waste material (CDW). Three representative ECO TILES mixtures were selected and characterized by means of XRD and SEM imaging in order to study the effect of the different binding materials (limestone powder, quartz powder and fine grinded WG powder) on coarse grained WG granulates. A fourth additional mixture of Portland cement and CDW material was characterized. Preliminary results on X-ray diffraction patterns show that during manufacture curing time there is no new formation harmful phases other than the starting ones. High magnification SEM imaging further confirmed this observation also highlighting the good binding performances of a mixture composed by the 78% of recycled WG.

An additional goal of this study is to demonstrate the possibility to minimize carbon dioxide emissions during the production of ECO TILES and reduce the environmental impact up to -20% than for the traditional tiles. For this purpose power consumption and gas emission of the production activities during a traditional tile manufacture cycle has been measured and compared to the manufacturing cycle for the ECO TILES production, in order to demonstrate the lower environmental impact of these sustainable products.

Finally, the conversion of waste into raw materials for new productive process, together with the reduction of the environmental footprint associated with industrial processes, will contribute to the achievement of EU 2020 goals on waste reducing Resource efficiency.

Jamshidi A., Kurumisawa K., Nawa T. & Igarashi T. 2016. Performance of pavements incorporating waste glass: The current state of the art. Renewable and Sustainable Energy Reviews, 64,211–236.

ECO TILES – ECO innovative methodologies for the valorisation of construction and urban waste into high grade TILES

Authors: E. Paris, V. Grandinetti, F. Radica, P. Stabile, M. Bello, H. Riegel, A. Pitts, M. Maimaiti, G. Carbonari, C. Muzi, G. Giuli

Presented at the Sardinia Symposium 2017, held in Santa Maria di Pula 2-6 October 2017.

ABSTRACT: ECO TILES (LIFE14 ENV/IT/000801) is a research project financed by the LIFE program of the European Union, under the topic ENVIRONMENT - WASTE. The project is a synergy between the University of Camerino and the Grandinetti company. The research demonstrated the possibility to produce fully recycled Terrazzo tiles using recycled glass, ceramic and Construction & Demolition Waste (CDW). The new products were found to have a substantial less environmental impact (up to 21% of CO_2 saved) compared to the traditional tiles as demonstrated by the Life Cycle Assessment (LCA)

Substituting raw materials with waste for new eco-sustainable building products (ECOTILES)

Authors: E. Paris, P. Stabile, F. Radica, F. Ansaloni, G. Giuli, M.R. Carroll

Presented at the GSA fall meeting 2017, held in Seattle 22-25/october/2017.

ABSTRACT: One of the fundamental challenges for a sustainable future is to minimalize the environmental footprint associated with industrial processes. This moves towards a circular economy, which implies a conversion of waste deriving from productive processes into new raw materials aimed at minimizing carbon dioxide emissions and the overall impact on the environment.

The aim of this study is to reduce the impact on environment, demonstrating the possibility to produce fully recycled (up to nearly 70%) pre-casted cement-based products (Terrazzo tiles) using recycled glass from urban and industrial waste, ceramic and Construction & Demolition Waste (CDW). This work wants to prove the possibility to reduce the environmental impact up to -20 % than for traditional tiles and achieve the manufacture of high-grade pre-casted products.

It points at increasing awareness of the improved eco-innovative solutions among the general public, policy-makers and in the European industry, focusing on the environmental and economic advantages as well as on the technical feasibility of innovations such as LIFE ECO TILES. Moreover, it aims to enlarge the understanding and consciousness of the necessity of a more sustainable development in future, in which the geosciences could play a direct and active role.

Finally, all the products resulted from the re-use of these wastes will contribute to the achievement of EU 2020 goals on Waste and Resource Efficiency for a smart, inclusive and sustainable economy, which means to limit Earth's resources in a sustainable manner while minimizing impacts on the environment.

Waste Material Based "Terrazzo" Tiles: The Effect Of Curing Time And Extreme Environmental Conditions Over Glass Aggregate/Cement Matrix Boundary

Authors: E. Paris, F. Radica, P. Stabile, F. Ansaloni, G. Giuli, M.R. Carroll

Presented at the AGU fall meeting 2017, held in New Orleans 11-15/12/2017.

ABSTRACT: Currently, more than half of all materials extracted globally (over three billion tonnes/year in the EU only) are transformed for use in construction. Before year 2020, the EU aims to reduce the environmental impact of the construction sector by recycling or re-using large amounts of these materials, thus reducing the consumption of raw materials and helping promote the sector's economic stability. With this challenge in mind an aesthetically pleasant and fully recycled (up to 78%) pre-cast cement based tile (Terrazzo tiles) was designed by replacing raw materials with Glass Waste (GW) and Construction/Demolition Waste (CDW). Several recent studies explored the effect of the addition of GW in the manufacture of urban pavements, concluding that the use of GW can improve various phases of pavement life and structure by enhancing the structural performance, durability, environmental friendliness, and aesthetic features.

In this study we extend this knowledge also to interior cement-based tiles by evaluating the technical performances of this this novel designed tile, in particular by focusing on the interface between the GW aggregates and different Portland cement based matrix at extreme environmental conditions.

For this work three representative waste material based "terrazzo" tiles were selected and characterized by means of XRD and SEM imaging in order to study the boundary effect between GW aggregate and different binding materials: limestone powder, quartz powder and fine ground WG powder. A fourth additional mixture of Portland cement and CDW material was characterized. Fragments of a Limestone matrix tile were also thermally threated at -18°C and at 60°C for one week to witness the possible formation of new harmful phases at the grain-matrix boundary.

Preliminary results on X-ray diffraction patterns show that 1 year after manufacture and/or thermal treatment there is no new formation of harmful phases other than the starting ones. High magnification SEM imaging further confirmed this observation also highlighting the good binding performances of a mixture composed by the 78% of recycled WG.

Waste Material Based “Terrazzo” Tiles: The Effect Of Curing Time And Extreme EnvironmentalConditions Over Glass Aggregate/Cement Matrix Boundary

Authors: E. Paris, F. Radica, P. Stabile, F. Ansaloni, G. Giuli, M. R. Carroll

Presented at the 6th Scientific day of School of Science and Technology in Camerino on the 28/9/2018

ABSTRACT: Currently, more than half of all materials extracted globally (over three billion tonnes/year in the EU only) are transformed for use in construction. Before year 2020, the EU aims to reduce the environmental impact of the construction sector by recycling or re-using large amounts of these materials, thus reducing the consumption of raw materials and helping promote the sector’s economic stability. With this challenge in mind an aesthetically pleasant and fully recycled (up to 78%) pre-cast cement based tile (Terrazzo tiles) was designed by replacing raw materials with Glass Waste (GW) and Construction/Demolition Waste (CDW). Several recent studies explored the effect of the addition of GW in the manufacture of urban pavements, concluding that the use of GW can improve various phases of pavement life and structure by enhancing the structural performance, durability, environmental friendliness, and aesthetic features. In this study we extend this knowledge also to interior cement-based tiles by evaluating the technical performances of this this novel designed tile, in particular by focusing on the interface between the GW aggregates and different Portland cement based matrix at extreme environmental conditions. For this work three representative waste material based “terrazzo” tiles were selected and characterized by means of XRD and SEM imaging in order to study the boundary effect between GW aggregate and different binding materials: limestone powder, quartz powder and fine ground WG powder. A fourth additional mixture of Portland cement and CDW material was characterized. Fragments of a Limestone matrix tile were also thermally threated at -18°C and at 60°C for one week to witness the possible formation of new harmful phases at the grain-matrix boundary. Preliminary results on X-ray diffraction patterns show that 1 year after manufacture and/or thermal treatment there is no new formation of harmful phases other than the starting ones. High magnification SEM imaging further confirmed this observation also highlighting the good binding performances of a mixture composed by the 78% of recycled WG.