POLITECNICO DI TORINO

# Honors thesis

COURSE OF

Architecture for the sustainability design

*Abstract*

## Biochar for sustainable architecture: production of cement based mortar with addition of micro/nano particles deriving from gasification of biomass


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The necessity to experiment new technologies for the production of cement derives from the incessant use of concrete as a building material: in fact, as the World Business Council for Sustainable Development states, it is the second material used in the world after water. Moreover, in 2016, Italy ranked among the top four concrete producers in Europe and among the top twenty at the global level, with a production of almost 30 million cubic meters. These numbers result in high energy expenditure during the production phase as well as the same amount of $CO_2$ emissions into the atmosphere, causing more pollution and contributing in a fundamental way to global warming. The data reported by "Il Sole 24 ore" in April 2018 inform that Italy has presented an increase in $CO_2$ emissions of about 3.2%, thus representing more than 10% of emissions related to the whole of Europe. Therefore, according to the data analyzed, it is evident that it is of primary importance to intervene at the root of these problems, focusing attention on the reduction of raw materials and on the consumption of natural fuels.

Because of this, we are increasingly oriented to respond to this environmental emergency with sustainable solutions that can efficiently meet the needs of new architecture technologies while respecting nature.

The present work is based on the use of bio-char, a by-product of a process of gasification of waste materials of vegetable origin, in cement-based composites. The material, previously characterized by the company NEOTRON Group-Analytical & Technical Services of Modena, has been added in different percentages in relation to the weight of the cement in order to produce experimental samples of cement mortar. The activity, especially of experimental nature, as well as research, was carried out within the DISEG where mechanical tests were carried out after 7 and 28 days of maturation.

The use of this by-product has guaranteed benefits from a performance point of view, making improvements in terms of strength, hardness and above all ductility.

During mechanical tests, parameters such as bending and compression strength and fracture energy were evaluated.

From the results obtained it is evident that the presence of nano-micro gasified particles contributes, as well as to the improvement of the mechanical properties, to the reduction of the linearity of the fracture trajectory compared to that obtained with traditional cement, with a consequent increase of the fracture surface and therefore fracture energy: this ensures greater performance of the material.

It should be stressed that the use of bio-char is of fundamental importance from an environmental point of view as it guarantees the reduction of $CO_2$ emissions into the atmosphere, thus making the construction material more sustainable. Moreover, the economic component should not be underestimated, as this process reduces costs linked to primary production but also those related to landfill waste disposal, once again responding positively to the issue of environmental sustainability.

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