

POLITECNICO DI TORINO  
FIRST SCHOOL OF ARCHITECTURE  
Master of Science in Architecture (Construction)  
*Honors theses*

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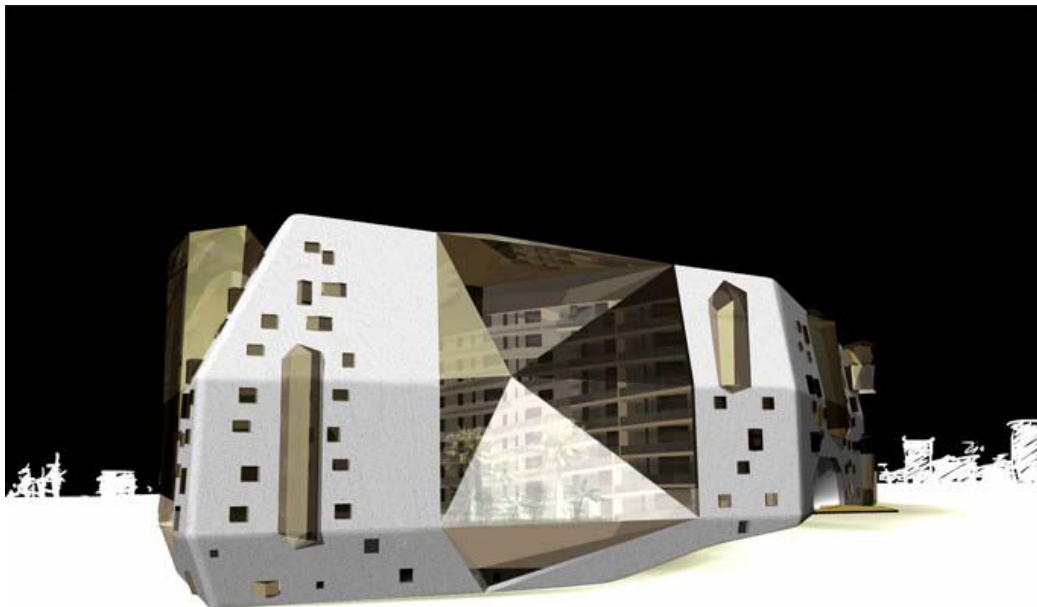
**The erratic boulder of the Bolzano's countryside. A bioclimatic block in MWC - Mineralized Wood Concrete**

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This work is made up of two different parts: a project section and an experimental one. The leading idea of all the work consists into the concept of boulder. Design section consists of the development of a residential block. The experimental study investigates the potential use of wood aggregates in substitution of natural ones to produce a more sustainable lightweight concrete: the Mineralized Wood Concrete (MWC). The purpose of the research is to study the effects of the addition of wood aggregates on thermal conductivity and on mechanical performances of concrete and, then, to use this concrete to realized external walls of the project building. The residential block, placed to the west side of Bolzano, is adjacent to the few left cultivated fields of this territory. The creative compromise consists in building an urban block in the countryside, which does have no impact on the agricultural soil: a sort of built island in the cultivated sea. Conceived as part of the territory, the monumental concrete building looks like a big stone, trapped into the rows of the apple-orchards.



West view of the block

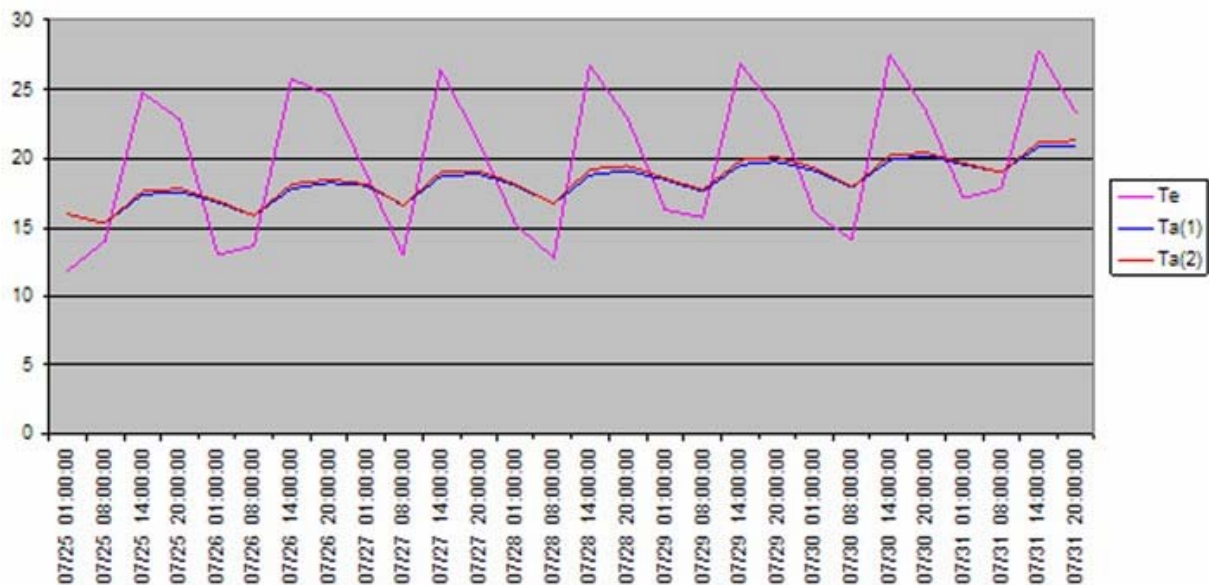
The building has been designed as a single volume, that was eroded by the time. This erosion has created some gaps in the block, that constitute the three courts. Some crystals come out from the volume: they are the windows and the greenhouses of accommodations.

Concept of rock has also led energy strategy. The very compact shape of the block allows to contain considerably thermal dispersions. The building is classified as passive house (according to the standards of CasaClima) thanks to compact shape and to the use of a material characterized by a low thermal conductivity. A new concrete has been prepared to realize external walls: it is a more sustainable lightweight concrete characterized by the substitution of natural aggregates with mineralized wood ones. It has been called Mineralized Wood Concrete (MWC). PLS®, that is a mixture of cement, water and wood aggregates, is the reference material. The use of wood aggregates is an attempt to improve thermal properties of concrete while preserving its mechanical performances. The aggregates, which stem from waste of woodworking activities, have been incorporated, after a preliminary treatment that consists of a mineralization with silica fume, into two types of concretes. One of these, constituting the matrix, is composed of cement, limestone filler, admixture and water. The other one is constituted by Flowstone®, that is a special cement with high mechanical performances, admixture and water.



Specimen in mineralized wood concrete

The results of compressive strength test indicate that mechanical properties drop with a decrease in density. However, one of the purposes of this work is to constitute a lightweight concrete with mechanical performances better than those of PLS®. The compressive strength of MWC (3,7 N/mm<sup>2</sup>) is the double of that of PLS®; Rck of MWC with Flowstone® (5,6 N/mm<sup>2</sup>) is the triple of that of PLS®. Wood aggregates greatly improve the thermal conductivity of the composite. A one-dimensional heat flow model has been used to predict the effective thermal conductivity of MWC (0,115÷0,46 W/mK) and MWC with Flowstone® (0,164÷0,43W/mK). Using this model it has been demonstrated that the inclusion of wood aggregates into concrete reduces material density to a considerable extent: consequently, thermal conductivity is improved. Finally, a numerical simulation of the temperatures distribution of a flat in the residential block, during the summer period, has been conducted on a Simulink® dynamical model. Since outdoor temperature (Te) undergoes remarkable changes, indoor temperature (Ta) varies less. Moreover, indoor temperature is always between comfort's boundaries thanks to use of MWC with Flowstone®.



Time profile temperatures

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