POLYTECHNIC OF TORINO
FACULTY OF ARCHITECTURE 2
Degree in Architecture
Honors theses

Feasibility study on the use of recycled plastic materials in low-cost housing constructions in the developing countries

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This research was prompted by the awareness of the problem of plastic waste in the developing countries. In particular, plastic packaging materials are often discarded without making any attempt to reuse them.
In Ouagadougou (Burkina Faso), where an important part of the experimentation was carried out, packaging materials and shopping bags are abandoned all over the place. This poses considerable problems of environmental deterioration and discomfort for the population.
The aim of the research was to explore possible ways to use plastic wastes to produce low cost building components for the developing countries - in the case in point, roofing elements alternative to those normally used.
The testing program was conducted according to the principles of economic, functional and environmental sustainability, in terms of: waste reduction, use of local materials, low energy requirements, no harmful emissions, compatibility with cultural and socio-economic conditions.
Since the building elements are to be used in low-income situations, the design criteria had to take into account basic requirements, such as low cost, use of unskilled labour and unsophisticated machinery. Accordingly, suitability for self-help construction techniques was considered, together the many constraints arising from the actual conditions of the building sector in the developing countries.

Insulating material made of ground plastic from shopping bags

The test performed on the ground plastic is as described in Italian standard UNI 7745 for the “Determination of thermal conductivity with the method of the hot plate with protective ring”.
The ground material (or fluff) may therefore be compared to materials specially designed to produce insulating layers in the building sector, in fact his thermal conductivity ranges from 0.056 to 0.06 W/ (m·K).

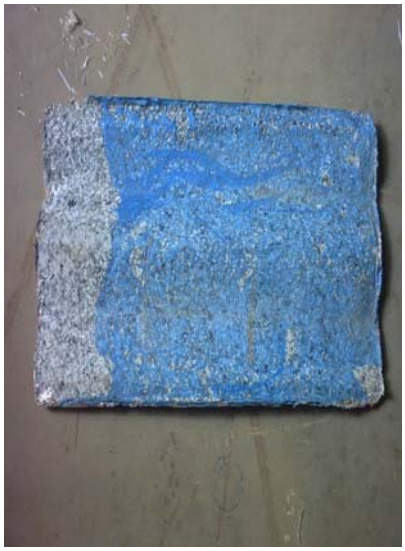
Figure 1. Ground plastic

Tiles made of ground plastic bags

From an analysis of plastic processing methods it proved possible to formulate an hypothesis on the conversion of plastic bags into tiles through the application of heat and pressure.

Owing to the lack of appropriate machinery, simple tools had to be used, such as metal moulds and a toaster. Heating times, temperature, shape and quantities were defined by performing several tests. The material used in these tests consisted of ground plastic particles obtained from shopping bags.

The experimental program was continued in Ouagadougou to fine-tune a tile production technique that would make use of local labour and resources.



Ground plastic tiles produced in Ouagadougou

The tiles were subjected to the impermeability test as defined in the “Quality Control Guidelines, Fibre or Micro Concretes Tiles” by the SKAT (GRAM, Hans-Erik, GUT, Paul, 1991, *Quality Control Guide Lines, Fibre or MIcro Concrete Tiles*, SKAT, St.Gallen, Svwitzerland, pag.41)

At the end of this study it was deemed necessary to compare the plastic tiles with a technology widely used in roof construction in the developing countries: metal plate. Both solutions are low cost, but the plastic roofing is cheaper (1800F.Cfa)
. The price per square metre of medium quality metal plate in fact is 2500 F.Cfa
(1€ = 655.96F.Cfa (as at 08/09/2004)
In terms of impact on the environment and energy consumption, plastic tiles are surely preferable, since they are made of recycled plastic bags requiring a minimal energy input (0.8 kW/h per kg), whilst the same quantity of aluminium or steel requires 15 kW/h to be molten and treated. The sound-proofing capacity of metal plate is poor and the noise of rain dripping or animals walking on the roof is a cause of discomfort for people living under a metal roof. As is known the greater is the density of a material, the greater is the transmission of intermittent noise (rain, sleet, etc.): the density of polyethylene is $\delta = 0.922$ g/cm^3 , that of steel is 7.85 g/cm^3.
It can be reasonably assumed that tiles offer a higher degree of thermal comfort compared to metal plate: the thermal conductivity [λ] of polyethylene is 0.35 W/(m·K), i.e., much lower than that of steel, which is 52 W/(m·K), and compares even more favourably with that of aluminium ($\lambda = 220$ W/(m·K).
A metal plate in the developing countries, i.e., after approx. ten years becomes corroded with rust. Ageing resistance of polyethylene is poor, but since no long-term experiments have been conducted on the effects on the tiles of time and exposure to the sun, their average life span cannot be defined.

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