POLYTECHNIC OF TORINO
FACULTY OF ARCHITECTURE 2
Degree in Architecture
<u>Honors theses</u>

Fiber reinforced concrete and high performance concrete: characteristics and applications

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The introduction of more and more resistant concretes is offering a new prospective for material which derive from cement. Studies have demonstrated that wit greater mechanical resistance there is a large increase in brittleness and strong structure instability.

A fundamental physical characteristics of HPC is low porosity, obtained both through super fludifying additives or by adding fillers (micro-silica, fly ash, silica sume).
The addictions are made up of fillers of reduced dimensions which fill the empty spaces between grains of cement and aggregates. The use of special raw materials, brings about a change in the mix design which is often very different from that of traditional concretes. The ACI defines High Performance Concrete a concrete whit special performances and uniformity, not always obtainable with the traditional materials and conventional practices generally used.

The main features of HPC are: low w/c (0,30 – 0,40); minerals filler, high quality aggregates breakable (basalt, granite, etc) that insure optimal interface; fluidifying additives.

The benefit due to the use of these materials are: less working time; increase span; last minor price; high durability; ecological material; fast hardening; resistance; resistance to polluting.

The HPC handicap are: High unit price; No specific law; no statistic database; brittleness.


Three Gorges Dame on the Yangtze, China, under construction, 350.000 mc of HPC - Filler: fly ash


Hibernia Platform off-shore, 1990 - Grand Banks, Canada - 165.000 mc of HSC - Rck 73,8 MPa - High 111 m - Filler: silica fume - w/c 0,36

The durability of concrete structures is governed principally by cracking (in addition to the quality of the materials), especially since it permits the ingress of water and other fluids leading to the corrosion of the steel reinforcement. Structures of extensive surface areas, that are exposed to high rates of evaporation at early age may be prone to plastic shrinkage. If the bleed water of the concrete is insufficient to compensate for the loss of moisture through to the exposed surface, the concrete undergoes shrinkage that leads to cracking when restrained. Normally, for the purposes of curing, the exposed surfaced of concrete elements and structures are expected to be covered with water, wet burlap or an impermeable membrane that would prevent the loss of water. However, in many practical situations the curing procedures is insufficient or is applied too late (after plastic shrinkage occurs) leading to considerable surface cracking.

In order to avoid plastic shrinkage cracking, polypropylene, nylon, steel, glass fibers are often incorporated in the concrete.

Forecasts of the performance of such materials as fiber reinforced composites become more reliable as knowledge increases of the mechanisms involved in fiber/matrix compatibility. The steel fibers operate according to their metallic nature, and to their geometry, number and distribution. The cementitious matrix operate according to its ceramic nature, which is very sensitive to initial formulation, to curing and to subsequent alterations induced by the environment.

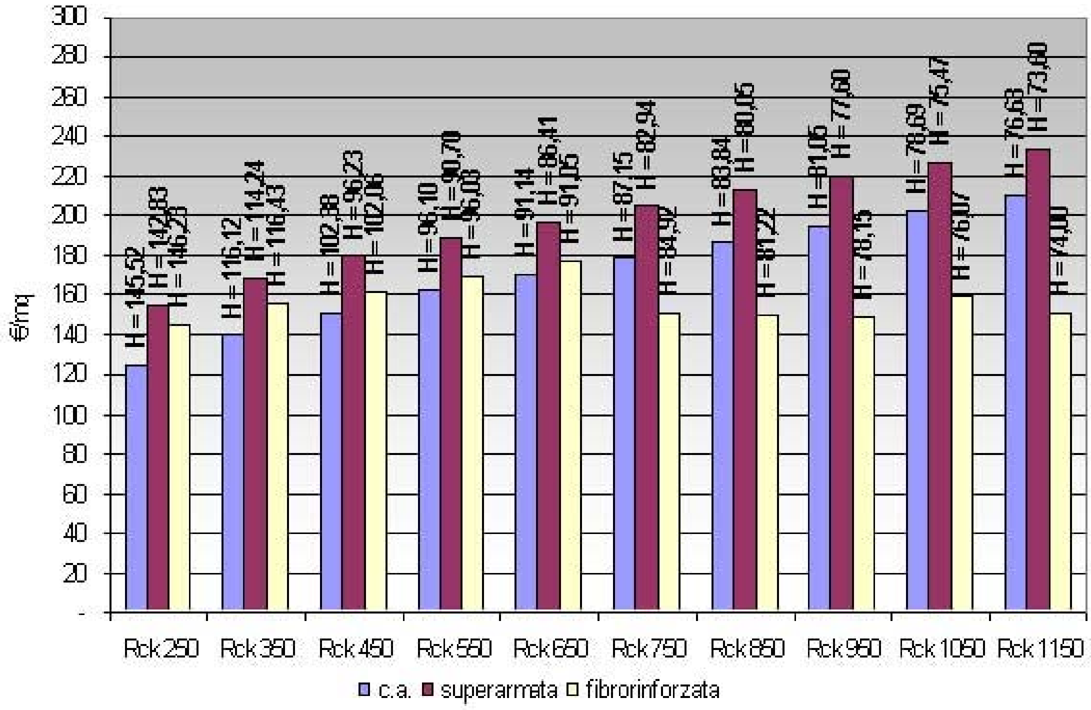
Furthermore, a fiber content lying between 0,25 and 0,5% by volume makes the concrete tougher, that is, it sensibly improve its post- cracking behaviour; its toughness, furthermore increase with the steel fiber aspect ratio (l/d).

The improvement in the mechanical proprieties and fatigue strength of fiber reinforced concrete enables, in the construction of highway and industrial pavements and floorings, a 40-50% reduction in depth with respect to ordinary concrete.

Moreover, in the structures, the presence of fibers reduces both the size and the number of shrinkage cracks, as well as their rate of propagation under load.

Our thesis use of a plan of beam in reinforced concrete. We compare FRHPC, NC and NC whit a lot of reinforcing bars for having the same strength of FRHPC. For any different type of material we calculated beam whit span between 5 and 30 m for a 120 total cases. So we compare crack performance and material price, without benefit obtained from fiber reinforced high performance concrete.

For the same price the beam in FRHPC is 74 cm high and the traditional beam is 102 cm high; for the same performance (cracking and space) the beam cost cut down of 35%.



beam 30 m – €/mq

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