POLITECNICO DI TORINO
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Master of Science in Architecture
***Honors theses***

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**Nanoreinforced concrete: the new frontier of architecture**

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“There's Plenty of Room at the Bottom”. Fifty years have passed since the famous lesson of physicist Richard Feyman, in which is suggested the possibility to face the processes of matter transformation through the direct manipulation of atoms and molecules.
In 1986 Kim Eric Drexler used first, in his book Engines of Creation (1986): The Coming Era of Nanotechnology, the term "nanotechnology".
A nanostructured material is a conventional material modified, but, in its chemical and physical structure with the use of nanotechnology; the original characteristics of the basic material undergo changes and implementation in order to enable the development of specific performance. These performances are usually higher or at least not comparable to those exhibited by materials in their ordinary texture and structure not nanostructured.
The purpose of this work is to discover whether these nanotechnologies can provide new improvement margins for the construction industry .
The subject discussed in this thesis is the concrete. We intervened in the nano-scale to implement the mechanical properties and to control the trigger of the birth of micro-fractures.
Carbon nanotubes have been added during the blending to increase the strength characteristics. There are two main types of nanotubes: (Fig 1):

- *Single wall nanotubes* (SWNT’s), is a graphene sheet rolled-over into a cylinder.
- *Multi wall nanotubes* ( MWNT’s), consists of several concentric graphitic cylinders.

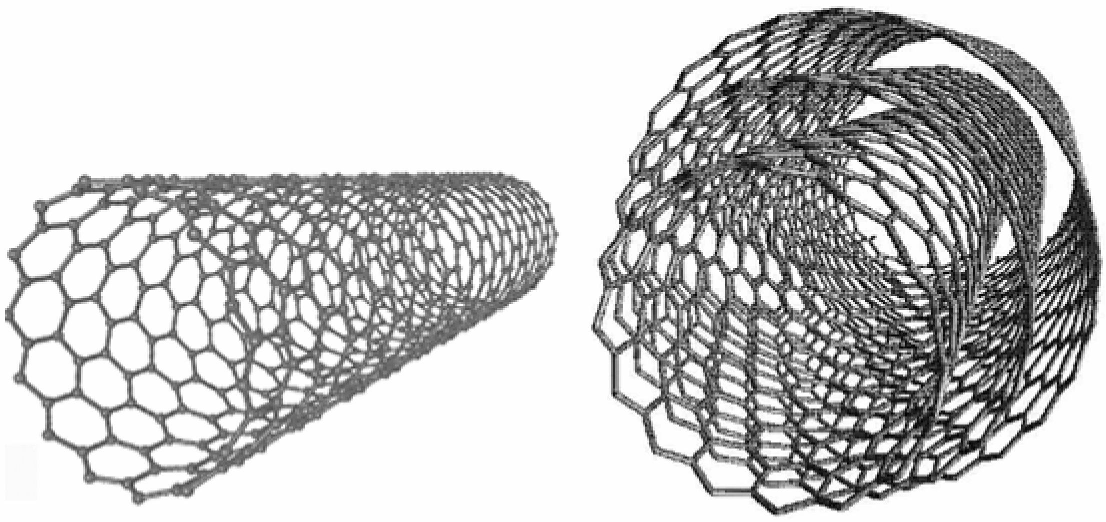

Figure 1 - SWNT’s a) e MWNT’s b)

| | Young’s modulus (Gpa) | Tensile Strength (Gpa) | Density (g/cm³) |
|---|---|---|---|
| SWNT’s | 1200 | ≈150 | 2.6 |
| MWNT’s | 1054 | 75 | 1.3 |
| ACCIAIO | 208 | 0.4 | 7.8 |

I started from a subsequent analysis of the hybrid fibers and then dropped to a study on carbon nanotubes: in a mixture containing fibers of different sizes (from cm to nm) characteristics of resistance may increase significantly.
As the concrete works much better in traction if reinforced with microfibers, it’s likely that his resistance will increase with the addition of nano-fibers (Fig 2).

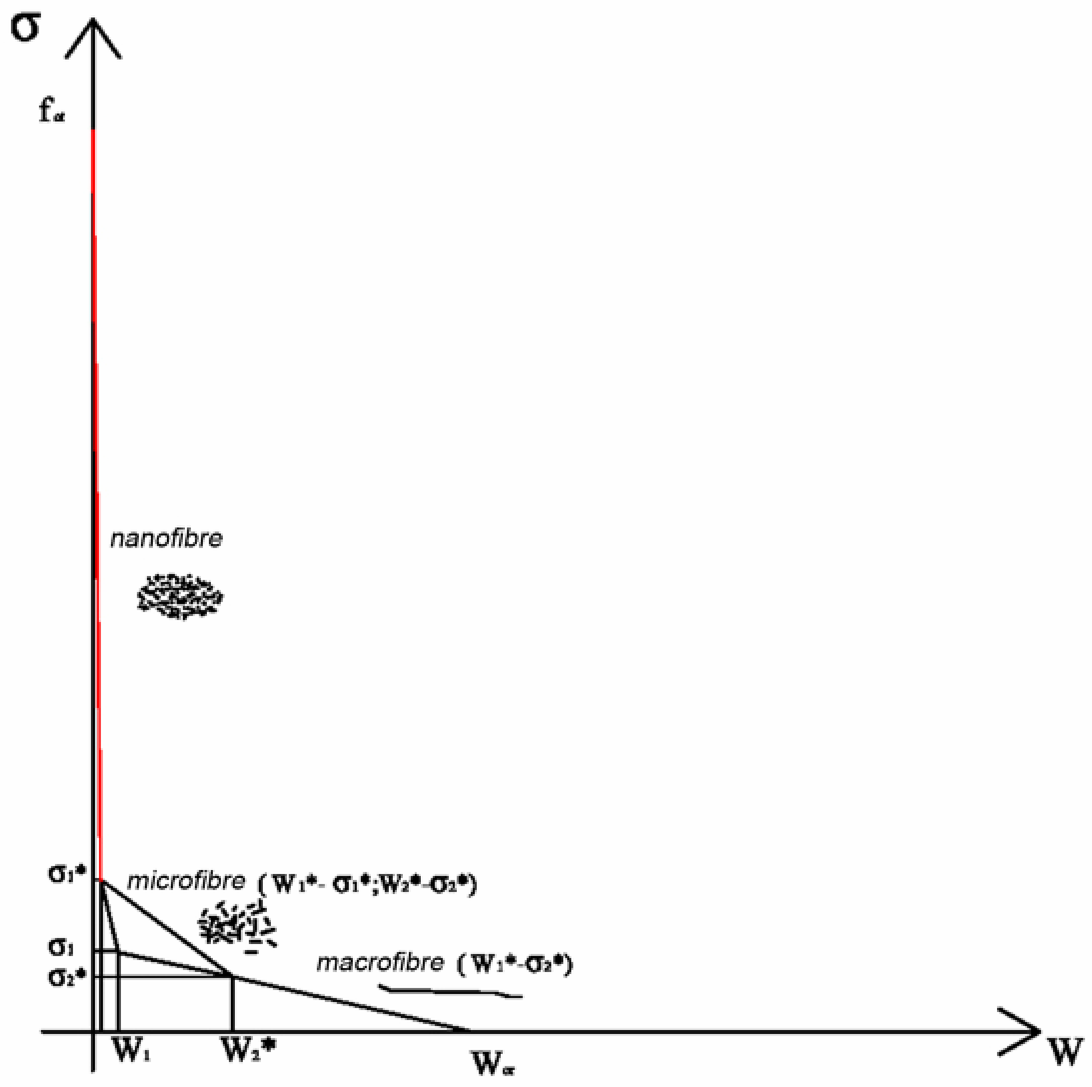


Figure 2 - Hypothetical fibermetric curve

If until now a granulose curve has always been adopted to represent concretes behaviour, in order to design the mechanical performance of concrete, now we could call it “FIBERMETRIC” curve. This graphical representation would be able to define the effort-deformation curve (constitutive law) that the designer considers most appropriate, choosing an appropriate distribution of fibers.
Following an analysis of two basic materials – concrete and nanotubes- my thesis focused on the results obtained from mechanical and physical-chemical analysis made on samples of concrete with and without the introduction of nanotubes pre-packaged or products by us in the laboratory (FCCF 189) (Fig 3), to study the behaviour of the reached mixture.

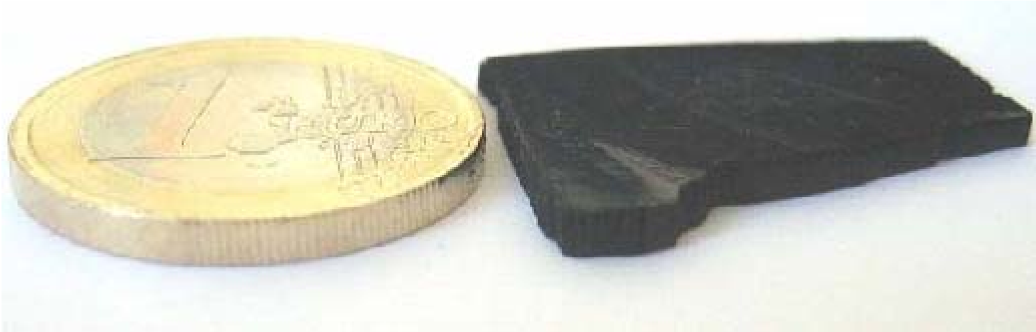

Figure 3 - Photos of the "carpet" of carbon nanotubes

The results achieved were compared with those obtained from a previous testing made by Canepa Architect. This past testing, unlike ours testing, has not only brought improvements but it also showed deterioration in all points of view.
The flexural strength of Canepa's samples is about 3,85 N/mm² , the flexural strength of FCCT 189 is about 10,08 N/mm²; the compression strenght Canepa's samples is about 15,53 N/mm² , whereas the compression strenght of FCCT 189 is about 72,04 N/mm².
Even if the obtained results were very important, our analysis may take place not as point of arrival but as a beginning of a long journey that will lead to the development of materials with high features.
Thanks to the extraordinary properties of the nanoreinforced, the designer will increase his chances not only in the choice of materials to use, but also in the way to conceive the building organism.

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