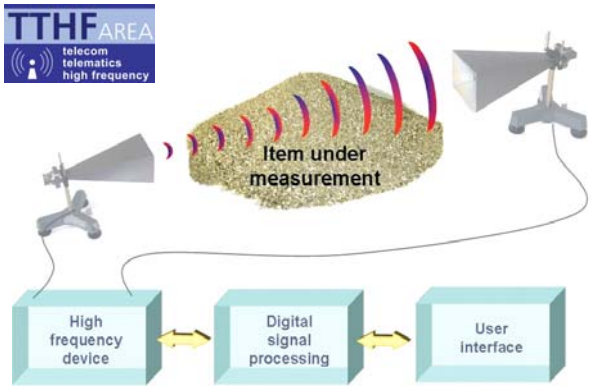
WaveTester: the moisture detector

An excessive degree of dampness in a material may damage it and even make it useless. To avert the risk, researchers in the Telecom, Telematics, and High Frequency area (TTHF) of the Department of Innovative Technologies (DTI), SUPSI, have designed WaveTester, an excellent non-invasive microwave system that screens for non-homogeneity and measures water content in materials. There are different applications; one is Beton Tester, used to produce concrete on the Alptransit building site. The project is carried out jointly with MEET Sagl and is funded by the Innovation Promotion Agency (known as CTI).

We do have to know whether there is damp in materials, because an excess of it may seriously damage them or write them off completely. WaveTester, a moisture meter that measures the volume of water by interacting with microwaves seems to be the solution to this problem. Launched in 1998, this project originally served to measure the degree of moisture in tobacco, so as to prevent mould from setting in. Today, WaveTester may be applied to any sort of product: some are in fact considering trying out the same principle to test moisture levels in other materials, in particular inert matter, hence concrete, where there is a big market. This is where the new project (Beton Tester) started; a device for probing inert matter, the 'precursor' of the system currently in use on the Alptransit building sites.

WaveTester is an innovative method, because it measures damp by surveying the dielectric constant of materials. But how does it work? "The principle is extremely simple", explains Andrea Salvadè, engineer and professor in the Department of Innovative Technologies, SUPSI, and head of TTHF and director of the project, "an electronic control station running at high frequency emits a signal intercepted by an aerial acting as a sensor. The signal broadcast by the aerial travels through the material, comes out at the other end and is picked up again by the aerial, which takes it back to the same electronic checkpoint. The signal interacts with the material, and is altered in the process. By measuring this variation on the microwave, one can trace it back to the dielectric constant, which represents the material's fingerprints".

Water in fact has a very high dielectric constant, whereas other materials, such as tobacco or inerts, have extremely low dielectric constants. Therefore, the higher the dielectric constant measured, the higher the moisture content of the material. A microwave-based system like the one described has several advantages, adds Salvadè: "First of all, it is a non-invasive method, i.e. it does not even touch the materials". If we inserted a probe into the material, the process would be circumscribed to the given area. No information would be gained on the material as a whole. Our method, on the contrary, would assure a total, comprehensive screening, and so achieve qualitatively better, reliable, and accurate measurements. Moreover, as there is no direct contact, there is no wear and tear; consequently, the life expectancy of the product may be much improved, and virtually at no maintenance costs. Finally, unlike the neutron-based probe (also non-invasive), microwaves are not radioactive. Therefore this method wards off any risks involved in radio-active waste, which are hard to deal with; and no specific staff training is required.



Working principle behind a WaveTester

The WaveTester project, conducted in association with MEET Sagl, Coldrerio, has been subsidised by the Innovation Promotion Agency (known as CTI). This project is a typical example of applied research and development carried out jointly by academic institutions and businesses, where new know-how generated in a research laboratory transfers very rapidly into marketable products.

Beton Tester: a tester for inert matter

Concrete is obtained by blending water, inert materials, cement and additives. Builders as well as concrete manufacturers need to know how much moisture is already present in inerts, so as to determine the optimum quantity of water to be added to the mix. The research project has come up with a perfect solution to the problem: Beton Tester, an instrument for measuring water content in inerts. Today, checking for water content can be done at three different stages of the concrete-production process: at the entrance to the silo (for example on the conveyor belt), at the exit of the respective silos, and on the scales. On the Alptransit building sites, in Pollegio, where Beton Tester has already been put to work successfully, water content in inerts is measured on the conveyor belts. Besides improving the quality of concrete, this system is commercially attractive, too; in fact, it helps curbing costs caused by purchases of excessively damp inerts. A further project, still being developed, consists in inserting the detectors straight into the concrete mixer, which has the advantage of measuring moisture and then remedy any possible water shortage without delay. This method is being road tested on the Alptransit building sites, in Pollegio, and it is expected to generate a new line of products in the next few months. The item seems to hold a peculiar appeal for companies active inthe building industry. Salvadè claims that: "Besides Holcim, Italcementi, the largest concrete producer in Italy, is planning to introduce sensors directly into their mixers and automated mixers, where concrete is made." A further outcome of this project is a portable measuring device to assess the quality of concrete, in the field and in real time. Determining the dielectric constant in each material is the basic principle, which generates a whole range of opportunities for even more application fields of WaveTester. This tester can then be applied like any other sort of material, e.g. skin, baked clay, wool, or wood. At the moment, the team headed by Professor Salvadè is setting up a new R&D project. One purpose is to test sizeable production lines in clay moulds; another is to carry out a feasibility study to develop a CAT scan (computerized axial tomography) for quality control in wood.

The sensor installed on a concrete mixer

Research at TTHF

The TTHF area (Telecom, Telematics and High Frequency) boasts expert knowledge in the field of information transport. Especially active in applied research, its several research projects include high frequency, metrology, non-ionising radiations, cable and wireless communication in general, security in telematics as well as in telecommunication, ad-hoc and sensory networks and the virtual network. On the strength of several close co-operations with local, national, and international industrial partners, the TTHF area has become a landmark, and made a name for itself mainly in high-frequency, telecom and non-destructive analysis of materials for firms keen to develop and implement new technologies. Moreover, TTHF provides enterprises with an opportunity to set up collaborative ventures within research programmes supported by the federal government.

In the picture: Professor Andrea Salvadè, director of the TTHF area.

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I M P R E S S U M

Project of the month
Nr. 13; december 2004
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