Concrete NEWS

FORCE TECHNOLOGY

No. 6 Newsletter from FORCE Technologys on concrete inspection and examination April 2006

In this issue

Editorial

In this current issue of Concrete News we will focus on how hidden magnetic and non-magnetic objects may be located easily, rapidly and without terminating on-going assignments by use of non-destructive measuring methods.

Among the other methods we have used, this is the first time the Metrotech-instrument is mentioned – a pipe and cable feeler gauge. The other mentioned methods are usually applied when detecting hidden objects and for evaluation of the quality of concrete structures.

For many years it has been a major wish to develop a hand-held voltmeter that collects many electrochemical potential measurements fast and easily. We have now developed such an instrument and it will be part of FORCE Technology's new instruments series in future. The instrument is called VMC/VMM for voltmeter with and without memory capacity.

Next issue of Concrete News is expected published at the end of the year.

Enjoy yourself reading!

Brián Kofoed
Editor

New products for supervising reinforcement corrosion

FORCE Technology has developed two new products for detection of reinforcement corrosion in concrete – a new probe and a new measuring device.

CorroRisk

The probe is a further development of the idea behind the already well-known probe CorroWatch and it work as a warning system for initiation of reinforcement corrosion. The CorroWatch is only designed for use in new structures, as it must be installed before concreting whereas the CorroRisk is applicable in existing structures to detect corrosion in the concrete cover and predict reinforcement corrosion.

CorroRisk mounted on a bridge pillar

The probes are hammered into predrilled holes in the existing concrete, which are then closed with a water-tight, not cement based material. The active part of the probe has good physical contact to the existing concrete, thus make it possible to measure the corrosion condition, exactly where it is placed. By distributing probes in various distances and depths in the concrete cover, information regarding the initiation of reinforcement corrosion may be obtained.

By use of the probe supplemented by the ERE 20 reference electrode embodied with a titanium net, electrochemical potential, corrosion current and the concrete resistance may be measured. These are parameters relevant for corrosion initiation and propagation and are thus recommended for continuous supervision. The probe has been developed during an EU project and tested over a number of years both in Denmark and abroad. The probe is especially recommended for use in difficultly accessible structures, such as e.g. tunnels, bridges in maritime environments, parking decks and in structures under water.

VMC/VMM - Volt Meter Converter/ Volt Meter with Memory

The measuring equipment has been developed specially for use with the ERE 20 reference electrode, but it may also be used as an ordinary voltmeter. The instrument is battery driven and may be used for hand-held potential measurements that require a very high input impedance (> 100 MΩ).

When potentials are measured against an embedded ERE20 reference electrode, they can easily be converted to an Ag/AgCl-electrode reading, often used for this kind of measurements also for concrete surfaces (half cell potential technique). All measurements may be stored in the instrument's memory that stores up to 1024 readings.

The new hand-held instrument

The instrument may also be applied for automatic measurement where it works as a typical 1 channel data-logger. The instrument is equipped with a date/time function to be set by use of a logically built-up menu, run by use of four arrow keys in the front panel. The stored data may be transmitted to a PC and may subsequently for data processing in a spreadsheet.

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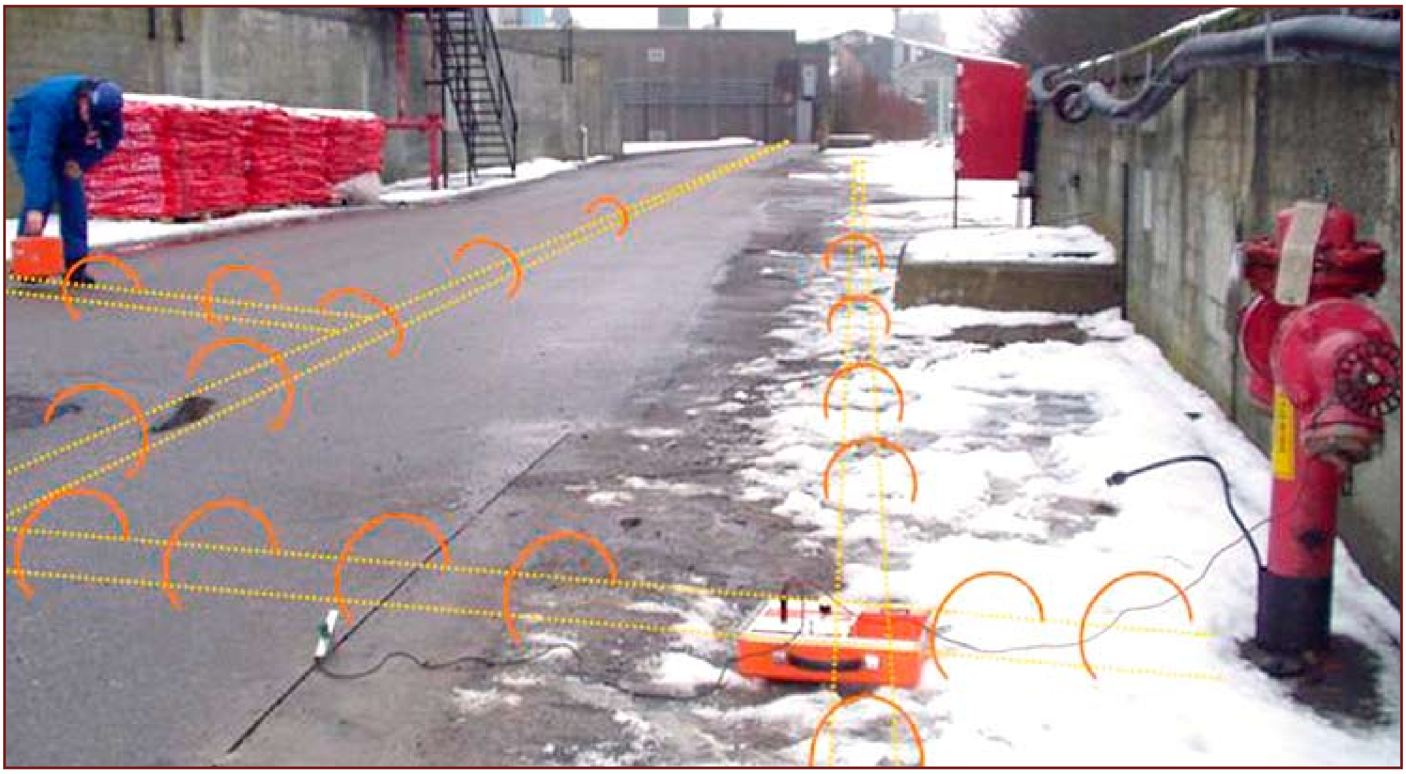
Localising embedded pipes



The transmitter is connected to the fire hydrant and to the ground via the ground plate. The FORCE Technology employee locates the pipe by using the reciver, which gives an acoustic signal when it is abowe the pipe.

Before considering major digging it is often an advantage to localise embedded pipes, both to avoid damaging the pipes and in order to dig in the right location if the purpose is to replace the pipes.

A Danish company needed their fire extinguishing system modified, which involved valve installations and establishment of wells at several locations in the embedded piping. Thus all 25 T-pieces and rotations were to be localised in a major industrial area.

Where are the pipes?

Local contractors had been hired to dig into the ground at the places where the owner assumed the pipes were placed. Over the past two weeks before FORCE Technology was involved the local contractors had engaged three men on the task. They had found the pipe at two locations by digging long trenches, unfortunately with up to 5 meters inaccuracy. In several of the excavated holes the pipe had not been located at all.

Fast result

FORCE Technology chose to use a Metrotech – pipe and cable locator – to trace the embedded piping. The method is the fastest and most efficient way to localise hidden and embedded pipes. The Metrotech works by attaching the transmitter to the pipe that shall be localised. The transmitter forms an electromagnetic field around the pipe. When the receiver is held parallel over the pipe the field lines will pass through the receiver antenna and thus give maximum signal.

The pipe is located in a depth of 1.8 m and with an accuracy of 20 cm.

By the use of this method specialists from FORCE Technology traced the embedded piping and branch connections in only 6 hours in an area of 2.5 hectare, and that with an accuracy of 20 cm at a depth of 1.8 m. – more than 30 cm deeper than what had originally been dug out.

One in many pipes

If one specific pipe in a large group needs to be located, it is necessary to connect the transmitter to the pipe – conductive coupling. The method can also be used by connections underground or in the air – so called inductive coupling.

Non-conductive materials can also be detected

The method may also be used for detecting non-conductive materials. However, this requires the input of a conductor, e.g. cleansing wire to be connected to the transmitter. If metallic marking tape has been placed over the piping or cables the method may also be used for localising such marking tape.

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Find the embedded cover plate for a 75 m³ water tank

It seems as an almost impossible task. The story is that the customer had had his yard coated with new asphalt, under which the large reserve water tank is embedded. Unfortunately, the locations of the cover plates had not been precisely marked, and a pump and some valves had to be replaced. The customer was not too keen on destroy the nice new asphalt layer. The water tank has two cover plates, of which one was visible, but the direction to the hidden cover plate was not known.

As can be seen on the figure, the cover was found by means of radar and it could be stated that the water tank was not oriented in the same direction as the adjacent buildings. Without the use of radar a lot of time and digging had been required in order to detect the cover plate.

Alternate applications

The radar technique is also used quite successfully to trace both first and second layers of reinforcement grid, cable ducts and large air- and water-filled gaps in asphalt, concrete and soil. The technique may also be applied to measure the thickness of rather thin reinforced concrete floors.

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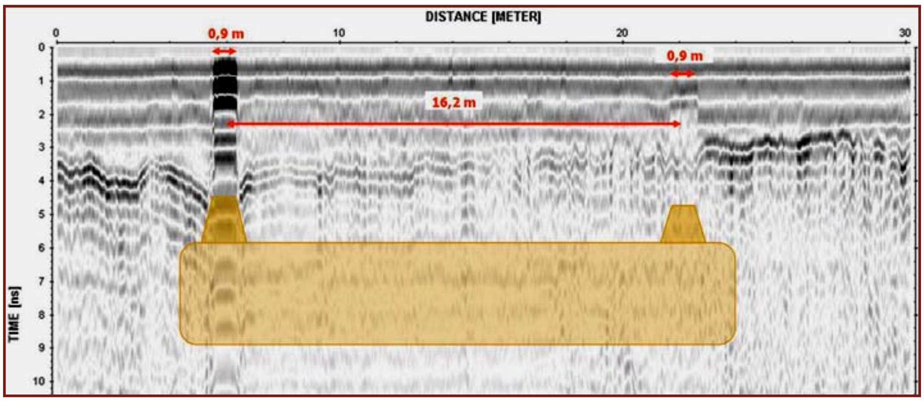


Radar profile with the two entrances stated. The red arrows indicates the width of the cover plates and the distance between the two cover plates.

Fact box

GPR is a high-resolution near-surface surveying tool. The immediate visual result is similar to a fish finder/ echo sounder. The transmitter antenna produces a short pulse of high frequency (10- 2000 MHz depending on antenna) of electromagnetic energy, which is transmitted into the material (concrete).

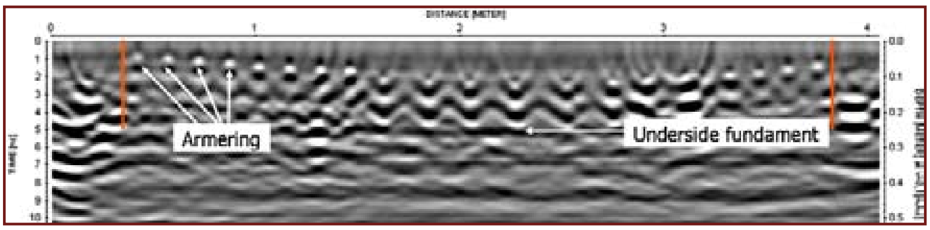
The propagation of the electromagnetic wave is dependent on the high frequency electromagnetic properties of the subsurface. The information received is based on the differences in the ability of the subsurface material to promote or reject the transmitted electromagnetic wave. The rejected (reflected) part of the signal, the amplitude and the two way travel time, is stored digitally. By recording the reflections along a survey-line versus the travel time, a depth section along the surveyed path is mapped.

The high scanning rate implies that great accuracy is achieved when the result of localising hidden objects seen in the radar scan is to be evaluated.

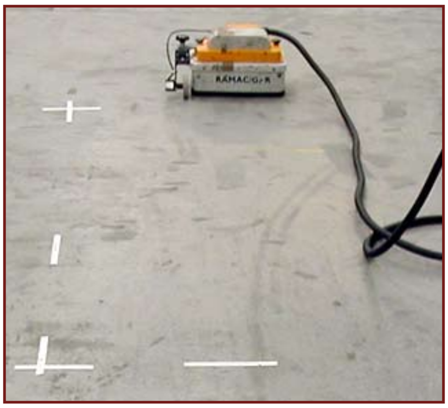
Can a foundation under an existing floor be located?

A customer needed to replace the existing equipment and machines in his factory hall by new ones and wanted to make sure that the floor could withstand the extra load. According to old architectural drawings without dimensions certain areas on the floor should have an extra thick and reinforced foundation, but the exact locations were somewhat uncertain. FORCE Technology was asked to help localising these areas.

We decided to localise the foundation by using radar techniques, as the method is fast for determining a structure profile. Nine scans were performed to determine the transition between the reinforced and non-reinforced floor. The scans detected the reinforced foundation and could also confirm that not only was the foundation rectangular, it also had areas of various width and length, as stated in the architectural drawings.



Exampel of the radar profile with the reinforcement indicated.



The Radar "on-the-job" finding the reinforced foundation.

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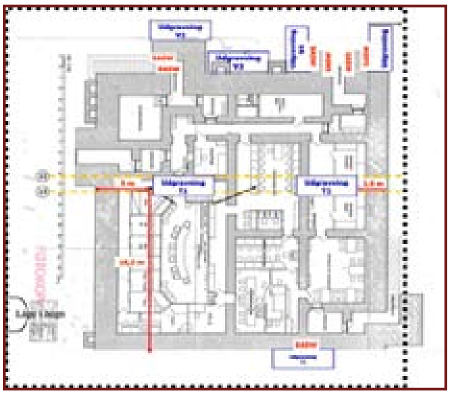
FORCE Technology examined the concrete in a German bunker from World War II.

The task was to determine the strength and homogeneity of the concrete in the up to two meter thick walls and ceilings in the abandoned 900 m^2 German bunker.

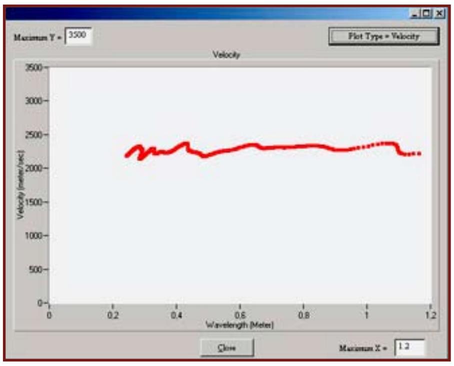


Layout of the old german bunker

The plan was to build a multi-purpose hall with the abandoned bunker as a sort of foundation. The owner himself did not doubt that the bunker would stand but he needed to be able to document it.

The SASW-method

The majority of FORCE Technology's examination was performed by using the SASW-method. The method was applied on the inside and outside of the walls and showed generally homogenous concrete.



An exampel of a velocity profile

The measured wave velocity does not vary a lot over the entire structure and the average speed is approximately 2450 m/s indicating good concrete quality. The measurements were supplied with core drill-outs up to 1.5 m into the structure for de-termining the compressive strength and E-module. The average compressive strength was 54.6 MPa and the static E-module was 34.6 GPa.

And the owner got his documentation.

Fact box

SASW - Spectral Analysis of Surface Waves - is the name given to an efficient non-destructive method for in-situ determination of shear stiffness. It is based on the dispersion effect that mechanical waves exhibit when travelling through an inhomogeneous media. This could be concrete, asphalt or even soil.

Since different wave lengths will be affected by the conditions at various depths from the surface the technique is able to map the shear stiffness vs. depth.

You get an idea of the sonic velocity through the structure and from this profile you can assess the concrete homogeneity and simultaneously detect defects, if any.

To a large extent FORCE Technology applies SASW to quickly determine concrete qualities, detecting defects and determining depth to the change-over between material layers.

The equipment is also used to calibrate the sonic velocity compared to other applied NDT methods.

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New Personnel

Allan Kristensen terminated his studies as a civil engineer from the Technical University of Denmark (DTU) in 2002. Prior to his employment with FORCE Technology he has worked with

operation and maintenance of Storebæltsbroen (the Great Belt Bridge).

Birgitte Leth terminated her studies as a civil engineer from the Technical University of Denmark (DTU) in 1996. From 1996 she was employed at Teknologisk Institut, where she worked

as a consultant on condition based assignments and failure analyses. Over the later years she has specialised in NDT-testing and examinations of concrete structures.

Peter Nygaard terminated his studies as a civil engineer from the Technical University of Denmark (DTU) in 2003. Peters Industrial Ph. D. project "Non-destructive Electrochemical Methods

for monitoring Reinforcement corrosion" has the aim of developing a new generation of the GalvaPulse instrument for measurement of corrosion in rein-forcement concrete.

Concrete *News* is a newsletter on concrete inspection and examination. The newsletter is published two to fore times a year.

The material may be copied, as long as the source is indicated.

Further information is available at www.forcetechnology.com

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