Concrete NEWS

FORCE TECHNOLOGY

No. 10 A newsletter from FORCE Technology on inspection and examination of concrete October 2009

This issue

Editorial

Welcome to this new edition of Concrete News, which is distributed to approximately 750 Danish and foreign recipients. This newsletter primarily deals with the problems of corrugated pipes in new building. Over the past years we have seen an increase of tasks in which a building's stability may be the reason for lacking or poor concreting of corrugated pipes. We have encountered error margins up to 20 %.

We use an advanced seismic non-destructive measuring method called Impact Echo or Ultrasonic Pulse Echo. The principles of both methods are described partly in an article in this Concrete News partly in Concrete News no.4.

Based on this increase in assignments FORCE Technology's Concrete department has invested in new American equipment, an Impact Echo scanner, described in detail in this issue of Concrete News. The new equipment is more efficient, as the lack of measurements allows us to perform faster and more accurately, and will provide us with a better basis for assessments.

Finally, as mentioned in previous issues of Concrete News, we are very pleased to launch new measuring equipment for measuring minor corrosion currents according to the 0-ohm ampere meter principle.

The next edition of Concrete News is expected released in the early summer 2010.

Enjoy your reading.

Brián Kofoed
Editor

Embedded corrugated metal ducts in concrete elements need checking

For some years now FORCE Technology has seen an increase in cases with embedded corrugated metal ducts in new constructions with missing or poor embedding leaving the structure without the required stability. We have found failure rates up to 20 %.

View in perimeter column showing granular material in corrugated metal duct, i.e. incoherent sand-like material.

Today many wall and column elements mounted at site contain embedded corrugated metal ducts for insertion of tensile reinforcement. After assembling the elements and tensile reinforcement, the corrugated metal ducts are embedded directly on-site with grout.

Frost reveals defects

Often a defect is discovered late in the construction work, or maybe it is not found at all which complicates and adds costs to locate defective embedding and subsequent repair. In all the tasks that FORCE Technology has been involved, the defect has only been detected because the concrete elements have burst due to impact of frost as a consequence of wet grout, which has not hardened properly, or water in the metal ducts. Having established defects in elements due to wrong embedding it has been questioned whether other embedded corrugated metal ducts in the constructions are defect. It may not be all elements that have been exposed to frost and thereby "tested". Therefore examinations have been initiated, during which FORCE Technology has located incorrect embedding by advanced nondestructive testing equipment to trace the ducts where repair works were necessary. In some cases we have also performed forensic examination.

Test drilling where nondestructive measuring has localised faulty embedding. Wet/moist grouting material and not dry drill dust may be seen on the shown 12 mm drill bit.

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Only the tip of the iceberg

It turned out that the burst elements were only the tip of the iceberg. Failure rates up to 20 % have been found in several large constructions. The failures have been corrected in these constructions, but it has been expensive and time-consuming. Further to costs of examination and repairs there have been additional costs to repeated paint work.

Breaking up of the wall and corrugated metal duct containing soft/wet grouting material.

Documentation required

Last years' experience shows that the quality of embedding in corrugated metal ducts should be documented. Concurrently a lot of money may be saved by examinations far earlier in the building process. A random check should be performed already when the first ducts have been embedded and should have the required strength. This will detect erroneous choice of method, procedure or product at an early stage so that it will only prolong and raise the costs of the building process minimally.

Today there are undoubtedly constructions with inadequate embedding that have not yet been found because the elements have no visible damages. It is not reassuring!

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Fact box

Forensic examination of concrete is defined as the necessary line of examinations and tests needed to describe the cause of failure, deterioration or reason for not meeting product specifications.

The typical line of forensic test used in concrete technology includes nondestructive acoustic, radiologic and electromagnetic and electrochemical methods for describing the structure on the site. The laboratory physical and chemical tests, on samples from the structure in spec, are combined with macroscopic and microscopic examinations to find the cause of failure. Also simulation of the failure can be performed.

Core drilling in column showing separated material in the corrugated metal duct, i.e. cement paste. The crack is caused by frost burst in the corrugated metal duct.

Fact box NDT:

Erroneously embedded corrugated metal ducts can be located by advanced seismic nondestructive testing devices e.g. Impact Echo or Ultra Puls Echo. The two types of equipment are based on reflection of ultrasonic waves or transient stress waves, respectively, caused by mechanical low energy impact of the surface measuring the reflection time of the wave. When the material velocity is known, e.g. 4000 m/s for good concrete (p-wave), the depth to reflection can be calculated.

The waves are reflected by difference in acoustic impedance (density x wave speed) e.g. at transition between concrete and air. The depth at which the reflection is found equals the element thickness provided that the ducts are fully embedded.

If the embedding is faulty in the corrugated metal ducts, the wave reflection depth will be increased. The waves propagate with reduced velocity through water or wet grout, which is why the reflection time and the calculated reflection depth are increased. If the corrugated metal duct is empty, the way of the wave through the material is elongated (the wave must propagate around the empty duct) and the actual reflection depth is augmented.

Erroneously embedded metal ducts in walls are easily detected by a specialist. Columns and integrated elements can also be examined - however this assessment requires a greater understanding of how waves are reflected by other geometries. Further to locating defective elements, we can also define good and bad areas on each element.

Impact Echo Scanner

Over the last couple of years FORCE Technology has seen an increase in problems with incorrect casting of corrugated metal ducts.

When FORCE Technology inspects ducts for problems with nondestructive measuring equipment, called NDT, Impact Echo measuring is often used. When doing Impact Echo measuring an impact-generated stress wave propagates through the concrete and then reflects to the receiver. By analysing the returned signal, it can be detected whether the corrugated metal duct is cast correctly, or whether it contains water, separated material without strength and homogeneity, or air. By normal Impact Echo measuring a manual reading is taken for each 10-20 cm along the whole duct. Each measuring point comprehends several single readings. It takes about 10 minutes to perform a measurement of a 3-metre long duct including preparation with marking of the measuring points.

More efficient and accurate measuring

To make measuring more efficient and accurate FORCE Technology has invested in a new instrument for locating defects in corrugated metal ducts.

The instrument is still based on Impact Echo measuring but instead of measuring manually at each reading point, the new equipment automatically performs readings for each 2.5 cm when the measuring instrument is pulled across the concrete surface with a velocity of 6 metres/minute. This instrument is called the "Impact Echo Scanner" and consists of a small carriage with a geophone on its underside, constantly in contact with the concrete surface. The geophone is the part receiving the stress wave when reflected from the concrete. Beside the geophone, a fitted solenoide strikes the concrete for each 2.5 cm, generating the stress wave propagating through the concrete.

Improved software

By use of the new equipment it is expected that measuring on a 3-metre long duct may be performed in roughly 2 minutes including preparation, i.e. 5 times as fast as with the previous form of Impact Echo measuring. Moreover 4-8 times as many readings are being performed, increasing the accuracy when analysing the results. Improved software also makes the analysis and documentation on measuring more manageable for the benefit of the operator as well as the customer. When applying the previously used Impact Echo equipment, documentation might take just as long time as it took to perform the readings; with the new Impact Echo Scanner and the improved software it is done automatically.

The Impact Echo Scanner may also be used to track anomalies in concrete, to detect areas with delamination, to control thickness measurements and for many other purposes.

Manual measuring is still applicable

The new device requires a relatively smooth surface. In addition thick plaster coats may muffle the generated stress wave so that a useful reflection from the concrete is made impossible. Therefore it may be necessary to use the old, manual Impact Echo measuring; however the improved software may still be applied.

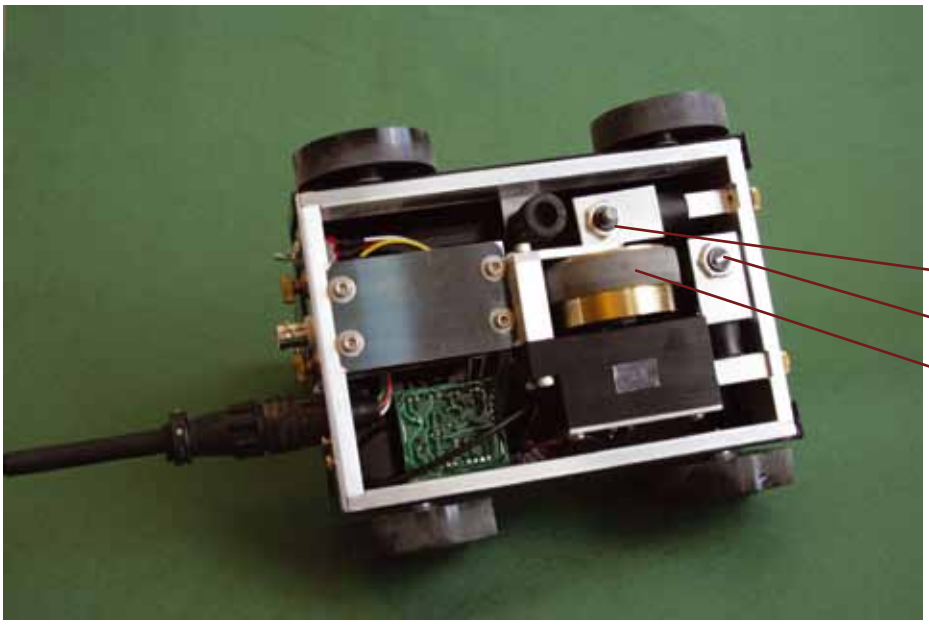
Fact box

An electrical solenoide consists of a loop of wire (electrical coil) and a massive, magnetic spring-loaded iron cylinder. When primarily direct current passes through the coil, it functions as an electromagnet. As a result the iron cylinder is pulled into the coil thereby pushing/shooting the iron cylinder end quickly onto the concrete surface. The spring pulls the cylinder back again, ready for the next measurement.

A geophone is built of a permanent magnet surrounded by a coil, hung up in leaf springs so that the coil may move up and down along the permanent magnet.

When an echo from a material boundary gets up to the concrete surface, the concrete surface momentarily shakes in an up-and-down movement. The geophone follows this movement, and it is designed to transform the movements into an electric current which can subsequently be converted into frequency and depth to the material boundary.

Source:
http://da.wikipedia.org/wiki/Solenoide
http://virtuelgalathea3.dk/node/635



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New handheld device for corrosion current measurements

A new product in FORCE Technologys series of handheld waterproof instruments and loggers is expected to be released in January 2010.

For the last year FORCE Technology has developed a "zero-ohm" ampere meter with high impedance voltmeter inputs. This device has been used in data-logger arrangements. But now the same technique is made specially for measuring low corrosion current at our probes called CorroWatch and CorroRisk-probes, or other corrosion current-applications.

Therefore the new device will be designed to measure and log:

- 4 "zero-ohm" ampere meters with high impedance voltmeter inputs
- 1 high impedance voltmeter input for reference electrode
- 1 temperature resistor input

These measurements are needed for evaluation of the CorroWatch multiprobes.

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System specifications:

Input range - Voltage inputs - Current inputs	 ±2000 mV ± 2000 µA
Reference electrode types	All types
Input impedance - Voltage inputs - Current inputs	 >20 Mohm <100 Mohm
Resolution	1 mV/1uA/0.1°c
Temperature coefficient	< 20 ppm/°c
Power source	Internal NiMH battery
Battery lifetime	Approx 60 hours
Sealed	IP65
Ambient temperature range when - Measuring - Charging	 - 10°c to 40°c 5°c to 40°c
Size including terminals	H: 40mm W: 85mm L: 185mm
Weight	Approx 450 g
Log size	1024 measurements

Testing of anchors in concrete

Recently FORCE Technology has experienced an increasing interest in testing concrete anchors - embedded anchors as well as drop in anchors and other types of metal anchors.

FORCE Technology has standardised equipment capable of pulling anchors up to 100 KN. If so desired, the displacement can be measured simultaneously with tensile testing. The equipment is portable, and testing may therefore be performed anywhere. FORCE Technology is also able to design special setups if testing of anchors with greater tensile strength than 100 KN is required.

FORCE Technology may further be of assistance by providing design criteria for test samples to ensure anchor testing under correct conditions, without boundary conditions and distance to other anchors influencing the expected fracture zone. We may also be of service manufacturing test samples and storing until testing, if so desired.

FORCE Technology is able to perform all sorts of anchor tests.

While performing our latest task within testing of embedded anchors for concrete we assisted the client in the following:

- Design requirements for test samples.
- Design requirements for concrete recipe.
- Test sample casting and preparation based on design requirements and concrete recipe.
- Tensile testing of test samples until fracturing.
- Compressive strength determination of concrete during tensile testing.
- Documentation on test sample manufacturing and tensile testing, i.e. videotaping, photos and reports.

We may also perform experiments for transversal strength determination, examination of steel quality used for manufacturing anchors, and all other types of anchor testing that the client might desire. We also test mountain anchoring and other kinds of fastening.

Fracture in anchor as a result of tensile testing.

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Concrete *News* is a newsletter on inspection and examination of concrete.

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For more information please visit our website: www.forcetechnology.com

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