MISTRAS
A World of NDT Solutions
Services Division

Application Brief

Nondestructive Concrete Testing

Introduction

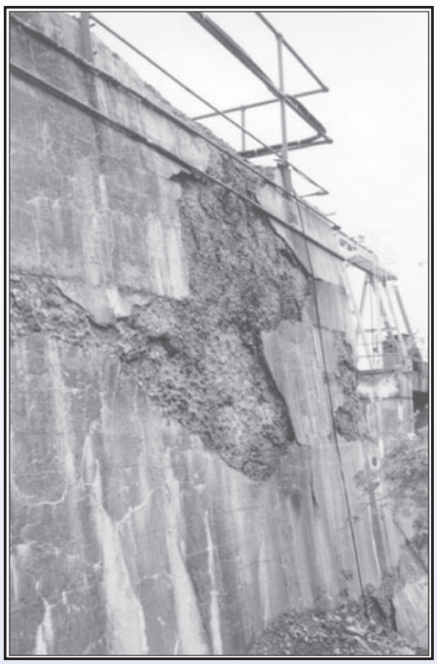
MISTRAS Group's Service Division offers a complete range of inspection, training and QA/QC services. We integrate innovative, new technologies with conventional testing methods to assure the integrity of industrial materials and components as cost effectively as possible.

Concrete structures are one of the many industries that uses our nondestructive testing techniques to detect, locate and assess structural problems.

Current Condition

Concrete is one of the most widely used construction materials for a wide variety of structural and architectural elements. But concrete can suffer from several forms of in-service deterioration. The most common deterioration modes are corrosion-induced delaminations and spalling. The corrosion process is driven by moisture and oxygen that can permeate the concrete.

Freeze-thaw damage can also deteriorate in-service concrete. This is a progressive deterioration of the concrete material caused by the entrance of water (into the concrete pores) that subsequently expands when it freezes, introducing tensile stresses that can cause concrete to crack. Freeze-thaw damage leads to a generalized deterioration of the concrete strength properties, widespread cracking, spalling, and eventually loss of section.



In addition to in-service deterioration, construction related factors can undermine concrete durability. These include low cover, honeycombing, and voids. Low cover occurs when insufficient material is placed between the embedded rebar and the atmosphere.

This lets water reach the rebar and accelerates corrosion. Honeycombing and voids usually result from: (1) improperly vibrated concrete, (2) a lack of workability (plasticity) of wet concrete, (3) a rebar layout that does not allow the concrete to completely fill the forms, or (4) a combination of these factors. Discontinuities introduced during construction can lead to poor durability, reduced load carrying capacity, and poor aesthetic quality of the finished concrete.

Application Solutions

Non-Destructive Examination (NDE) provides cost-effective and reliable methods for identifying deficiencies in concrete. Methods ranging from very simple to highly technical are employed depending on the purpose where the simplest, least expensive method that will yield the required results is selected. Hammer sounding is a rudimentary approach in which a common hammer is used to strike the surface of the concrete. Hollow or dull tones that can be heard and recognized by the inspector indicate the existence of relatively shallow delaminations in the structure. Hammer sounding can also be useful for locating areas of severe damage to the cement matrix that correspond to reduced strength.

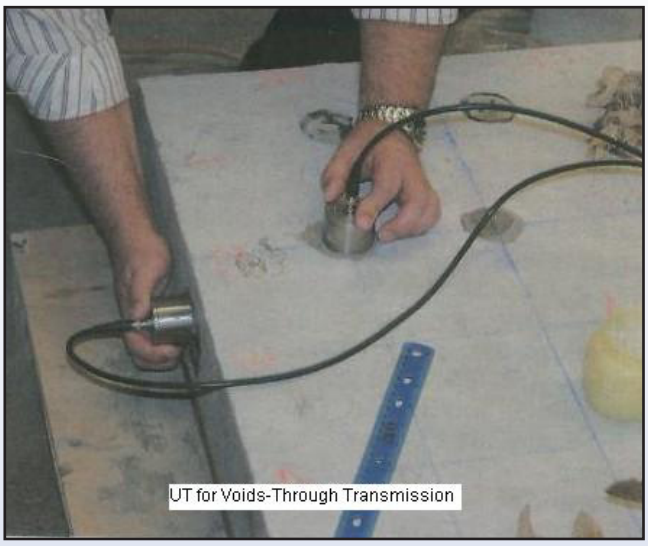
Related to the sounding technique is the impact echo method. Impact echo consists of striking the concrete surface with a spring-loaded device, a small, hardened steel ball four to 20 mm (0.16 to 0.8 in.) in diameter. Stress waves generated by the impact propagate in the concrete and are detected by either a piezoelectric displacement transducer or an accelerometer located adjacent to the impact location. Data are collected over sufficient time to allow for several

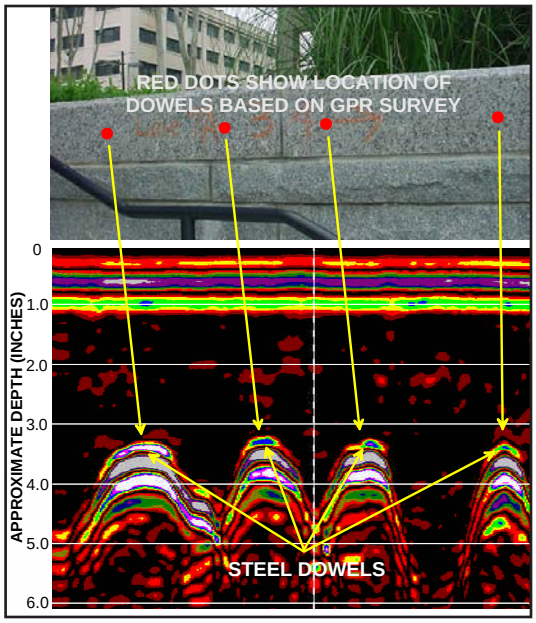
reflections of a primary wave (longitudinal or p-wave) through the thickness of the concrete. This method is effective for estimating the thickness of a concrete slab and can also be applied to the detection of subsurface defects including delaminations and voiding.

Ground Penetrating Radar (GPR) is another safe and effective way to locate buried obstructions in concrete structures. The system locates rebar, post-tension cables, conduits and voids, inspects walls, floors, bridge decks, tunnels, balconies, parking garages, etc., measures slab thickness and locates targets to a depth of 18" and more.

Ultrasonic pulse velocity provides a tool for the qualitative assessment of concrete material properties. This method uses the travel time of a longitudinal wave over a known distance to measure the pulse velocity. The quality of the concrete is inferred from the pulse velocity, with lower velocity corresponding to poorer quality concrete. This method can be effective for estimating the extent of damage resulting from fire or freeze-thaw cycles, detecting poor quality concrete, and is commonly applied to detect internal honeycombing or voids.

Thermographic cameras can be used to detect subsurface defects in concrete. Delaminations can disturb the thermal transfer properties of the concrete and result in temperature variations at the surface of the concrete. Under proper conditions, these temperature variations can be detected using commonly available infrared cameras. Daily ambient temperature variations provide a temperature gradient in the concrete sufficient to provide temperature contrast between the delaminated area and the intact concrete. In practice, the method is complicated by many factors that contribute to the temperature contrast apparent in images. These include variations in material properties, variations in moisture content of the concrete, debris typically found on bridge decks, and variable environmental conditions.


UT for Voids-Through Transmission



Magnetic concrete covermeters are widely used to estimate the thickness of concrete (cover) over embedded rebars. The meters produce a time varying magnetic field that interacts with the ferromagnetic rebars and is monitored with a search coil. The method works best when the meter head is located over a single rebar.

The methods described are just a few of the nondestructive testing technologies available for inspection of concrete structures. Many other methods exist with widespread use, including half-cell potential measurements, rebound hammers (e.g. Windsor Probe and Swiss Hammer), and many variations of the acoustic methods described herein.

MISTRAS Services, a member of MISTRAS Group, Inc., is a team of skilled researchers, engineers, technicians and manufacturing personnel dedicated to the development of practical and cost saving solutions to your challenging inspection needs.

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