Non Destructive Testing of Structures

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***Abstract*— Non destructive testing(NDT) is used to obtain material properties and specimens without the destruction of specimens .It is also used to do the structural health monitoring. Rebound hammer,Ultra pulse velocity, Electric resistivity meter test and Vibration base analysis are useful in monitoring structural health . By using visual inspection,NDT,laboratory and field test performance structure can be analyse. A review of these tests have been provided for structural health monitoring of a RCC structure .The easiest and the most fundamental method is to inspect existing structures and,visual inspection. This presentation aims on the explanation of NDT techniques and their application to structure.**

Keywords: Reboundhammer, Ultrapulsevelocity, Electric resistivity meter test .

I. INTRODUCTION

Non destructive testing (NDT) is a group of analysis techniques .It is used to evaluate the properties of a material, component or system without causing damage**.** NDT does not permanently alter the article being inspected. It is a highly-valuable technique that can save both money and time in product evaluation, troubleshooting, and research. NDT methods like ultrasonic, magnetic-particle, liquid penetrant, radiographic, and eddy-current testing are the common NDT methods.It is also used in forensic engineering, mechanical engineering, electrical engineering, civil engineering, systems engineering, medicine, and art.

Typical situations where non-destructive testing may be useful are, as follows:

(1)Quality control of pre-cast units

(2)Removing uncertainties about the acceptability of the material supplied owing to apparent non-compliance with specification

(3)Confirming or negating doubt concerning the workmanship involved in batching,mixing,placing, compacting or curing of concrete

(4) Locating and determining the extent of cracks, voids, honeycombing and similar defects within a concrete structure

(5) Determining the concrete uniformity, possibly preliminary to core cutting, load testing or other more expensive or disruptive tests

(6) The position, quantity or condition of reinforcement can be determine.

(7) Increase the confidence level of a smaller number of destructive tests application or similar purpose .

II. NON DESTRUCTIVE TESTING

Non destructive testing (NDT) are non invasive techniques. For examining the integrity of a Material, component or structure or quantitatively measure some characteristic of an object NDT can be used. It is implemented without doing harm, stress or destroying the test object. It is also inappropriate in many circumstances. NDT is significant in ensuring cost effective operation, safety and reliability of plant. It also provides resultant benefits to the community. NDT is mainly used in industrial areas also it is used for any stage in the production and life cycle of many components. Aerospace and civil structures, power generation, automotive, railway, petrochemical and pipeline markets are the mainstream applications. NDT is mainly used in welds.

The most common NDT Methods are discussed in this presentation. In order of most used, they are: Ultrasonic Testing (UT), Radiographic Testing (RT), Liquid penetrant Testing, Magnetic particle Testing, Electromagnetic Testing (ET) in which Eddy Current Testing (ECT) is well known and Acoustic Emission (AE or AET). Besides the main NDT methods, other NDT techniques are Shearography Holography, Microwave etc. Both old and new structures the NDT can be applied. The testing of existing structures is usually related to an assessment of structural integrity or adequacy. In either case, if destructive testing alone is used, for instance, by removing cores for compression testing, the cost of coring and testing may only allow a relatively small number of tests to be carried out on a large structure which may be misleading.

NDT techniques/methods depends upon four main criteria:

- Material Type
- Defect Type
- Defect Size
- Defect Location

The NDT being fast and it is easy to use at site. It is relatively less expensive can be used for,

- Any number of pointes and locations can be tested
- The actual condition of reinforcement can be assessing
- Main objective of assessment is to ensure that structure and its different parts do not fail under its loading condition.
- Assessment is carried out so that its maximum resistance capacity can be observed.
- Cracks, voids, fractures , honeycombs and weak locations can be detected
- Reduce the local damage affecting the life span of structures.
- To remove excessive vibration which causes discomfort to mankind
- Scanning for reinforcement location ,stress location
- Overall stability of the structure can be assess

III. LIQUID PENETRATION

Dye penetrant inspection (DPI), also called liquid penetrant inspection (LPI).It is widely applied and low-cost inspection method.It is used to locate surface-breaking defects in all non-porous materials . The penetrant may be applied to all non-ferrous materials. For inspection of ferrous components magnetic-particle inspection is preferred for its subsurface detection capability. LPI is used to inspect and detect casting and forging defects,cracks, and leaks in new products, and fatigue cracks on in-service components. Limited training is required for the operator , low testing costs are the merits of this technique.

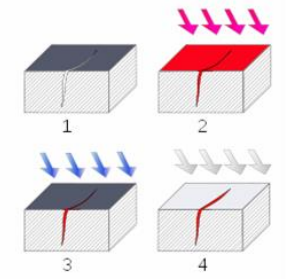

Fig 1 : liquid peneteration

IV. ELECTROMAGNETIC TESTING

Electromagnetic Testing (ET), is a form of nondestructive testing. It is the process of inducing electric currents or magnetic fields or both inside a test object and observing the electromagnetic response. When the test is set up properly the defect inside the test object creates a measurable response "Electromagnetic Testing" is mean eddy-Current Testing (ECT). However with an expanding number of electromagnetic and magnetic test methods, "Electromagnetic Testing" is used to mean the whole class of electromagnetic test methods. Eddy-Current Testing is just one common methods of Electromagnetic Testing

a.Eddy Current Technique

The principle of the eddy current technique is depend on the interaction between a magnetic field source and the test material. This interaction induces eddy currents in the test piece .

Eddy current testing is very fast at automatically inspecting semi-finished products . The results of eddy current testing are practically instantaneous.

It permits crack detection in large variety of conductive materials, either ferromagnetic or non-ferromagnetic. Another advantage of the eddy current method over other techniques is that without any direct physical contact between the sensor and the inspected piece inspection can be implemented.

V. RADIOGRAPHIC TESTING

Radiographic Testing (RT), is used for inspecting materials for hidden flaws using the ability of short wavelength electromagnetic radiation (high energy photons) to penetrate various materials. The amount of radiation emerging from the opposite side of the material can be detected and measured.Thickness of material can be determine by the variations in this amount (or intensity) of radiation. Penetrating radiations are restricted to that part of the electromagnetic spectrum of wavelength less than about 10 nano meters.

a. X-Ray Method

In this method for inspection purposes x rays of high frequencies are used.

Benefits:Metals, nonmetals, composites and mixed materials can be tested. Used on all shapes and forms; castings, welds, electronic assemblies, aerospace, marine and automotive components.

VI. ACOUSTIC EMISSION

Acoustic emissions are micro seismic activities originating from within the test specimen .It occurs when specimen subjected to an external load. Acoustic emissions are caused by local disturbances such as microcracking, dislocation movement, intergranular friction, etc. The acoustic signals (mechanical waveforms) convert to electric signals when an acoustic signal travels to a number of piezoelectric transducer.The electric signals are captured by digital oscilloscope. The time of arrival of the signal at each transducer depends on the distance of the transducer from the aerosource. To quantify the Nature of microfracture in various materials the source, frequency

and amplitude of the AE events have been used. By calculating the difference in time taken for the wave to arrive at the different transducers ,AE sources can determined. Using the ultrasonic pulse velocity method the velocity of the waves in the specimen can be determined

a.Parallel Seismic Method

The parallel seismic method belongs to low energy seismic methods. For testing concrete and reinforced concrete, precast or cast-on-site foundation piles as regards their length and the continuity of their cross section along the length parallel seismic method are used. For determining the length of steel and reinforced concrete sheet pilings , contiguous piles parallel seismic methods are used.In this method along the investigated element a hole will be bore. In this hole a hydrophone is placed . Along the pile the hydrophone can move in the hole. The pile's head is struck with a calibrated hammer After each strike the time it takes the acoustic wave to pass from the investigated element to the hydrophone is recorded.On the laptop dedicated software is installed and is used to process the registered signals in order to determine the acoustic wave passage time. A marked increase (sharp peak) in acoustic wave passage time registered along the length of the investigated element may indicate the element's length or a discontinuity in its crosssection.

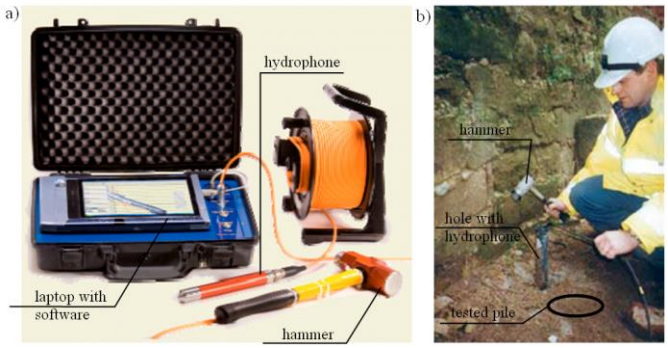

Fig 2: (a) measuring set , (b) typicaltest

a.Impulse Response Method

Detecting voids under concrete and reinforced concrete slabs laid on the ground, detecting the lack of interfacial cohesion (delaminations) in multilayer systems,locating defective areas and in homogeneities (honeycombing) in concrete elements, the impulse response method are very useful .In the impulse response method an elastic wave is induced in the tested element by striking its surface usingthe calibrated rubber-ended hammer in previously selected measuring points .By using the geophone the signal of the elastic wave propagating in the element is registered and is simultaneously amplified by the amplifier(with a maximum frequency of 1000 Hz). Dedicated software is installed on the laptop being part of the measuring set,so that the registered signals are processed.Maps of five characteristic parameters like average mobility (Nav), stiffness(Kd), mobility slope(Mp), mobility times mobility slope (Nav × Mp) and voids index(v) are obtained .

VII. MISCELLENEOUS METHODS

a.Visual Inspection

Visual testing is the most important of all non-destructive tests. It provides valuable information to the well trained eye. Visual features may be related to workmanship, structural serviceability, and material deterioration . It is particularly important that the engineer is able to differentiate between the various signs of distress which may be encountered. These include for instance, cracks, pop-outs,spalling, disintegration,colour change, weathering, staining, surface blemishes and lack of uniformity. Extensive information can be gathered from visual inspection. It gives a preliminary indication of the condition of the structure .

b . Schmidt Hammer

Using a spring-driven pin at a defined energy the test hammer hits the concrete. and then measures the rebound (in rebound units). The rebounds depends on the hardness of the concrete.It is measured by test equipment. When conducting the test the hammer should be held perpendicular to the surface which in turn should be at and smooth. It does not work well for small samples and will make marks. By reference to the conversion tables, the rebound value can be used to find out the compressive strength. In several different energy ranges Schmidt hammers are available from their original manufacturers

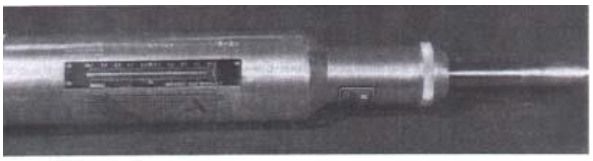

Fig 3: schmidt hammer

VIII. APPLICATIONS

a. Testing of Wood In Structures

To assess strength, homogeneity, humidity with the use of ultrasonic,radiological, dielectrical methods and Specialist testing on the cut-off samples the testing of wood and connections between elements in the structure are used.Quality of screw, bolt, nail or glue connections with the use of ultrasonic, thermovision and radiological methods as well as specialist methods on models and cut-off samples can be tested.Corrosion and biological destructions can be identify with the use of chemical methods .New techniques and methods using computer technologies are also being developed.

b. Steel Structure Testing

Following methods are mainly used in the diagnostics of steel structures

Ultrasonic, rotary current and radiographic methods as well as testing on cut-off samples are used to test strength properties of steel and connections in the structure.Non-destructive specialist methods and tests on models or cut-off samples are used to test elements, steel plates and connections. Acoustic, ultrasonic, electrical thermovision, electromagnetic and other methods are usedto test corrosion and protective layers.

c .Testing Walls In Structure

To test and assess walls in the building structures various methods are improved in order to:– assess strength and durability of bricks, joints and walls with the use of ultrasonic, radiological, sclerometric methods . The samples taken out of the structure;– assess structures, cavities, humidity, thickness and corrosion with the use of ultrasonic, radiological,thermovision, electrical and dielectrical methods.

d. Testing Of Concrete In Elements And In Building Structures

To assess compression strength and tensile strength, homogeneity ,size and distribution of honeycombing and cavities in concrete, concrete-concrete connections and steel-wood connections in nods, stiffness, thickness and destruction of elements diagnostic in situ testing of concrete in products, elements and structures are carried out.

e. Testing Of Plastic Elements

To assess strength, durability, resistance to UV-radiation and high temperatures, quality of connections, chemical and usable properties and radioactivity plastic elements are tested .The above testing is carried on directly on elements and on samples or elements taken out of the structure with the use of specialist methods in accordance with technical norms and approvals. For specific structures, products and special structural solutions the new specialist non-destructive testing methods are being developed.

IX. CONCLUSION

On the basis of the literature on the subject and their own research the current trend in the development of new non-destructive methods for the diagnostic testing of building structures is mainly towards detection of flaws and defects in concrete elements and structures and that acoustic methods predominate in this field. NDT testing can be applied for various concrete structures of the transportation network,like:bridges, tunnels,retaining walls, road pavements, underground structures, etc. For the same problem different methods can be applied ,but based on the features of the problem the best method can be choosen.

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