NONDESTRUCTIVE TESTING METHODS FOR CIVIL INFRASTRUCTURE pdf

1: NDT - Nondestructive Testing, Ultrasonic, Eddy Current, Radiography Web Resources Database

This proceedings, Nondestructive Testing Methods for Civil Infrastructure, contains papers presented in the sessions on nondestructive testing (NDT) for the Structures Congress held in Irvine, California on April , The purpose of this proceedings is to bring the modern NDT techniques that are being used in the aerospace and medical industries into the civil infrastructure.

Knovel Release Date Covers designing for testability, examination of welds, development of structural health monitoring protocols, evaluation of reinforced concrete, polymer composites, steel, aluminum, etc. More Covers designing for testability, examination of welds, development of structural health monitoring protocols, evaluation of reinforced concrete, polymer composites, steel, aluminum, etc. More For complex operating modalities and dimensionalities, the design and development of high-performance sensing and imaging systems represent the most direct and significant advances in the field of system analysis and signal processing. In this field, the core components are physical modeling, mathematical analysis, formulation of image reconstruction algorithms, performance evaluation, and system optimization. This book covers the full scope of these components, with an emphasis on the applications of system analysis and signal processing in acoustical sensing and imaging. This book ensures a broad appreciation of the design concepts, analysis, and development of high-performance sensing and imaging systems. More The papers which make up this volume reflect the very diverse nature of nondestructive evaluation; covering as they do topics ranging from traditional NDE to newly developing NDE methods such as structural health monitoring; where nondestructive technologies are rapidly progressing by integrating emerging technologies from various fields. The collection is divided into twenty-seven chapters: This thorough coverage will make it a quite indispensible reference work. More The aim of this 3-volume set is to bring together the expertise of scientists and engineers, in academia and industry, who are active in the field of non-destructive testing and evaluation. The papers cover activities which include analytical techniques as well as experimental case studies. The set consists of over papers, including three plenary papers: The headings of the various sections are: It describes a wide variety of NDT More This critical book is among the first to provide a detailed assessment of non-destructive testing methods for the many materials and thousands of parts in aircraft. It describes a wide variety of NDT techniques and explains their application in the evaluation and inspection of aerospace materials and components ranging from the entire airframe to systems and subsystems. At the same time the book offers guidance on the information derived from each NDT method and its relation to aircraft design, repair, maintenance and overall safety. This book also contains important instructional material for courses on NDT, composite materials, corrosion and inspection reliability. Applications are frequency control and detection More This edited work covers piezoelectric materials in the form of beams, plates, shells, and other structural components in modern devices and structures. Applications are frequency control and detection functions in resonators, sensors, actuators, oscillations, and other smart and intelligent structures. The contributions cover novel methods for the analysis of piezoelectric structures including wave propagation, high frequency vibration, material characterization, and optimization of structures. Understanding of these methods is increasingly important in the design and modeling of next generation devices and micro-structures with piezoelectric elements and effects. More Recent advances in fiber optic technology, and the possibility of their use in civil structures has instigated the development of a number of research activities in the civil engineering community. This book is intended for rapid dissemination of current state of the art on this emerging technology. Fiber optic sensors and smart structure technology have been successfully employed in space and aeronautics applications. With minimal research, these technologies can be applied to civil structures. It specifically deals with: More This project encompasses various aspects of bridge health-monitoring, maintenance and safety. The objective of the project is to introduce recent research results into the fields of bridge health monitoring, bridge maintenance and safety. It should be required reading not only for civil and mechanical engineers, but also municipal functionaries. To many engineers, the language of inverse analysis projects a mysterious and frightening image, an image made even more intimidating by the highl To many engineers, the language of inverse analysis projects a mysterious and frightening image, an image made even more intimidating by the highly mathematical nature of most texts on the subject. But the truth is that given a sound experimental strategy, most inverse engineering problems can be well-posed and not difficult to deal with. This book sets forth in clear, easy-to-understand terms the principles, computational methods, and algorithms of inverse analyses based on elastic waves or the dynamic responses of solids and structures. After describing the features of inverse problems, the authors discuss the regularization methods useful in handling ill-posed problems. The book also presents practical optimization algorithms, including some developed and successfully tested by his research group. With straightforward examples, a wealth of specific applications and clear exposition written by engineers for engineers, this book offers an outstanding opportunity to overcome any trepidation and begin using inverse analysis in practice. More With energy costs increasing, the gains to be made from weight-saving are most significant in the aerospace domain, but such gains are clearly also advantageous for road transport and this is even beginning to be recognised in shipbuilding. Consequently, improved reliability and resistance to degradation and durability in severe environments are always important requirements. Thus the development of composites, nano-composites and refractory alloys having specific properties has become a key factor in industrial and technological progress. Another challenge is the recyclability of advanced materials, as reflected by the emergence of projects involving thermoplastic-matrix composite fuselages. The purpose of these topics is to bring together researchers and specialists from universities and industry who are working on new composites and nano-composites, titanium alloys, etc. It identifies advances in measurement science and technology for nondestructive evaluation, and it details common measurement tro More This book examines electronics reliability and measurement technology. It identifies advances in measurement science and technology for nondestructive evaluation, and it details common measurement trouble spots.

NONDESTRUCTIVE TESTING METHODS FOR CIVIL INFRASTRUCTURE pdf

2: Nondestructive Testing Methods for Civil Infrastructure | ASCE

Papers highlight modern NDT techniquest used in the aerospace and medical industries that could be applied to civil infrastructure. Papers discuss new developments in NDT methods and their use in testing materials, building components, and highway structures.

Garden State Ballroom 9: Mr Xiangang Lai Co-Authors: Regency Ballroom ABC 9: NDE techniques have the potential to uncover internal defects as well as to estimate material properties with a relatively high spatial resolution at the material level. Other approaches that are often referred to as Structural Health Monitoring SHM provide information at a somewhat lower spatial resolution but the measurements attempt to assess the overall behavior of a structure structural level assessment. Both NDE and SHM share an inherent complexity and need proper understanding of the challenges, potentials, and shortcomings to extract reliable information. The authors are attempting to unveil some of these complexities to a relatively broad range of users including infrastructure owners, researchers, and industry stakeholders through the creation of a virtual laboratory website. The creation of this virtual laboratory represents the primarily goal of an ongoing federally sponsored research study. The Virtual laboratory contains interactive modules where users can learn through simulations or observe real NDE data. The virtual laboratory also attempts to show how different tools can be integrated to improve the decision making process in infrastructure management through case studies on real operating infrastructures with performance concerns. The paper provides highlights of the current content of the virtual laboratory. There are some presentation materials available for download. In order to download the materials, you must be logged in and registered for the event. Mr Roman Pinchuk Co-Authors: Ultrasonic material testing in its both functions â€” flaw detection and mechanical property evaluation â€” offers one of the possible instrumentation for the quality assurance in construction industry. Due to its unique deep penetrating capability, ultrasonic testing in certain cases remains the only suitable method for evaluating internal structure of large constructions. It allows extracting valuable additional information about slight acoustic impedance changes in the material by means of statistical processing of individual wavelets obtained by Dry Point Contact DPC transducer arrays and coherent integration of the impedance gradients. In the current contribution, the basic principles of the new technique are explicated and few application cases are cited showing the potential of the novel approach for variety of practical ultrasonic inspection tasks in the construction industry. Print this page 9: Mr Sascha Feistkorn Co-Authors: This includes the assessment of the practical needs, typical inspection tasks as well as the limitations of the applied methods regarding their reliability and accuracy. Among others, the analysis of former field inspections in Switzerland was carried out in more than 40 different individual projects as well as the development of new theoretical approaches. Therefore, the research partners conducted an extensive study in collaboration with large construction companies to analyze the scope of NDT-CE methods applied in the past decades in Switzerland. As a result, the most relevant difficulties were identified depending on field conditions, such as reinforcement ratio, moisture content, tendon duct material or the size of a discontinuity of the component inspected. To predict the success of a field inspection, the methods of POD Probability of Detection and GUM Guide to the Expression of Uncertainty in Measurement were used to quantify the performance and the accuracy of Radar and Ultrasound for common practical inspection tasks under different field conditions. As one result, typical penetration depth values of GPR applied on concrete have been calculated. Furthermore, the estimated success of the respective methods is provided as a function of different field conditions.

3: Introduction to Nondestructive Testing

*Nondestructive Testing Methods for Civil Infrastructure: A Collection of Expanded Papers on Nondestructive Testing from Structures Congress '93 [Hota V. S. Gangarao] on www.enganchecubano.com *FREE* shipping on qualifying offers.*

What Is Nondestructive Testing? Nondestructive testing NDT is the process of inspecting, testing, or evaluating materials, components or assemblies for discontinuities, or differences in characteristics without destroying the serviceability of the part or system. In other words, when the inspection or test is completed the part can still be used. In contrast to NDT, other tests are destructive in nature and are therefore done on a limited number of samples "lot sampling" , rather than on the materials, components or assemblies actually being put into service. These destructive tests are often used to determine the physical properties of materials such as impact resistance, ductility, yield and ultimate tensile strength, fracture toughness and fatigue strength, but discontinuities and differences in material characteristics are more effectively found by NDT. Today modern nondestructive tests are used in manufacturing, fabrication and in-service inspections to ensure product integrity and reliability, to control manufacturing processes, lower production costs and to maintain a uniform quality level. During construction, NDT is used to ensure the quality of materials and joining processes during the fabrication and erection phases, and in-service NDT inspections are used to ensure that the products in use continue to have the integrity necessary to ensure their usefulness and the safety of the public. It should be noted that while the medical field uses many of the same processes, the term "nondestructive testing" is generally not used to describe medical applications. NDT Test Methods Test method names often refer to the type of penetrating medium or the equipment used to perform that test. Current NDT methods are: Each of these test methods will be described here, followed by the other, less often used test methods. Magnetic Particle Testing MT Magnetic Particle Testing uses one or more magnetic fields to locate surface and near-surface discontinuities in ferromagnetic materials. The magnetic field can be applied with a permanent magnet or an electromagnet. When using an electromagnet, the field is present only when the current is being applied. When the magnetic field encounters a discontinuity transverse to the direction of the magnetic field, the flux lines produce a magnetic flux leakage field of their own as shown in Figure 1. The magnetic particles may be a dry powder or suspended in a liquid solution, and they may be colored with a visible dye or a fluorescent dye that fluoresces under an ultraviolet "black" light. As shown in Figure 2 a , an electric coil is wrapped around a central core, and when the current is applied, a magnetic field is generated that extends from the core down through the articulated legs into the part. This is known as longitudinal magnetization because the magnetic flux lines run from one leg to the other. When the legs are placed on a ferromagnetic part and the yoke is energized, a magnetic field is introduced into the part as shown in b. Because the flux lines do run from one leg to the other, discontinuities oriented perpendicular to a line drawn between the legs can be found. Because the magnetic field between the prods is travelling perpendicular to a line drawn between the prods, indications oriented parallel to a line drawn between the prods can be found. Coils Electric coils are used to generate a longitudinal magnetic field. When energized, the current creates a magnetic field around the wires making up the coil so that the resulting flux lines are oriented through the coil as shown at the right. Because of the longitudinal field, indications in parts placed in a coil are oriented transverse to the longitudinal field. Heads Most horizontal wet bath machines "bench units" have both a coil and a set of heads through which electric current can be passed, generating a magnetic field. Most use fluorescent magnetic particles in a liquid solution, hence the name "wet bath. When testing a part between the heads, the part is placed between the heads, the moveable head is moved up so that the part being tested is held tightly between the heads, the part is wetted down with the bath solution containing the magnetic particles and the current is applied while the particle are flowing over the part. This type of inspection is commonly called a "head shot. The part is then wetted down with the bath solution and the current is applied, travelling through the central conductor rather than through the part. The ID and OD of the part can then be inspected. As with a head shot, the magnetic field is perpendicular to the current flow, wrapping around the test piece, so indications running axially down the length of the part can be found using this technique. Liquid Penetrant Testing PT The basic principle of liquid penetrant testing is that when a very low viscosity highly fluid liquid the penetrant is applied to the surface of a part, it will penetrate into fissures and voids open to the surface. Once the excess penetrant is removed, the penetrant trapped in those voids will flow back out, creating an indication. Penetrant testing can be performed on magnetic and non-magnetic materials, but does not work well on porous materials. Penetrants may be "visible", meaning they can be seen in ambient light, or fluorescent, requiring the use of a "black" light. The visible dye penetrant process is shown in Figure 7. When performing a PT inspection, it is imperative that the surface being tested is clean and free of any foreign materials or liquids that might block the penetrant from entering voids or fissures open to the surface of the part. After applying the penetrant, it is permitted to sit on the surface for a specified period of time the "penetrant dwell time" , then the part is carefully cleaned to remove excess penetrant from the surface. When removing the penetrant, the operator must be careful not to remove any penetrant that has flowed into voids. A light coating of developer is then be applied to the surface and given time "developer dwell time" to allow the penetrant from any voids or fissures to seep up into the developer, creating a visible indication. Following the prescribed developer dwell time, the part is inspected visually, with the aid of a black light for fluorescent penetrants. Most developers are fine-grained, white talcum-like powders that provide a color contrast to the penetrant being used. These penetrants are usually visible in nature, commonly dyed a bright red color that will contrast well against a white developer. The penetrant is usually sprayed or brushed onto the part, then after the penetrant dwell time has expired, the part is cleaned with a cloth dampened with penetrant cleaner after which the developer is applied. Following the developer dwell time the part is examined to detect any penetrant bleed-out showing through the developer. They are most often applied by dipping the part in a penetrant tank, but the penetrant may be applied to large parts by spraying or brushing. Once the part is fully covered with penetrant, the part is placed on a drain board for the penetrant dwell time, then taken to a rinse station where it is washed with a course water spray to remove the excess penetrant. Once the excess penetrant has been removed, the part may be placed in a warm air dryer or in front of a gentle fan until the water has been removed. The part can then be placed in a dry developer tank and coated with developer, or allowed to sit for the remaining dwell time then inspected. Post-emulsifiable penetrants are applied in a similar manner, but prior to the water-washing step, emulsifier is applied to the surface for a prescribed period of time emulsifier dwell to remove the excess penetrant. When the emulsifier dwell time has elapsed, the part is subjected to the same water wash and developing process used for water-washable penetrants. Emulsifiers can be lipophilic oil-based or hydrophilic water-based. Radiographic Testing RT Industrial radiography involves exposing a test object to penetrating radiation so that the radiation passes through the object being inspected and a recording medium placed against the opposite side of that object. For thinner or less dense materials such as aluminum, electrically generated x-radiation X-rays are commonly used, and for thicker or denser materials, gamma radiation is generally used. Gamma radiation is given off by decaying radioactive materials, with the two most commonly used sources of gamma radiation being Iridium Ir and Cobalt Co The recording media can be industrial x-ray film or one of several types of digital radiation detectors. With both, the radiation passing through the test object exposes the media, causing an end effect of having darker areas where more radiation has passed through the part and lighter areas where less radiation has penetrated. If there is a void or defect in the part, more radiation passes through, causing a darker image on the film or detector, as shown in Figure 8. When exposed to radiation these crystals undergo a reaction that allows them, when developed, to convert to black metallic silver. That silver is then "fixed" to the plastic during the developing process, and when dried, becomes a finished radiographic film. To be a usable film, the area of interest weld area, etc. These items are a function of the strength of the radiation, the distance of the source from the film and the thickness of the part being inspected. If any of these parameters are not met, another exposure "shot" must be made for that area of the part. This technique uses a reusable, flexible, photo-stimulated phosphor PSP plate which is loaded into a cassette and is exposed in a manner similar to traditional film radiography. The cassette is then placed in a laser reader where it is scanned and translated into a digital image, which take from one to five minutes. The image can then be uploaded to a computer or other electronic media for interpretation and storage. The CT image is developed from multiple views taken at different viewing angles that are reconstructed using a computer. With traditional radiography, the position of internal discontinuities cannot be accurately determined without making exposures from several angles to locate the item by triangulation. With computed tomography, the computer triangulates using every point in the plane as viewed from many different directions. The three principle technologies used in direct digital imaging are amorphous silicon, charge coupled devices CCDs , and complementary metal oxide semiconductors CMOSs. These images are available for viewing and analysis in seconds compared to the time needed to scan in computed radiography images. The increased processing speed is a result of the unique construction of the pixels; an arrangement that also allows a superior resolution than is found in computed radiography and most film applications. Ultra-high frequency sound is introduced into the part being inspected and if the sound hits a material with a different acoustic impedance density and acoustic velocity , some of the sound will reflect back to the sending unit and can be presented on a visual display. By knowing the speed of the sound through the part the acoustic velocity and the time required for the sound to return to the sending unit, the distance to the reflector the indication with the different acoustic impedance can be determined. The most common sound frequencies used in UT are between 1. The two most commonly used types of sound waves used in industrial inspections are the compression longitudinal wave and the shear transverse wave, as shown in Figure Compression waves cause the atoms in a part to vibrate back and forth parallel to the sound direction and shear waves cause the atoms to vibrate perpendicularly from side to side to the direction of the sound. Shear waves travel at approximately half the speed of longitudinal waves. Sound is introduced into the part using an ultrasonic transducer "probe" that converts electrical impulses from the UT machine into sound waves, then converts returning sound back into electric impulses that can be displayed as a visual representation on a digital or LCD screen on older machines, a CRT screen. If the machine is properly calibrated, the operator can determine the distance from the transducer to the reflector, and in many cases, an experienced operator can determine the type of discontinuity like slag, porosity or cracks in a weld that caused the reflector. Because ultrasound will not travel through air the atoms in air molecules are too far apart to transmit ultrasound , a liquid or gel called "couplant" is used between the face of the transducer and the surface of the part to allow the sound to be transmitted into the part. If the sound hits an internal reflector, the sound from that reflector will reflect to the transducer faster than the sound coming back from the back-wall of the part due to the shorter distance from the transducer. This results in a screen display like that shown at the right in Figure Digital thickness testers use the same process, but the output is shown as a digital numeric readout rather than a screen presentation. If the frequency and wedge angle is not specified by the governing code or specification, it is up to the operator to select a combination that will adequately inspect the part being tested. In angle beam inspections, the transducer and wedge combination also referred to as a "probe" is moved back and forth towards the weld so that the sound beam passes through the full volume of the weld. As with straight beam inspections, reflectors aligned more or less perpendicular to the sound beam will send sound back to the transducer and are displayed on the screen. The UT machine is mounted on a movable platform a "bridge" on the side of the tank so it can travel down the length of the tank. The transducer is swivel-mounted on at the bottom of a waterproof tube that can be raised, lowered and moved across the tank. The bridge and tube movement permits the transducer to be moved on the X-, Y- and Z-axes. All directions of travel are gear driven so the transducer can be moved in accurate increments in all directions, and the swivel allows the transducer to be oriented so the sound beam enters the part at the required angle. Round test parts are often mounted on powered rollers so that the part can be rotated as the transducer travels down its length, allowing the full circumference to be tested. Multiple transducers can be used at the same time so that multiple scans can be performed. The transmitting transducer sends sound through the part and the receiving transducer receives the sound. Reflectors in the part will cause a reduction in the amount of sound reaching the receiver so that the screen presentation will show a signal with a lower amplitude screen height. By varying the time when each element is activated, the resulting sound beam can be "steered", and the resulting data can be combined to form a visual image representing a slice through the part being inspected. One transducer transmits sound waves and the other transducer acting as a receiver. Unlike other angle beam inspections, the transducers are not manipulated back and forth towards the weld, but travel along the length of the weld with the transducers remaining at the same distance from the weld. Two sound waves are generated, one travelling along the part surface between the transducers, and the other travelling down through the weld at an angle then back up to the receiver.

NONDESTRUCTIVE TESTING METHODS FOR CIVIL INFRASTRUCTURE pdf

4: SMT and NDT-CE

Dalton, P.A., , "Physical Infrastructure: Challenges and Investment Options for the Nation's Infrastructure," Testimony Before the Committee on the Budget and the Committee on Transportation and Infastructure, US House of Representatives, US Government Accountability Office. Ellenberg, A., A.

 Abstract Adoption of periodic or continuous monitoring strategies to assess condition state of infrastructure elements is a vital part of service life management SLM. NDT methods are increasingly seen as an attractive and viable strategy to support condition monitoring. One of the main advances involved the development of artificial neural network ANN models for correlating compressive strength and UPV measurements. Another examined problem was how to deal with the large amount of raw data derived from inspection of large structures. Several studies were carried out to check different mapping techniques, as reported by Lorenzi et al. This paper relates one investigation where UPV and rebound hammer RH measurements were collected from a beam containing several induced defects, simulated using different materials. The results were processed using a mapping strategy, which indicated suspicious points where core extraction was undertaken. All cores taken from points derived from UPV results were found to have flaws providing evidence that this may be a suitable tool to assess concrete structures, when data is properly interpreted. Introduction Concrete is the most widely used construction material in the world. Preserving its integrity is therefore paramount to achieve the desired service life. However, when concrete is not properly designed or when the production process is inadequately controlled, flaws and defects can be introduced very early in the material. Furthermore, concrete damage may arise as scattered microcracks, due to freeze-thaw or other expansive actions or in the form of localized large cracks due to mechanical or thermal effects, which may extend for significant distances within the structure. All these flaws can affect performance and reduce strength or durability. Given this, it is important to detect and assess their importance as early as possible. That is one of the main reasons why nondestructive testing NDT techniques, which are capable of detecting, locating, and characterizing most types of damage, have called the attention of practicing structural engineers, as discussed by Shah et al. The NDT concept encompasses all test methods used to examine an object, material, or system without impairing its integrity or usefulness. Over the last decades, several NDT methods have evolved from laboratory curiosities to vital quality control tools in different productive fields. These methods are nowadays commonly used to check variations in structure, changes in surface, presence of cracks, or other physical discontinuities, measure the thickness of materials, and determine other characteristics of industrial products. In civil engineering, NDT methods are becoming very important parts of the recommended inspection procedures for several infrastructure objects: This demand will probably increase since aging infrastructure requires regular inspections for optimal planning of repair and intervention, in order to ensure performance and human safety [2]. The challenge, therefore, is to assess the potential and learn how best it is to collect, use, and interpret NDT data. Nondestructive Testing NDT methods are test methods that rely upon physical or chemical principles that can be monitored or measured without significantly affecting the appearance or performance of the analyzed structures. For this reason, NDT methods are favored when testing many structural materials and structures. According to Nesvijski [3], they allow evaluation in situ during service and enable monitoring for an extended period of time. The application of NDT methods in civil engineering is spreading in several countries. In addition of allowing the evaluation of aged and deteriorated structures, they can also be used for quality control of new structures [4]. In Brazil, the application of these techniques is still restricted, but it is growing rapidly in some sectors. The interest in NDT techniques is rising particularly in inspection of civil engineering infrastructure, mostly made of concrete. Concrete deterioration may be a result of several degradation mechanisms, which may damage the integrity of structures [5]. NDT monitoring techniques are being used to prevent and control the deterioration of concrete structures without damaging the material. The present study proposes a surface mapping technique of UPV and RH data which may be very useful in concrete analysis. Ultrasonic Pulse Velocity Ultrasonic testing is a well-established nondestructive technique for the detection of flaws and characterization of materials, based on the monitoring of the propagation speed of an ultrasonic wave throughout the material. During tests, transmitting and receiving transducers are placed on different parts of the object, allowing an ultrasonic pulse to be sent through the material [6]. If a flaw is encountered, the wave is delayed. Using this knowledge, UPV can be used as an assessment tool to help quantify the existence extent and progression of damage in different structures, [7]. Although most applications of this test focus on the inspection of metals, ultrasonic pulse transmission technique has been shown to be useful also for testing concrete elements. UPV have already been applied to new and old structures, slabs, columns, walls, fire damaged areas, hydroelectric structures, pipes, prefab, and prestressed beams [8]. The UPV method is particularly effective, powerful, and flexible, allowing in-depth analysis of material homogeneity. It is possible to determine concrete uniformity, to control its quality, to follow up the deterioration, to check the presence of internal flaws and voids using UPV, and to make comparisons with reference specimens, it may estimate potential compressive strength. Finally, when regularly used, it may provide data on the development of problems. The evaluation of ultrasonic results is a highly specialized and complex activity, which requires careful data collection and expert knowledge and sensitivity to obtain reliable diagnosis. In order to map the homogeneity of a structure, it is necessary to interpret and connect a large number of UPV readings. Accurate analysis requires reliable interpretation strategies, but there is not yet a proper widely accepted method to analyze this data. The research related in this work aimed to investigate a strategy to analyse these data using 3D mapping techniques used to build topographic models. Rebound Hammer The rebound hammer test is essentially a surface hardness tester, where an elastic mass is projected against the surface and the rebound is measured, resulting in the RH number [9]. The rebound mass depends on the hardness of the surface against which the mass impinges [10]. Of course there is a relationship between rebound number and surface strength but deducing concrete strength from the RH number must be done with great care, because several superficial effects can affect the rebound without affecting concrete resistance [11]. Despite the weak theoretical relationship between concrete strength and rebound number, several empirical correlations have been created and used, with mixed success. The key to understand the inherent limitations of the test for estimating strength is recognizing the factors influencing rebound distance. Essentially, it is a complex problem of impact loading and stress-wave propagation. The rebound distance depends on the kinetic energy in the hammer before impact with the shoulder of the plunger and the amount of that energy absorbed during the impact. Part of the energy is absorbed as mechanical friction in the instrument, and part of the energy is absorbed in the interaction of the plunger with the concrete. It is the latter factor that makes the rebound number an indicator of the concrete properties. The energy absorbed by the concrete depends on the stress-strain relationship of the concrete [12]. Nowadays, the RH method is mostly used to make a preliminary assessment of uniformity or to determine suspicious regions where low or damaged concrete may be located. Given the easiness of application, a quick map of large areas can be done in little time. That is the way the test was used in the present study. This period was chosen to minimize the influence of concrete strength variation on the measurements. The size of the objects placed inside the beam varied between 30 and 95 mm. All objects were detected by NDT measurements. It measures and correlates concrete strength to a standard strength measurement, allowing nondestructive testing of complete structures [8]. The James Concrete Test Hammer is an advanced, completely automated system for estimating concrete compressive strength. Its calculation, memory, and recording functions allow for quick, easy, and accurate test results. They indicate the compressive strength of hardened concrete [13]. Rebound hammer at concrete beam. The main objective of the test was to collect data and verify if the analysis of the results could allow the detection of the objects inside the beam. Surface mapping technique was used for interpretation of results, as reported by Lorenzi et al. In order to investigate which methods were more accurate to detect the objects inside the concrete beam, one grid was tested. Figure 3 shows one of the faces of the grid. Readings were made around each point. The readings were grouped and generated the reading quadrants. The main issue was to determine the best strategy to organize and to interpret ultrasonic pulse velocity results and rebound hammer results. The software program Surfer 7. Figure 4 shows the beam prepared for performance of the ultrasonic tests. A measurement answer sheet was used to ensure the perfect positioning of the transducers during the tests. Location of the objects into the beam. UPV measurements at the beam. Materials The mix proportions used to prepare the concrete beam mixture were 1: This resulted in a 60 mm slump and a day compressive strength of 20 MPa. The measurements were taken after 1 year using two measurement grids: Table 1 describes the objects introduced into the beam. In addition rebar elements were also introduced into the beam. Four additional single stirrups were placed in one of the sides of one half of the beam, to check if they would interfere with the UPV measurements. A corroded rebar piece and piece of prestressing tendon were also placed along the main direction of the beam. Description of the objects used to induce defects in the beam. The elements are shown in Figures 5 and 6. They were kept in place using nylon threads. Reinforcement bars were placed inside the beam to check if their presence would influence the UPV readings. Figure 6 shows a lateral view of the prototype beam with all objects positioned with the aid of nylon threads. One year after being built, the beam was tested. Simulation of situations inside the beam. Lateral view of the rebar and the objects used to induce defects in the beam. Items of Investigation The present study shows the application of two different NDT to interpret data from an experimental beam, measuring cm, in which some defects were induced. After measurements were performed, the surface was mapped. The objective was to verify the efficiency of defect detection of the applied methods. The collected data were mapped and core samples were taken from the positions that each method pointed out as problematic. Surface Mapping Using a surface mapping software Surfer 7. The coordinates of the contour map were the position in the grid expressed as and values and the UPV measurement coordinate.

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5: All Topics - Nondestructive Testing & Evaluation - Knovel

Nondestructive testing methods for civil infrastructure: a collection of expanded papers on nondestructive testing from Structures Congress ' approved for publication by the Structural Division of the American Society of Civil Engineers [i.e. Engineering].

Heat Exchanger Life Assessment System RTJ Flange Special Ultrasonic Testing Personnel training, qualification and certification[edit] Successful and consistent application of nondestructive testing techniques depends heavily on personnel training, experience and integrity. Personnel involved in application of industrial NDT methods and interpretation of results should be certified, and in some industrial sectors certification is enforced by law or by the applied codes and standards. Their annual conference at the Golden Nugget in Las Vegas is a popular for its informative and relevant programming and exhibition space Definitions[edit] The following definitions for qualification and certification are given in ISO Procedure, used by the certification body to confirm that the qualification requirements for a method, level and sector have been fulfilled, leading to the issuing of a certificate. Demonstration of physical attributes, knowledge, skill, training and experience required to properly perform NDT tasks. In the aerospace sector, EN Written statement by an employer that an individual has met the applicable requirements of this standard. The skills, training, knowledge, examinations, experience and visual capability required for personnel to properly perform to a particular level. It is generally necessary that the candidate successfully completes a theoretical and practical training program, as well as have performed several hundred hours of practical application of the particular method they wish to be trained in. At this point, they may pass a certification examination. While online training has become more popular, many certifying bodies will require additional practical training. Certification schemes[edit] There are two approaches in personnel certification: Under this concept the employer compiles their own Written Practice. The written practice defines the responsibilities of each level of certification, as implemented by the company, and describes the training, experience and examination requirements for each level of certification. Certification under these standards involves training, work experience under supervision and passing a written and practical examination set up by the independent certification authority. In the United States employer based schemes are the norm, however central certification schemes exist as well. Canada also implements an ISO central certification scheme, which is administered by Natural Resources Canada , a government department. The roles and responsibilities of personnel in each level are generally as follows there are slight differences or variations between different codes and standards: They can only report test results. Normally they work following specific work instructions for testing procedures and rejection criteria. Level 2 are engineers or experienced technicians who are able to set up and calibrate testing equipment, conduct the inspection according to codes and standards instead of following work instructions and compile work instructions for Level 1 technicians. They are also authorized to report, interpret, evaluate and document testing results. They can also supervise and train Level 1 technicians. In addition to testing methods, they must be familiar with applicable codes and standards and have some knowledge of the manufacture and service of tested products. Level 3 are usually specialized engineers or very experienced technicians. They can establish NDT techniques and procedures and interpret codes and standards. They also direct NDT laboratories and have central role in personnel certification. They are expected to have wider knowledge covering materials, fabrication and product technology. Indication The response or evidence from an examination, such as a blip on the screen of an instrument. Indications are classified as true or false. False indications are those caused by factors not related to the principles of the testing method or by improper implementation of the method, like film damage in radiography, electrical interference in ultrasonic testing etc. True indications are further classified as relevant and non relevant. Relevant indications are those caused by flaws. Non relevant indications are those caused by known features of the tested object, like gaps, threads, case hardening etc. Interpretation Determining if an indication is of a type to be investigated. For example, in electromagnetic testing, indications from metal loss are considered flaws because they should usually be investigated, but indications due to variations in the material properties may be harmless and nonrelevant. Flaw A type of discontinuity that must be investigated to see if it is rejectable. For example, porosity in a weld or metal loss. Evaluation Determining if a flaw is rejectable. For example, is porosity in a weld larger than acceptable by code? Defect A flaw that is rejectable â€" i. Defects are generally removed or repaired. A common error in POD tests is to assume that the percentage of flaws detected is the POD, whereas the percentage of flaws detected is merely the first step in the analysis. Since the number of flaws tested is necessarily a limited number non-infinite , statistical methods must be used to determine the POD for all possible defects, beyond the limited number tested. Another common error in POD tests is to define the statistical sampling units test items as flaws, whereas a true sampling unit is an item that may or may not contain a flaw. Department of Defense Handbook.

6: Non Destructive Testing (NDT) Methods | Element

Note: Citations are based on reference standards. However, formatting rules can vary widely between applications and fields of interest or study. The specific requirements or preferences of your reviewing publisher, classroom teacher, institution or organization should be applied.

7: NDT Non-Destructive Testing Lab Services | CTLGroup

Nondestructive Testing. FDH Infrastructure Services is a pioneer in the nondestructive evaluation (NDE) of critical structures. The firm's research and development of electromagnetic and dispersive wave propagation (DWP) techniques has led to the award of three U.S. patents and multiple proprietary analysis techniques.

8: Nondestructive testing - Wikipedia

Non destructive testing is an inspection method where the items or infrastructure being tested are in the same condition once inspected that they were previously. IPC (Infrastructure Preservation corporation) is a complex bridge inspection, roadway inspections, nondestructive testing (NDT) and robotic engineering company.

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