UT-Online 2021 Preface & Abstract Book

Welcome to the UT-online 2021 - free, online and on-demand!

It is our pleasure to welcome you to the 'International Ultrasonic Testing Online Conference 2021' (UT-Online 2021). The Conference on 'Novel methods and applications in ultrasonic testing' will start on 1 November 2021 and will last until 30 November 2021.

The event is organised by NDT.net in cooperation with the Ultrasound Institute at Kaunas University of Technology. This online Conference is a special one, it is free of charge and happens on- demand. You can access presentations 24/7 based on your schedule and interests. We also invite you to join and start discussions on the Conference Themes and presentations in our Conference Forum Board. Anyone can join the discussion from anywhere and at any time during the event.

The Programme

We are pleased to present you with 40 diverse contributions from all over the world. 20 countries have been registered. Most of them will be recorded and will be made available via Screencast. Even though the event will run for an entire month, we will focus our discussions in weekly spotlights on specific presentations accordingly to the following conference sessions.

Conference Discussions

Two themes per week will be opened on our Conference board in NDT.net's forum. Check out the presentations and post your questions and comments directly from the presentation page or join existing discussions on the Conference Board.

We would like to use this opportunity to thank our Sponsors, Olympus Scientific Solutions and Eddyfi Technologies, for supporting NDT.net's open access philosophy and this event in particular.

We also thank NDT.net's Advisory Board as well as the Canadian Institute for Non-Destructive Evaluation (CINDE) and the Non-Destructive Testing Society (Singapore) for their support.

Enjoy this event.

For any questions and comments please e-mail info@ndt.net .

Conference Chair
Rolf Diederichs
NDT.net

Scientific Committee Chair
Elena Jasiuniene
Ultrasound Institute at Kaunas University of Technology, Lituania

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1. Panel Discussion
Monday 1. Nov 08:00 CET

Novel Design of Ultrasonic Equipment for Material Testing and Future Trends
E. Jasiuniene, L. Mažeika, L. Svilainis, P. Holloway, B. Lepage, F. Reverdy; *Kaunas University of Technology, Lithuania*

2. Ultrasonic Phased Arrays - TFM
Monday 1. Nov 09:00 CET

Total Focusing Method with Phase-Only Ultrasound Signal for Small Flaw Detecion
A. LeDuff, N. Badeau, E. Peloquin, G. Painchaud-April, C. Kwan, B. Gauthier; *Olympus, Canada*

Examples of code compliant applications using Total Focusing Method (TFM)
F. Reverdy, B. Billebeau, T. Couturier; *Eddyfi, France*

Multimode Total Focus Method (TFMi): Improved Imaging with 3D Rendering
P. Holloway, E. Ginzel; *Holloway NDT & Engineering Inc., Canada*

Transient Sparse Firing for Reducing Full Matrix Capture Data Volume and Increasing Scan Speed
J. Lesage, M. Matheson, M. Marvasti; *Acuren Application Development Group, Canada*

3. Signal & Data Processing and Defect Characterization
Wednesday 3. Nov 09:00 CET

Pulse Compression for improved Signal-to-noise Ratio in Ultrasonic Testing
A. Carcione, M. Veidt, I. Pettigrew; *The University of Queensland, Australia*

Signal Technologies for Ultrasound
L. Svilainis, A. Chaziachmetovas, T. Gomez Alvarez-Arenas, J. Camacho, A. Rodriguez-Martinez; *Kaunas University of Technology, Lithuania*

Proposal of a standard for the measurement of relative ultrasonic nonlinearity parameter
D. Song, K. Jhang, J. Yoo; *Hanyang University, South Korea*

Slicer 3d Crack Reconstruction
J. Groom; Metalogic Inspection, USA

4. Modeling & Simulation
Monday 8. Nov 09:00 CET

Phase velocity method for computing dispersion curves in thin plates
M. Cruz Rodriguez, E. Moreno Hernández, V. Hernández Mederos, J. Estrada Sarlabous, A. Mansur Graverán; *Institute of Cybernetics, Mathematics and Physics (ICIMAF), Cuba*

Accurate simulation of multi-pulse ultrasonic echoes from an internal side drill Hole by a precise finite elements modeling
E. Moreno Hernandez, A. Ramos Fernandez; *Instituto de Cibernetica Matematica y Fisica, Cuba*

Evaluation of Artificial Defects in Additively Manufactured Turbine Blade using Ultrasonic Immersion Testing
G. Bhat, E. Jasiuniene; *Kaunas University of Technology (KTU), Lithuania*

5. Modeling & Simulation - POD
Monday 8. Nov 10:00 CET

MAPOD based reliability assessment of ultrasonic features for bonding quality evaluation
B. Yilmaz, D. Smagulova, E. Jasiuniene; *Kaunas University of Technology (KTU), Lithuania*

6. Modeling & Simulation - TOFD
Monday 8. Nov 11:00 CET

Variations on Time-of-Flight Diffraction
E. Ginzel, O. Volf; *Materials Research Institute, Canada*

Quantifying Contact Acoustic Nonlinearity in TOFD measurements via Quasi-static Loading
A. Carcione, M. Veidt, I. Pettigrew; *The University of Queensland, Australia*

7. Guided Waves
Wednesday 10. Nov 09:00 CET

Applications of Guided Wave Testing Method
S. Kim, H. Kim; *Guided Wave Analysis LLC, USA*

Data Analysis and Reporting of Guided Wave Testing of Pipeline
S. Kim, H. Kim; *Guided Wave Analysis LLC, USA*

Relationship between Defect Size and Operating Center Frequency in Guided Wave Testing
S. Kim, H. Kim; *Guided Wave Analysis LLC, USA*

Application of Deconvolution technique for ultrasonic Lamb wave signals
A. Asokkumar, R. Raišutis; *Kaunas University of Technology, Lithuania*

Detection and assessment of defects in pipelines using high order symmetrical modes
D. Cirtautas, V. Samaitis, L. Mažeika, R. Raišutis; *Ultrasound Institute at Kaunas University of Technology, Lithuania*

Characterization of Guided Wave Mode Behaviour in CFRP Panel with Delamination
M. Papanaboina, E. Jasiuniene, V. Samaitis, E. Zukauskas; *Prof. Kazimieras Barsauskas Ultrasound Research Institute, Lithuania*

8. Laser Ultrasonics
Wednesday 10. Nov 10:00 CET

The Design of a Laser-based and Non-contactable Inspection System that can Trigger Narrowband Ultrasonic Waves for Detecting Rails' Surface and Subsurface Defects
P. Tse, I. Ghafoor; *City University of Hong Kong, Hong Kong, China*

9. Industrial Applications
Monday 15. Nov 09:00 CET

Ultrasonic Measurement of Oxide Layer Thickness and Oxide Influence on Flaw Detection and Sizing in Pressure Tubes
A. Karpelson; Kinectrics Inc., Canada

Effects of Shear Wave Mode Conversion on a Corner
A. Jhanorwala, J. Patel, S. Tilva; *L&T MHI Power Boilers Pvt. Ltd. (LMB), India*

Ultrasonic Testing of Carbon Fiber Bicycles:
S. Small, H. Wilson; *Ruckus Composites, USA*

Ultrasonic High-temperature Corrosion Mapping
N. Pearson, G. Mugford; *Eddyfi Technologies, United Kingdom*

Inspection of Solid Axles in the Rail Industry: A Phased Array Solution
F. Turcu, G. Corti, V. Chumillas, R. Fernandez; *Olympus, France*

Use of industrial ultrasound for welded joints on painted surfaces with naval industry applications
J. Santo; SmartNDT, USA

Hot Isostatic Processing's LoF Healing Effect and the Subsequent Lack of Ultrasonic Detection
S. James, E. Ginzel, L. Warhol, M. Warhol, Y. Gao; *NDT Practices and Application Consultant, LLC, USA*

10. Industrial Applications - HTHA
Monday 15. Nov 10:00 CET

High Temperature Hydrogen Attack (HTHA) - Optimized Probes and Techniques
S. Couture; Olympus, Canada

High Temperature Hydrogen Attack (HTHA) inspection using ultrasonic techniques
F. Reverdy, C. Wassink, O. Fromentin; *Eddyfi, France*

11. Civil Engineering
Wednesday 17. Nov 09:00 CET

Non-Destructive Testing of Concrete Irradiated by Neutrons
Z. Hlavac, J. Balak, I. Maruyama, O. Kontani, M. Takizawa; *Centrum výzkumu Řež s.r.o., Czech Republic*

Ultrasonic Inspection of Bolts using an Integrated Probe Attachment
A. Bin Rosli, C. Liew; *Singapore Institute of Technology, Singapore*

Simulation and construction of a focussing borehole probe for ultrasonic investigations at sealing structures for radioactive waste repositories
P. Prabhakara, F. Mielentz, H. Stolpe, M. Behrens, V. Lay, E. Niederleithinger; *Bundesanstalt für Materialforschung und –prüfung (BAM), Germany*

Wave based monitoring of concrete beams with Stay-in-Place (SIP) formwork
S. Majhi, J. Loo, A. Mukherjee, S. Booth; *Curtin University, Australia*

12. Materials Characterization
Monday 22. Nov 09:00 CET

Online Characterization of Polymer Filaments During FDM Additive Manufacturing Process
V. Sajadi, F. Honarvar, M. Kari; *K. N. Toosi University of Technology, Iran*

Characterization of polymer additive manufacturing components by ultrasonic testing
A. Bagheri bami, F. Honarvar; *K.N.Toosi university of technology, Iran*

13. NDT Data Management
Wednesday 24. Nov 09:00 CET

Transforming NDT Data Management through Cloud-Based Solutions
A. Lamarre; OLYMPUS SCIENTIFIC SOLUTIONS AMERICAS, Canada

Ultrasound data post-processing. Technological transfers from the aerospace industry to the others
G. Ithurralde, I. Kameneff, C. Bertrand, S. Lazar, C. Duteil, R. Bacry, S. Barut; *TESTIA SAS, France*

14. General
Wednesday 24. Nov 10:00 CET

New generation of NDE technicians, support of new technologies
A. Munoz, M. Maggioni, T. Ott, M. Felice; *Screening Eagle Technologies, Switzerland*

1. Panel Discussion

Monday 1. Nov 08:00 CET

Novel Design of Ultrasonic Equipment for Material Testing and Future Trends
E. JASIUNIENE, L. MAžEIKA, L. SVILAINIS, P. HOLLOWAY, B. LEPAGE, F. REVERDY*
**e-mail: rd@ndt.net*

A specific highlight in the programme is a panel discussion, which, in the spirit of the event, will also be accessible on-demand. Six experts from the academia and the industry will exchange their views on the theme of "Novel Design of Ultrasonic Equipment for Material Testing and Future Trends". Like all presentations also this video will be discussed in the Conference Forum Board.
Keywords: Ultrasonic Testing (UT),

2. Ultrasonic Phased Arrays - TFM

Monday 1. Nov 09:00 CET

Total Focusing Method with Phase-Only Ultrasound Signal for Small Flaw Detecion
A. LEDUFF, N. BADEAU, E. PELOQUIN, G. PAINCHAUD-APRIL, C. KWAN, B. GAUTHIER*
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The total focusing method (TFM) is now a widely known and accepted nondestructive testing (NDT) technique. Although TFM enables easier image interpretation than the conventional phased array inspection technique, the use of a single element in transmission during acquisition can result in images with a low signal-to-noise ratio (SNR). This low SNR is due to poor acoustic penetration, typically in thick parts or in highly attenuative material. An imaging method using a TFM algorithm with only the phase-related information of the acquired signals is proposed here. Removing the amplitude information from the acquired signals enables the generation of images solely based on signal coherence. This thereby enables the detection of flaws with signal amplitudes similar to the incoherent noise in amplitude-based TFM images. Since material attenuation does not affect the phase of the signal, phase TFM could be particularly helpful for thick or highly attenuative material inspection applications. Another potentially important benefit of phase summation imaging is that the coherence level of the noise can be statistically defined, enabling easier dissociation of meaningful indications from noise. The defined noise coherence threshold acts as a logical filter in generated images, separating the noise regions from the meaningful indication regions. The phase TFM algorithm is described in this paper and experimental results on applicative cases such as high-temperature hydrogen attack

(HTHA) are presented. Preliminary results showed that phase TFM better highlights small defects than its amplitude-based counterpart.
Keywords: Ultrasonic Testing (UT), Ultrasound, High Temperature Hydrogen Attack, Total Focusing Method

Examples of code compliant applications using Total Focusing Method (TFM)
F. REVERDY, B. BILLEBEAU, T. COUTURIER*
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Imaging techniques based on ultrasonic Total Focusing Method (TFM) are applied more and more to industrial applications. Adoption of the technique has been made easier with the publication of the revised ASME V and ISO 23864 and 23865 standards. Technique description, equipment standards, personnel qualification and application standards are described in detail allowing operators to prepare their procedures with care. After being the first one to introduce TFM on a portable PAUT system, Eddyfi has improved the performances of the TFM technique in terms of scanning speed and sensitivity while providing code compliant calibration tools. Examples of implementation and verification of FMC/TFM in a procedure according to the ASME and ISO standards will be presented for weld testing and other applications.
Keywords: Ultrasonic Testing (UT), PWI, TFM, FMC

Multimode Total Focus Method (TFMi): Improved Imaging with 3D Rendering
P. HOLLOWAY, E. GINZEL*
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In a recent publication, the advantages of using simultaneous processing of multimodal Total Focussing Method (TFM) data were provided. The resulting images provide improved characterisation and sizing of indications. In this paper we illustrate how the process can be used to produce high resolution images that can be rendered in three dimensions (3D) using an open-source software, Slicer. TFMi (the simultaneous processing of multiple TFM images) is used to process FMC scanning data on a test coupon with a fabricated crack that transitions from a surface-breaking crack to a subsurface crack. Merging the scan samples along the length of the coupon and from probe positions on both sides of the weld, a detailed 3D solid of the flaw can be generated. This is compared to several cross-section photos to illustrate the detail possible when using the technique.
Keywords: Ultrasonic Testing (UT), rendering, ultrasonic, phased-array, FMC, TFM, total focussing method

Transient Sparse Firing for Reducing Full Matrix Capture Data Volume and Increasing Scan Speed
J. LESAGE, M. MATHESON, M. MARVASTI*
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Full matrix capture (FMC) is becoming increasingly popular for ultrasonic inspection applications where accurate sizing and characterization is critical. Easily interpretable, high resolution images are rendered most commonly with the Total Focusing Method (TFM) algorithm using the elementary A-Scans which are then discarded. This raw data can instead be saved for further post-processing with additional soundpaths e.g. TT-T, TT-L, and/or alternative algorithms e.g. Phase Coherence Total Focusing Method (PCTFM), Delay Multiply and Sum (DMaS), etc., however, this process is currently impractically slow and generates a huge volume of data, particularly for large aperture probes. A number of firing sequences have been proposed in order to reduce the amount of data to be collected and stored including: Plane Wave Imaging (PWI), Virtual Source Imaging (VSI) and sparse firing. Fundamentally, these techniques cut down on the amount of data (consequently increasing scan speeds) at the expense of image quality, a trade-off which can be carefully optimized to meet inspection requirements. In this paper, a new approach is proposed which leverages the spatial redundancy along the scan axis to decrease the data collected without significantly compromising the transmission focus of the rendered images. The

algorithm, called Temporal Sparse Firing (TSF) is inspired by the Temporal Anti-Aliasing technique commonly used to mitigate artefacts in the field of computer graphics. In essence, a different reduced transmission sequence is used at each scan position and then a running average is formed along the scan axis. Images rendered using the proposed method are compared with other reduced transmission sequences of comparable data volume as well as the complete FMC scans. Criteria for selecting the optimal averaging window for a given probe (frequency/elevation) and scan increment are presented. TSF is found to provide an ideal compromise between image resolution and scan speed/data volume and can be used with any reduced transmission sequence/imaging algorithm.
Keywords: Ultrasonic Testing (UT), Total Focusing Method, Phase Coherence Total Focusing Method, Sparse Firing, Full Matrix Capture

3. Signal & Data Processing and Defect Characterization

Wednesday 3. Nov 09:00 CET

Slicer 3d Crack Reconstruction
*J. GROOM**
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Ultrasonic nondestructive testing only just recently began utilizing 3D modeling for evaluation, but the medical industry has been working with it for decades. In this presentation we will discuss some of the advanced technology in Slicer 3d, an opensource medical software, and how it relates to NDT. Imported ultrasonic data of a complicated multifaceted crack will be used in Slicer 3D to review measurement tools, scanning techniques, reporting capabilities and lessons learned on how to improve data collection and processing in the future.
Keywords: Ultrasonic Testing (UT), PAUT, UT, 3D, Optically

Pulse Compression for improved Signal-to-noise Ratio in Ultrasonic Testing
A. CARCIONE, M. VEIDT, I. PETTIGREW*
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Pulse compression is a technique used in radar systems which allows a long duration, low-amplitude power pulse to attain the range resolution and detection performance of a short-duration, high-amplitude inspection system. This is accomplished by coding the RF carrier to increase the bandwidth of the transmitted waveform and then compressing the received echo waveform by using a matched filter. Pulse compression can be used to increase the range resolution as well as the signal to noise ratio of a measurement system. In this paper, we demonstrate how the pulse compression principle can be applied to ultrasonic non-destructive testing where signal to noise radio is poor. It is shown how the resultant pulse-compressed signal is equivalent to a single high-energy pulse after pulse compression, and how this technique is resilient to external noise.
Keywords: Ultrasonic Testing (UT), TOFD, Signal Processing, Vibrations, NDE, NDT, Pulse Compression

Signal Technologies for Ultrasound
L. SVILAINIS, A. CHAZIACHMETOVAS, T. GOMEZ ALVAREZ-ARENAS, J. CAMACHO, A. RODRIGUEZ-MARTINEZ*
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Ultrasound is widely used in NDT. Main advantages are direct physical interaction with material properties, equipment safety, inspection speed, portable equipment and acceptable cost. Yet, bandwidth and SNR are limiting the results attainable. Going non-contact ultrasound is always confronted with signal coupling losses and the requirement for contact or immersion is sometimes a limiting factor. Here we present the signal technologies that help to solve these issues. Essential for good signal are the ultrasonic transducers. Developments in the air-coupled ultrasound allowed for significant air

transduction losses reduction: sensitivities of -30dB can be obtained at more than 70% bandwidth for frequencies up to MHz. This means that 3V signal can be obtained on receiving transducer without any gain at 200V excitation voltage in air. However, insertion of the test sample significantly reduces the signal obtained due to impedance mismatch: losses can reach 100dB. Simple gain increase in such case in not enough because the noise floor is the limiting factor. Noise figure reduction of the receiving electronics is important and such examples are presented, but large gain is possible with only extremely narrowband electronics. Then developments in excitation come to help: excitation up to few kV is possible. Developments in both reception and excitation electronics are presented. Still, bandwidth and SNR will suffer. Resonant spectroscopy is the tool to maintain low frequency but keep the resolution. Examples of spectroscopy working in reflection will be given. Further bandwidth and SNR improvement is possible when spread spectrum signals are used, which already received acknowledgment in biomedical imaging and radars. Examples presented indicate, that spectral content can be matched to transducer or even compensate the spectral losses for bandwidth improvement. Time delay errors and their sources are discussed. Best results are achieved when generation of the spread spectrum signals is accompanied by the proper signal processing. Significant signal quality improvement can be achieved when combined with adaptive correlation, split spectrum, phase coherent imaging, SAFT or iterative/reiterative deconvolution processing. Finally, spread spectrum signal can be used to solve the problems of ther low power (thermoelastic) laser ultrasound.
Keywords: Ultrasonic Testing (UT), Laser ultrasound, time of flight (TOF), resonant spectroscopy, spread spectrum signals

Proposal of a standard for the measurement of relative ultrasonic nonlinearity parameter
D. SONG, K. JHANG, J. YOO*
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The relative ultrasonic nonlinearity parameter which is defined by the received electric signal amplitude is easy to employ in industry because of simple measurement in contrast with the absolute ultrasonic nonlinearity parameter defined by pm level displacement amplitude. However, since the relative ultrasonic nonlinearity parameter measurement is affected by equipment specifications and measurement environment, it is needed to establish a standard for stable measurement. In this study, we propose a standard for the measurement method of the relative ultrasonic nonlinearity parameter using the longitudinal tone-burst wave based on the through-transmission method in contact. In this standard, there are following contents: setup of devices, required performance of a receiver, affection of contact condition, condition of an incident wave amplitude, signal processing method of a received signal, and calculation method of the relative ultrasonic nonlinearity parameter. In addition, an automatic measurement system to which the proposed standard was applied has been developed and, showed excellent stability with a repetition error of less than 2%. The standard is expected to contribute to accurate and quantitative measurement of relative ultrasonic nonlinearity parameters.
Keywords: Ultrasonic Testing (UT), Standard, Ultrasonic nonliearity parameter, Measurement system, Relative measurement, Nonlinear ultrasonic technique

4. Modeling & Simulation

Monday 8. Nov 09:00 CET

Phase velocity method for computing dispersion curves in thin plates
M. CRUZ RODRIGUEZ, E. MORENO HERNáNDEZ, V. HERNáNDEZ MEDEROS, J. ESTRADA SARLABOUS, A. MANSUR GRAVERáN*
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Lamb waves are extensively used in non-destructive tests (NDT) in thin plates. Their phase and group velocities depend on the frequency and on thickness of the guide plate. In this

work, we use the phase velocity method (PVM), in combination with finite element method (FEM), to compute the dispersion curve for phase velocity of an ultrasonic pulse traveling in a thin transversally isotropic plate. The FEM-PVM is based on the numerical solution of the wave propagation equations for several selected frequencies. For each fixed value of the frequency we solve the corresponding partial differential equations with FreeFem++ software. The phase velocity for a given frequency is obtained from the computed displacements at few points on the top of the plate. Dispersion curves are computed for transversally isotropic plates with constant thickness and also for plates with slowly varying thickness.
Keywords: Ultrasonic Testing (UT), dispersion curve, plate element, phase velocity method, finite element method, Lamb wave, NDT

Accurate simulation of multi-pulse ultrasonic echoes from an internal side drill Hole by a precise finite elements modeling
E. MORENO HERNANDEZ, A. RAMOS FERNANDEZ*
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In many standard norms for NDE, a side drill hole is used as echo reference during calibration of ultrasonic inspection instruments, where the strong fundamental echo component is mainly used. Nevertheless, satellite echoes arise from interaction of emitted ultrasonic pulse with the hole. One of these echoes is described as a consequence of a creeping wave around that. Here, a specific FEM Comsol model is presented for the interaction of the emitted pulse with the hole, which describes the echo-pulse created by the creeping wave. In addition, another satellite echo is obtained from our model, which is related to a transversal-longitudinal conversion. This particular FEM simulation was implemented with the Discontinuous Galerkin method assuming wideband pulsed excitation in a steel material block containing the hole. The new tool presented here will permit also to analyze other more complex industrial pieces with accuracy improved respect to the classic tools nowadays available.
Keywords: Ultrasonic Testing (UT), Conversion Modes, Side Drill Hole, FEM Simulation, Ultrasonic, Pulse Propagation

Evaluation of Artificial Defects in Additively Manufactured Turbine Blade using Ultrasonic Immersion Testing
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One of the most important components of an aero-engine is the turbine blade. The additive manufacturing (AM) of jet engine turbine blades is complex as the machining process involves the majority of the challenging aspects of metal cutting. Due to the reason of complex component geometry, surface roughness, and variable thickness, it is very hard to perform the inspection on such components. Even with the probability of having several defects, various non-destructive testing (NDT) techniques may perhaps be needed to inspect the component to detect the defects. Using numerical modeling in CIVA software, the purpose of this analysis is to identify the artificial internal defects in the turbine blade using immersion non-destructive testing (NDT) technique. The flaw size and geometry can be determined from the images produced by the ultrasonic scan.
Keywords: Ultrasonic Testing (UT), Non-destructive testing, additive manufacturing, turbine blade, numerical modelling

5. Modeling & Simulation - POD

Monday 8. Nov 10:00 CET

MAPOD based reliability assessment of ultrasonic features for bonding quality evaluation
B. YILMAZ, D. SMAGULOVA, E. JASIUNIENE*

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This work aims to evaluate the reliability of different ultrasonic features with model-assisted probability of detection (MAPOD) curves for adhesive bonding quality assessment. Although adhesive bonding has advantages such as homogenous load distribution, high strength to weight ratio, and ability to join dissimilar materials and complex structures; applications are limited in industries like aerospace due to the lack of reliability in non-destructive evaluation of bonding quality. Hence, we propose a cost-effective reliability assessment methodology with feature-based ultrasonic non-destructive testing technique. In order to estimate the detectability of debonding defects and weak bonds, numerical models for aluminum-epoxy-aluminum single-lap joints were built with three different bonding quality: debonding at the interface, weak bond due to contamination, weak bond due to faulty curing. Scanning acoustic microscopy set-up with 50 MHz focused transducer is selected for ultrasonic testing. Semi-analytical finite element method with CIVA is used to model high-frequency ultrasonic wave propagation. Numerical models have been validated with experiments. Five different ultrasonic features are considered to be interest: (1) peak-to-peak amplitude, (2) time delay, (3) frequency (Amax) domain absolute maximum amplitude, (4) frequency shift of Amax, (5) attenuation in adhesive layer. According calculated MAPOD curves, it is shown that different ultrasonic features dominate the detection of debonding defects and weak bonds. Also, frequency based ultrasonic features can improve the weak bond detection reliability.
Keywords: Ultrasonic Testing (UT), Weak Bond, Adhesive Bonding, Acoustic Microscopy, Reliability, POD, MAPOD, Ultrasonic NDT

6. Modeling & Simulation - TOFD

Monday 8. Nov 11:00 CET

Variations on Time-of-Flight Diffraction

E. GINZEL, O. VOLF*
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The term "Time-of-Flight Diffraction" (TOFD) has been around since the mid-1970s. However, earlier applications of the concepts have been documented by Ermolov since 1968. Provided the technique makes a timing measurement and relies primarily on diffracted wave energy, rather than specular reflection, there is no reason why it should not be considered a TOFD technique. This paper looks at variations on the traditional TOFD technique using probes located on the same side of the joint being inspected, rather than on opposite sides. Results of the technique are illustrated for both steel and HDPE joints.
Keywords: Ultrasonic Testing (UT), Time-of-Flight Diffraction, TOFD, forward scatter, backscatter

Quantifying Contact Acoustic Nonlinearity in TOFD measurements via Quasi-static Loading

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Normally, nonlinear ultrasonic techniques are based around the identification of features in the frequency domain. Known as sidebands, these features occur due to intermodulation between multiple excitation sources. Typically, continuous excitation is used as this provides the best frequency resolution. However, continuous excitation approaches suffer from poor defect localisation. In this paper, we propose a novel method which is based on conventional time of flight diffraction (TOFD) nondestructive testing, but adds external quasi-static load. It is shown that this external loading causes modulation of damage interfaces which can be observed as changes in the time-domain TOFD response. Extracting load-dependent features in the TOFD waveforms allows the identification and quantification of contact acoustic nonlinearity characteristics. Importantly, the new technique does not sacrifice any time-resolution and hence maintains localisation capability

of conventional TOFD. It is shown that the technique can differentiate between different types of damage within a sample such as fatigue cracks or voids.
Keywords: Ultrasonic Testing (UT), NDT, TOFD, Nonlinear Acoustics, Contact Acoustic Nonlinearity, NDE

7. Guided Waves

Wednesday 10. Nov 09:00 CET

Applications of Guided Wave Testing Method
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Guided wave testing (GWT) method has been used to detect corrosion and crack defects in pipelines and plates as a rapid screening tool. GWT uses the short- and long-range propagation of ultrasonic wave along the metal wall of structure from a remote accessible location. GWT has expanded for assessing the condition of pipes, pipelines, pressure vessel, and tank wall where ordinary NDT is difficult or expensive to perform such as those at high elevations, behind walls, or under insulation. GWT saves the time and money that would otherwise be used for scaffolding, insulation removal, or excavation. This presents about the basic knowledge of guided wave testing, sensitivity of guided wave testing, inspection range, applications, and field testing examples of pipe and plate structure.
Keywords: Ultrasonic Testing (UT), pressure vessel, tank, plate, Guided wave testing, pipeline, GWT, long-range ultrasonic testing, LRUT, GWT application

Data Analysis and Reporting of Guided Wave Testing of Pipeline
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One of the most difficult parts of guided wave testing method is data analysis and reporting because of large coverage and long-range inspection. For data analysis, the software uses multiple plots of rf data, video data, and spectrogram. The reporting requires three calibrations of distance, amplitude, and attenuation. Software was developed for automatic calibration if a pipeline drawing is plotted with location of geometric features and weld reflections. The presentation will demonstrate how to generate pipeline drawing with acquired data plot and how to calibrate the data for finding indications. Data acquired at 3 or more center frequencies are compared for better finding defects and estimating defect sizes. Guided wave testing sometimes generates false calls due to mirror reflection and multiple reflections. The software will show how to reduce false calls by marking those locations after calculating with big reflectors in the data.
Keywords: Ultrasonic Testing (UT), software, long-range ultrasonic testing, pipeline, GWT reporting, GWT data analysis, LRUT, Guided Wave Testing, GWT, large coverage ultrasonic testing

Relationship between Defect Size and Operating Center Frequency in Guided Wave Testing
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How is the amplitude of reflected wave in guided wave testing (GWT) depending on the defect size and the operating frequency? It is the main part of guided wave field testing for finding defects in plate or pipeline structure. The guided wave test was performed with 6 different numbers of defects on the carbon steel plate at 7 different center frequencies. The guided wave signal was increased as the cross-sectional area of defect increased. Increasing the defect numbers along the wave propagation direction made the wave reflection increased or decreased depending on the relationship between the wave length and spacing of two adjacent defects. This experimental showed the guided wave testing at the field should be done using multiple center frequencies for finding different sizes of

defects. Some field testing results acquired at multiple center frequencies on pipeline are presented for proving the experimental observation.
Keywords: Ultrasonic Testing (UT), Guided wave testing, GWT, long-range ultrasonic testing, LRUT, operating frequency, defect size, defect characterization, wavelength, wave reflection

Application of Deconvolution technique for ultrasonic Lamb wave signals
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Lamb waves are ultrasonic waves known for long range Structural Health Monitoring applications in pipelines, railway lines and aircraft structures. In case of aerospace structures, the interpretation of the signals becomes complex to interpret due to the following reasons: the dispersive nature of the Lamb waves results in stretching of the wave packets when propagating; multiple modes can propagate in same frequency of excitation which can cause overlapping of wave packets in the received signal; the change in the propagating medium such as bonding region in composites, stiffeners and defects causes reflections and mode conversions which can result in new wave packets in received signals. Such kinds of effects make it difficult for one to understand recorded signal after propagation for further signal processing and defect detection algorithms. Using the deconvolution signal processing technique, it is possible to compensate the dispersion effect, improve signal to noise ratio and to separate each wave packet present in the signal in spite of the overlapping effects. So, this work explains the application of deconvolution technique to improve the interpretability of ultrasonic Lamb wave measurements using the data from experimental investigation of composite aircraft structures.
Keywords: Ultrasonic Testing (UT), Deconvolution, Lamb waves, Guided waves, signal processing, mode separation, signal processing

Detection and assessment of defects in pipelines using high order symmetrical modes
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Monitoring and detection of defects in pipe structures can prevent hazardous accidents and unexpected losses. Ultrasonic guided waves showed good potential detecting various defects in pipeline networks at sufficiently large distances. However, in practise usually low order fundamental guided waves are used for non-destructive testing along pipe structures due to relatively easy setup and analysis of transmitted or reflected signals. Despite long range coverage such waves have less sensitivity to localized corrosion that mostly lead to a sudden leakage. Hence, more advanced ultrasonic testing techniques with capabilities to detect such defects are required. Such techniques are usually based on high order guided wave modes that offer better sensitivity and resolution at a cost of propagation distance and complicated signal analysis. There are number of issues that must be solved in order to develop successful NDT technique for inspection of pipe-wall defects using high order modes, i.e. mode selection, wave excitability, detectability, sensitivity to a defect, propagation losses and overlapping with co-existing modes. In this research novel medium range guided wave screening method was developed that uses high order symmetrical modes for detection of localized and uniform defects in the cross section of the pipelines. A comprehensive analysis was performed in order to select most suitable mode for inspection taking into the account the excitability and detectability of the mode; displacement profile; sensitivity to a defect; leakage and propagation losses; group velocity and geometrical features of the considered defects. The investigations demonstrated that S3 mode at 1MHz has high group velocity, sufficiently short wavelength and low leakage losses which made it a good candidate for inspection of localised defects in pipes. Different techniques based on phased array excitation were tested in order to excite S3 mode into the structure without generating undesired waves. Finally, the interaction between the S3 mode and structural defects were investigated, revealing which signal parameters assist in detecting the defects and assessing defect parameters. In contrast to existing approaches,

the proposed screening technique offer increased sensitivity, allow to assess pipes with circumference up to 2m and can be used with conventional UT equipment.
Keywords: Ultrasonic Testing (UT), Guided Waves, Mode-Selective Excitation, Structural Health Monitoring, Screening, Pipeline Corrosion, High Order Modes

Characterization of Guided Wave Mode Behaviour in CFRP Panel with Delamination
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In aerospace applications, structural health monitoring (SHM) requires enabling safety, reliability, and quality control of the structure. Among SHM techniques, ultrasonic guided wave (GW) techniques are widely used due to versatile applications. The primary advantage of the guided waves for the inspection of multi-layered structures are: these waves are sensitive to small changes in the object under inspection, can propagate long distance with less attenuation, and enables long-range inspections. Hence, guided wave inspection techniques are preferred for the application of multi-layered composite structures. It is important to note that the GW multimode and dispersive nature leads to complex signal interpretation. Therefore, the preferred mode can be selected to reduce the complexity. Although multi-mode inspections are efficient in some inspections. However, signal processing methods can be implemented to filter the guided waves to reduce the complexity. The semi-analytical finite element method was used to obtain the GW dispersion parameters and mode selection. GW signal damping in anisotropic composite structures cannot be neglected. GW attenuation calculation is a critical parameter for mode selection and long-range inspection. Therefore, it is important to estimate the signal attenuation to achieve uncompromised and reliable results. This research focuses on the GW propagation in a multi-layered CFRP panel to determine the delamination position in the longitudinal direction. The 2D and 3D finite element simulations were performed to study in detail guided wave interaction with delamination. The influence of delamination size and location was examined in the CFRP panel. The variation in delamination size and position significantly influences the transmitted and reflected GW amplitude. The key features analyzed in this research are GW mode behavior with delamination, mode velocity, time of flight (ToF), wavenumber, and wavelength. By analyzing these characteristics of the reflected and transmitted mode, the delamination presence, location, and severity can be estimated. The forward and backward scattered and converted modes are filtered to reduce the complexity of signal interpretation. The inverse 2D FFT was used to preserve the forward converted mode.
Keywords: Ultrasonic Testing (UT), 2D FFT, SAFE, SHM, CFRP Panel, Guided Waves

8. Laser Ultrasonics

Wednesday 10. Nov 10:00 CET

The Design of a Laser-based and Non-contactable Inspection System that can Trigger Narrowband Ultrasonic Waves for Detecting Rails' Surface and Subsurface Defects
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According to world railroad administrations, transverse surface and subsurface defects occurred in railheads are one of the major causes of train accidents. Particularly for subsurface defects that hidden inside the rail structure. Continuing ignoring the growth of such defects may lead to derailment. Unfortunately, detecting subsurface defects is very difficult because they are invisible from the rail surface. Several types of nondestructive testing (NDT) methods, such as eddy current (EC), ultrasound (UT), are available for detecting subsurface defects. However, these methods have limitations. The accuracy of EC can be affected by grinding marks, surface finish and lift-off variations. Its depth of penetration is limited and is a point-to-point slow inspection method. UT is also point-to-

point slow inspection method. It cannot detect critical defects masked by spalled rail or shallow defects. Laser-generated Rayleigh waves can provide a totally non-contact and a faster line-to-line inspection method. However, the wave signals emitted by laser are in broadband, making the reflected signals too complex to be analyzed. A newly designed optical system called Sagnac interferometer-based optical system (SIOS) can be used to generate laser-emitted Rayleigh wave in narrowband. This research work reports the design of an adjustable line arrayed pattern (LAP) to convert the excited laser circular beam to line arrayed beams. The emitted wave frequency can be tuned to a desired narrowband by adjusting the width of the emitted laser lines. To verify the effectiveness of SIOS, a Nd-YAG pulsed laser was used as the laser emitter. The propagation of Rayleigh wave along the rail was received by a 3D scanning vibrometer. A completely non-contact inspection. In order to check the sensitivity of generated waves for defect detection, experiments were carried out on healthy and defective rail samples. The time-frequency analysis of both simulation and experimental results show that the SIOS is promising in generating desired narrowband Rayleigh waves and able to detect both surface and subsurface defects. For future inspection, a 6-degree freedom robot was used to drive the pulsed laser and 3D laser scanner to inspect the head, web and foot of the rails.
Keywords: Ultrasonic Testing (UT), Rail inspection, Laser 3D vibrometer, Rayleigh wave, NDT, Automation

9. Industrial Applications

Monday 15. Nov 09:00 CET

Ultrasonic Measurement of Oxide Layer Thickness and Oxide Influence on Flaw Detection and Sizing in Pressure Tubes

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Oxide layer on the pressure tube inside surface in CANDU reactors masks flaws; complicates their detection, characterization and sizing; entails degradation of the material properties and brittle microstructure; and leads to many other different issues. Various ultrasonic methods, techniques, and transducers, used for detection, characterization and sizing of different flaws in Zr-2.5%Nb tubes covered by oxide ZrO2 and also for oxide layer detection and its thickness measurement in pressure tubes are described and analyzed. Obtained experimental results have demonstrated that using ultrasonic waves, it is quite possible to characterize and size flaws covered by oxides and also detect and measure oxide layers in pressure tubes by using ultrasonic signals in the time and frequency domains.
Keywords: Ultrasonic Testing (UT), ultrasonic inspection, pressure tube, oxide layer detection and sizing

Effects of Shear Wave Mode Conversion on a Corner

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Whenever shear wave incidence occurs on a corner at less than the critical angle, then along with reflected shear wave, a mode converted longitudinal wave generates. Reflectors like square notches in calibration blocks or surface connected planer flaws in weld components forming such corner are not only affected by amplitude loss due to mode conversion, but often inaccuracies in depth positioning arise. Phased array probe is used to identify amplitude loss and apparent depth error on the inspection angle range of 45° to 70°. The cause of depth error and effect of beam spread on depth error are explained. Further to this, the depth error is analysed in phased array electronic and sectorial scan images.
Keywords: Ultrasonic Testing (UT), notch, mode conversion, corner, Ultrasonic testing (UT), amplitude variation, depth error, phased array ultrasonic testing (PAUT), surface connected planer flaw

UT-Online 2021 Preface & Abstract Book

Ultrasonic Testing of Carbon Fiber Bicycles
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Carbon Fiber Reinforced Plastic (CFRP) is the material of choice for most high-end bicycles due to its high tensile strength, high stiffness, and low weight to strength ratio in comparison to aluminum, steel, or titanium. These properties allow for design and manufacture of bicycles that are lighter, more responsive, and more comfortable to ride than their metal counterparts. However, the stiffness of CFRP leaves it vulnerable to damage from impact, improper use, or manufacturing quality deviations. The CFRP bicycle sector is currently undergoing rapid expansion, with recently published market research forecasting growth of almost 60 million units by 2025, creating a surge of bicycles needing repair. We present several case studies where phased array ultrasonic testing (PAUT) is used to detect non-visible damage to CFRP bicycles. The results of the PAUT are subsequently confirmed by sectioning the damaged areas. We also discuss damage mechanisms and common failure modes of CFRP bicycles, reinforcing the need for nondestructive testing modalities such as PAUT.
Keywords: Ultrasonic Testing (UT), failure modes, bicycles, carbon fiber composite, phased array ultrasound, nondestructive testing

Ultrasonic High-temperature Corrosion Mapping
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Corrosion mapping with ultrasonic testing (UT) is becoming a common solution to assess the structural condition of large assets such as storage tanks, pipes and vessels. Large amounts of data are collected in a regular grid pattern and displayed as a colour coded map to represent variations in thickness. Commonly this is conducted on assets in ambient temperature but there is a call to perform such mapping on process components, some of which can vary in temperature from 50°C to 500°C and beyond. Recently Eddyfi Technologies took part in trials to test the capability of using a high-temperature UT probe in conjunction with the automated Rapid Motion Scanner (RMS) magnetic crawler to inspect pipe samples varying in temperature from ambient up to 250°C with successful results. This paper describes the system setup necessary for high-temperature trials and the UT measurements collected and contrasted to a given benchmark.
Keywords: Ultrasonic Testing (UT), High Temperature, Corrosion Mapping

Inspection of Solid Axles in the Rail Industry: A Phased Array Solution
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Public policies in the current international contexts of health, climate change, and energy are leading to a higher priority being given to rail transportation. As governments across Europe invest in expanding the railway infrastructure, the maintenance of rail cars, tracks, and related critical components is also gaining importance. In this context, inspection providers in the rail industry are looking into more efficient, reliable, and faster inspection methods to ensure operational safety and keep downtime to a minimum. Rail car axles are critical components that are continuously exposed to stress during normal operation. This paper aims to investigate the ultrasonic inspection methods applied to solid axles by the rail industry. In the first phase, simulations using Extende's CIVA software are performed for an ultrasonic phased array (PA) configuration. These PA results are then compared to those obtained by modeling a configuration employing single-beam conventional ultrasonic testing (UT) transducers. In a second phase, infield tests are carried out using a dedicated solution based on phased array electronics, a novel mechanical scanning assembly, and a linear phased array probe. The results are used to validate the simulations previously described. To conclude, benefits and improvements introduced by the phased array technique will be discussed.

Keywords: Ultrasonic Testing (UT), Ultrasound, Solid Axle, Railway, Phased Array

Use of industrial ultrasound for welded joints on painted surfaces with naval industry applications

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Painting on ships is one of the most effective methods used for corrosion protection on metal surfaces. It is possible to prove it due to its low cost, ease of application and maintenance. Understanding the need to carry out the ultrasound test in some areas covered by paint in oil tankers, which could not be removed, contrasting the inspection procedure that required a smooth surface, free of oxides and paints. In this paper, the ultrasound test was carried out taking into account two distinct conditions, a prepared specimen, free of oxides, paints, scales or any agent that would make inspection difficult, according to the ASME Code - Sec. V. And, another specimen test under conditions identical to the real one, painted in accordance with the painting plan required for vessels. After performing the test procedures, positive results were observed, which met the requirements of the applied standard, in addition to the equivalence in the discontinuities found, ratified by the x-ray test. However, the region had to comply with the painting procedure in order to determine the adhesion of the paint according to the normative standard, and not influence the ultrasound test. This research aimed to reduce rework costs, since all areas that had inspection were reworked by the painting team.
Keywords: Ultrasonic Testing (UT), Inspection, Naval plates, Industrial painting, Ultrasound, Naval Industry

Hot Isostatic Processing's LoF Healing Effect and the Subsequent Lack of Ultrasonic Detection

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There are two objectives of this study the first to expand ultrasonic understanding of AM is to compare the ultrasonic responses of embedded lack of fusion (LoF) anomalies in the "as printed" and after "hot isostatic pressing" (HIP) The second which stemmed from the first answer, asks another, is the material quality of this "healed" LoF containing argon of any structural fatigue concern?
Keywords: Ultrasonic Testing (UT), build layer separation, c-scan, additive manufacturing, lack of fusion, hot isotropic pressing

10. Industrial Applications - HTHA

Monday 15. Nov 10:00 CET

High Temperature Hydrogen Attack (HTHA) - Optimized Probes and Techniques

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Early detection of high-temperature hydrogen attack (HTHA) damage can help oil, gas, and petrochemical facilities avoid catastrophic failures of critical high-pressure assets. While it is essential to evaluate the equipment's condition, HTHA is challenging to detect and assess, including for ultrasonic testing (UT). For this reason, Olympus created probes specifically designed to detect HTHA-induced damage at an earlier stage. The solution comprises Dual Linear Array™ (DLA) probes that are used to perform the pitch-catch technique and phased array (PA) probes that are fine-tuned for the total focusing method (TFM). These methods, combined with TOFD screening, are used as part of a complete multi technology inspection strategy.
Keywords: Ultrasonic Testing (UT), HTHA, PA, TFM, Olympus, Phased, Array, DMA

High Temperature Hydrogen Attack (HTHA) inspection using ultrasonic

techniques

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HTHA occurs in an environment containing hydrogen and high temperatures. High temperatures change the atomic form of hydrogen to form methane bubbles into the steel which can turn into cracks. Refinery owners have started additional inspections for HTHA after the component failure that was not anticipated. However, HTHA defects are very small and difficult to detect with conventional ultrasonic testing or other volumetric NDT methods. Recently, new UT techniques have been proposed, including FMC/TFM, TOFD and PAUT. They have been applied in the field and improved based on the experience gained. In this paper, FMC/TFM ultrasonic technique for HTHA inspection will be presented. Data on a component, removed from the field, will be shown and cross-referenced with information from field examination and follow-up investigations. Conclusions will be drawn on the level of success in identifying HTHA correctly. The purpose of the paper is to demonstrate the importance of proper technique and equipment selection when inspecting for HTHA.

Keywords: Ultrasonic Testing (UT), TFM, PAUT, HTHA

11. Civil Engineering

Wednesday 17. Nov 09:00 CET

Non-Destructive Testing of Concrete Irradiated by Neutrons

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Two types of concrete samples were irradiated in Jeep II nuclear research reactor in Norwegian town Kjeller. Concrete cylinders were exposed to combined neutron and gamma radiations in order to determine their effect on concrete properties. Three different irradiation periods were employed to simulate various durations of nuclear power plant operation. Several destructive and non-destructive testing methods were proposed for post irradiation examination of concrete samples. One of the non-destructive testing methods was ultrasonic pulse velocity measurement. Radioactive samples were tested in controlled area, behind radiation shielding walls. Mechanical properties of concrete samples decreased by several tens of percent due to neutron radiation. Effect of irradiation on non-destructive testing results is provided in the paper.

Keywords: Ultrasonic Testing (UT), Expansion, Aggregates, Damage, Reactor, Nuclear, Neutrons, Irradiation, Concrete

Ultrasonic Inspection of Bolts using an Integrated Probe Attachment

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Anchor bolt inspection for an overhead catenary system (OCS) in an underground tunnel has been a significant operational challenge. The existing method of visual testing gives an inadequate measure of the bolt's integrity as the embedded section of the bolt cannot be inspected. Ultrasonic testing provides a more effective approach to inspect the entire bolt volume but there are difficulties in performing this manual inspection in the tunnel at an overhead position, at height and with inadequate lighting. With these challenging operating conditions, one major problem encountered is the inconsistency in the ultrasound signals acquired due to the inability to maintain good surface contact and sufficient pressure between the probe and the bolt. This paper proposes a novel design of an integrated ultrasound probe that is permanently attached to the anchor bolt and only requires the operator to connect the cable to the probe to function. Several inspection runs have been conducted to study the consistency of the ultrasonic testing results over a period of time for bolt specimens integrated with this probe attachment. Cuts of various depths

were also fabricated to simulate defects on these specimens and it was found that repeatable results could be observed in detecting and quantifying these defects.
Keywords: Ultrasonic Testing (UT), At Height, Overhead, Tunnel Conditions, Bolt Inspection, Probe Design

Simulation and construction of a focussing borehole probe for ultrasonic investigations at sealing structures for radioactive waste repositories
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A novel ultrasonic borehole probe is developed for the quality assurance of sealing structures in radioactive waste repositories using existing research boreholes. The aim is to analyse the sealing structures made of salt concrete concerning potential cracks, delamination, and embedded objects. A first prototype of the probe uses 12 individual dry point contact (DPC) shear horizontal wave transducers separated by equidistant transmitter/receiver arrays, each consisting of six individual transducers. It is operated with a commercial handheld ultrasonic testing device used in civil engineering. In order to increase the generated sound pressure of the borehole probe, the number of transducers will be increased to 32 for the novel probe. In addition, a time-controlled excitation of the individual probes is used to steer a focused sound beam to a certain angle and focus on a certain distance based on calculated time delays. Hence, the sensitive test volume is more limited, and the signal-to-noise ratio of the received signals improved. This paper presents the validation of the newly developed phased array borehole probe by beam simulation and experimentally on a half-cylindrical test specimen to investigate the directional characteristics. In combination with geophysical reconstruction method, an optimised radiation characteristic of the probe, an improved signal quality and thus an increased reliability of the results in imaging is expected. This is of great importance to construct safe sealing structures needed for radioactive or toxic waste disposal.
Keywords: Ultrasonic Testing (UT), Phased Array Technique, Borehole probe, Sealing structure, Non-Destructive Testing, Engineered Barrier System (EBS)

Wave based monitoring of concrete beams with Stay-in-Place (SIP) formwork
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Flexible stay-in-place (SIP) formwork for concrete structures can be an alternative to conventional removable formwork. They save construction time and are thus economical. The present paper presents a novel non-destructive wave-based approach for monitoring SIP concrete beams under 4-point bending. Model concrete beam specimen with Glass Fibre Reinforced Polymer (GFRP) gratings as tension and bottom reinforcement were cast. After curing, the beams were tested under 4-point bending and monitored using ultrasonic waves at various stages of loading. Variation in the ultrasonic signal response at different stages of loading was evaluated using a novel time-frequency approach. The veracity of signal variation is thus studied vis-à-vis variation in flexural loading. Thus, the experimental results demonstrate the efficacy of wave-based monitoring of SIP concrete beams
Keywords: Ultrasonic Testing (UT), Ultrasonic monitoring, signal processing, time-frequency analysis, flexural testing, Stay-in-Place (SIP) formwork, Glass Fibre Reinforced Polymer (GFRP) formwork

12. Materials Characterization

Monday 22. Nov 09:00 CET

Online Characterization of Polymer Filaments During FDM Additive Manufacturing Process
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Fused Deposition Modeling (FDM) represents the largest group of additive manufacturing (AM) technology in extrusion AM processes. In FDM technology, parts are fabricated by using filaments of a solid thermoplastic material as the raw material. The molten filament is selectively precipitated layer by layer in a predetermined pattern to produce the final product. The filament has a vital role in shaping the physical and mechanical properties of the final product. This paper aims to develop an ultrasonic testing technique for online measurement of various properties of the filament including its elastic constants and attenuation during the manufacturing process. The properties of the filament are extracted from acoustic waves scattered from the cylindrical filament. The process is carried out by solving an inverse problem in which the normalized backscattered spectrum is compared with its mathematical model by solving an inverse problem. The details of the technique are described, and preliminary results are presented.
Keywords: Ultrasonic Testing (UT), acoustic wave scattering,inverse problem,filament,fused deposition modeling (FDM),additive manufacturing (AM)

Characterization of polymer additive manufacturing components by ultrasonic testing

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Fused Deposition Modelling (FDM) is an additive manufacturing process in which melted polymer or composite material is selectively deposited in a pre-determined path layer-by-layer to produce a 3D-component. The properties of a component made by FDM process depends on both filament material and layup configuration. Depending on how the layers are laid up with respect to one another, the final component would show different elastic properties. In most cases, the material becomes anisotropic due to the layup structure of the filaments. In this study, ultrasonic testing method is utilized to measure the elastic properties of several FDM specimens made from polylactic acid (PLA) filaments. In the manufacturing of these components, various parameters can be controlled to lead to different elastic properties of the final product. Changes in the values of some parameters has higher effect on the anisotropy of the component compared to other parameters. The objective of this paper is to measure the elastic constants of these components and show the different classes of anisotropy of these components.
Keywords: Ultrasonic Testing (UT), Finite Element Method (FEM), Ultrasonic Testing (UT), Polylactic Acid, Elastic Constants, Additive Manufacturing (AM), Fused Deposition Modelling (FDM)

13. NDT Data Management

Wednesday 24. Nov 09:00 CET

Transforming NDT Data Management through Cloud-Based Solutions

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Digital transformation is revolutionizing nearly all personal and professional areas, including the NDT world, improving process efficiency and data integrity. While the connectivity of NDT devices is a key element of digital transformation, the seamless integration of these devices into a data-management platform adds considerable value to the data used by asset owners (AOs), inspection service providers (ISPs), and other stakeholders. With this in mind, Olympus is developing several digital initiatives, including the Olympus Scientific Cloud™ (OSC 3.0), a platform that is accessible to everyone and enables users to connect and manage numerous instruments. In this paper, I will review the advantages of using connected instruments, such as the Vanta™ XRF analyzer, the 38DLP™ thickness gauge, the EPOCH™ 6LT flaw detector, and the OmniScan™ family. In addition, I will present version 1.0 of the Oil & Gas Cloud and Digital Solution (O&G CDS),

which is a cloud-based solution to optimize ultrasonic and visual data acquisition, reporting, and inspection management to assist the oil and gas industry.
Keywords: Ultrasonic Testing (UT), Digital, Cloud, Data management, IoT, Ultrasonic, visual, integrity

Ultrasound data post-processing. Technological transfers from the aerospace industry to the others
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While Artificial Intelligence (AI) is a major R&D topic today, the growing importance of data is clear to all. Unlike X-ray testing, Ultrasound Testing (UT) data is recorded in various formats, depending on the proprietary software of the company which provides the acquisition system. Most of the associated analysis software are 'black boxes' which do not allow users to add specific features. This situation causes difficulties for industrial companies to capitalize on dedicated post-processing tools for their applications, and to take advantage of the latest AI developments. Since 2004, AIRBUS, the parent company of TESTIA, invested in the development of 'NDTkit UT' software to overcome these barriers. This also manages the huge quantity of UT data acquired in its plants involved in the manufacturing of components made of Carbon Fibre Reinforced Plastics (CFRP). This guarantees the possibility to read raw data all along aircrafts life cycles, typically 20 to 30 years on average. TESTIA is responsible not only for the development of 'NDTKit UT', but also for the software maintenance and for the promotion and diversification into other industries. This paper starts with a reminder of the main diagnosis assistance features required by the aerospace industry: data merging, defects detection and clustering, porosity content evaluation, thickness measurements, automatic reporting, etc. The second section discusses new capabilities developed for End-to-End (E2E) digital continuity, one of the pillars of NDE4.0. Major examples consist of exporting analysis results to either cloud hosted databases, and/or Digital Mock-Ups (DMU), to help design offices to manage concessions. Finally, it presents some direct transfers of existing features like scripts & plug-ins. Some of which were developed either by TESTIA or by customers themselves for use in other industries, such as: raw metallic materials, welds & bond lines, forged parts, corrosion mapping, Glass Fibre Reinforced Plastics, etc.
Keywords: Ultrasonic Testing (UT), data post-processing

14. General

Wednesday 24. Nov 10:00 CET

New generation of NDE technicians, support of new technologies
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Several professionals and essential expertise will leave the NDE industry in the next five to ten years owing to retirement. Several service/inspection companies are currently experiencing a resource shortage, and it is becoming increasingly difficult to recruit new NDT technicians. Technology complexity and severe environmental conditions, along with outdated equipment, are not the ideal business cards for the younger generation. However, Modern technology is poised to revitalize the NDT world, making this segment appealing once more.
Keywords: Ultrasonic Testing (UT), Remote support, Wireless, new technicians, Non-Destructive Testing (NDT), NDE 4.0