EWGAE 2010
29th European Conference on Acoustic Emission Testing 2010
Vienna, Austria, September 8-10, 2010
Abstract Booklet

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29th European Conference on Acoustic Emission Testing 2010
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2010-09-08 10:55 Room: Wilhelm Neusser Room
Session: AE Main

Validation of AE-signals recorded with conventional Equipment using 3D-Scanning-Laser-Vibrometer

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Abstract:
The work presented in this paper focuses on interpretation and explanation of AE Signals recorded by means of piezoelectric AE Sensors. It is a well known fact that AE signals are changing on their way from the source to the sensor. Especially the spectral contents of the recorded signal and the source-signal are generally not the same. Among the main influencing factors are the mechanical characteristics of the solids the (ultra)sound waves travel through, of the sensor connection (coupling) and of the sensor itself as a somewhat resonant system. For a better understanding of the impact of these factors on a recorded signal a Polytec 3-D Scanning Vibrometer for non-contact and non-reactive acquisition of three dimensional vibration and surface wave data has been used on a geometrically simple structure (steel cuboid) in combination with conventional AE measurement equipment (i.e. a piezoelectric sensor). The simple geometry of the chosen structure also allows for a relatively reliable numerical calculation of its natural frequencies - at least in the lower frequency spectrum - by means of a modal analysis using Finite Element Methods. The paper contains comparisons of the recorded spectra and the calculated natural frequencies regarding emissions generated by "artificial" sources (piezoelectric actuator) and "natural" sources (friction generated by files).

Keywords: Acoustic Emission (AE), Modeling and Simulation, wave propagation, practical applications, Tribological examinations

2010-09-08 11:20 Room: Wilhelm Neusser Room
Session: AE Main

Acoustic Emission Source Location in Plate-Like Structures using a closely arranged Triangular Sensor Array

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Abstract:
In order to identify the location of Acoustic Emission (AE) sources in large plate-like structures it typically requires the use of at least three widely spaced sensors. The distance between these sensors is defined by, for example, expected AE intensity and attenuation of the signals. This work will present a novel configuration of the three sensors, which are installed in a closely arranged triangular array with the sensors just a few centimetres apart. The algorithm locates AE sources by determining the direction from which the wave is approaching the array using the time of arrival and the distance the wave has travelled using the wave mode separation. Tests were conducted on a composite (CFRP) plate with anisotropic lay-up. In this work it is shown that the technique is able to accurately identify the source location. The technique is particularly suitable for Non-Destructive Testing (NDT) and Structural Health Monitoring (SHM) applications where the close positioning of the sensors allows the array to be installed in one housing to simplify mounting and wiring. It is expected that this sensor arrangement could reduce the number of sensors needed to monitor large plate-like structures compared to more conventional AE source location methods.

Keywords: Acoustic Emission (AE), structural health monitoring (SHM), localisation of damage, composite materials

2010-09-08 11:45 Room: Wilhelm Neusser Room
Session: AE Main

Influence of specimen geometry on acoustic emission signals in fiber reinforced composites: FEM-simulations and experiments

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Abstract:
Acoustic emission signals recorded during failure of fiber reinforced composite materials were investigated with pattern recognition techniques to obtain classes of signals each with similar characteristics. Pattern recognition techniques in combination with cluster validity indices allow a fast and valid separation into distinct types of signal classes. A valid correlation of these classes with failure mechanisms in the material is a more difficult task. This is due to the complex formation process of the acoustic emission signal, the dispersive propagation of the excited elastic waves, reflections at the specimen boundaries and to the detection process using a multi-resonant sensor. All these processes alter the inherent acoustic emission signal characteristics associated with a failure mechanism and have to be included in the signal analysis. To better understand the modifications of the acoustic emission signals during propagation and detection we present a finite element simulation approach for three experimental setups used for mechanical testing of fiber reinforced composites. The simulation includes a micromechanical model of the acoustic emission source, an anisotropic propagation medium and a model of a typical broadband acoustic emission sensor. We discuss the influence of the sensors aperture and the changes in its frequency sensitivity. The latter depends on the elastic properties of the material the sensor is in contact with. Further we compare simulations of typical failure mechanisms for geometries of flexural testing, tensile testing and GIc-testing with the respective acoustic emission signals obtained in the experiment. In all three specimen geometries the inherent characteristics of the source mechanism are distinguishable by characteristic frequency parameters and can be used to identify the failure type.

Keywords: Acoustic Emission (AE), Modeling and Simulation, pattern recognition, materials characterization, finite element simulation, fiber reinforced composites

2010-09-08 13:10 Room: Wilhelm Neusser Room
Session: AE Main

Acoustic Emission on-line Inspection of Rail Wheels

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Abstract:
The ever-increasing demand for safer, faster and cleaner surface transportation such as railway, imposes heavy usage and loads on train axes and wheels. Such components, during usage, are subjected to complex, fatigue loading, shock loads, impacts, bending, etc. and/or combinations of the above. Train wheel and axle failures while train is in operation occasionally lead to catastrophic failures, possibly with human victims. Within the scopes of an R&D project, aiming to develop novel methodologies and techniques for the inspection of wheel sets, extensive Acoustic Emission measurements have been performed on various trains and trams. In this set up, AE sensors were mounted on the rail aiming to diagnose wheel problems by monitoring the AE transferred through the rail in real-time and while the vehicles were moving. The purpose of the trials was to investigate the usage of AE for on-line detection of defects on wheels such as flats, bearing failures and possibly significant cracks, and to establish optimum setup parameters in this respect. The present paper presents the raw data and evaluation results from AE experiments on train and tram wheels, (both healthy ones or containing known defects). During measurements different AE sensors were placed the on the side of the rails while the railcars or trams were passing at different speeds. The effect of sensors frequencies and placement were investigated All different AE monitoring techniques i.e. Time Driven Data, Hit Driven Data as well as long (>10 sec.) waveforms were acquired simultaneously. Data analysis involved both traditional AE features, source location and digital signal processing of acquired waveforms. The Initial results presented herein highlight the different AE behaviour for defected and non-defected wheels, and indicate clearly the potential of AE as diagnostic tool. Furthermore results shows that the availability of acquired long, continuous waveforms significantly enhanced analysis capabilities, when combined with advanced AE DSP software and pattern recognition analysis.

Keywords: Acoustic Emission (AE), pattern recognition, signal processing, railway, quality control, software, Rail Axes Monitoring, AE Long Waveforms, Train Wheels Inspection

2010-09-08 13:35 Room: Wilhelm Neusser Room
Session: AE Main

The use of acoustic emission testing on long term monitoring of damaged component

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Abstract:
Conventional acoustic emission (AE) commercial applications in the USA focus on assessing the structural integrity of pressure vessels and tanks. Even though there is a wide variety of newly developed advanced non-destructive techniques supporting these assessments as an alternative to AE, the variety of situations under which AE can be helpful continue to expand. This presentation aims at illustrating some new applications of AE on our historically pressure vessel oriented focus.

Keywords: conventional AE, pressure vessels, monitoring, long term, damage, AE, Cracks, alternative techniques

2010-09-08 14:00 Room: Wilhelm Neusser Room
Session: AE Main

Cost effective corrosion and fatigue monitoring (CORFAT)

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Abstract:
Corrosion damages and fatigue cracks are the main causes for structural failures of all surface transport products like ships, road tankers and railway tank cars. Examples are catastrophic ship accidents with a tremendous pollution of the maritime environment or fatal explosions during the use of transport vehicles. Although evolving defects have to be identified in time to enable appropriate repair, preventive maintenance activities are usually carried out on time driven basis. As example transport products for cargo like crude oil and pressurised gases have to be taken out of service for visual inspection and sub-sequent non-destructive tests (NDT). Findings have to be repaired later on. This procedure is time consuming and expensive, especially the lost service time decreases the competitiveness of the European transport industry. Despite this high effort the risk of not detecting the onset of a defect is still implied in this maintenance process and thus failure within the next service period may occur. Within the presented EC-funded project (SCP7-GA-2008-218637) a prospective overall strategy for the maintenance and inspection, which is based on the results of AE-monitoring, and the necessary AE-equipment for the different transport products will be developed. The partners of this funded project represent many leading companies on their specific field of expertise (NDT, AT, Inspection, Classification, Research (Universities and Public Institutes, Maintenance, ship-yard). The partners are: TÜV AUSTRIA SERVICES (Austria), Vallen Systeme (Germany), ABS Europe (United Kingdoms), BAM Berlin (D), University of Thessaloniki (Greece), University of Gdansk (Poland) ISQ (Portugal), University of Krakow (Poland), Nuclear NDT (Romania), Reneko (Estonia) and Naval Ship Yard Gdansk (Poland). The presentation shall point out the basic research and developments, which were performed during the 1st part of the project. Within this work the ability of AT for monitoring and different follow-up NDT methods were proofed. The next steps for the adaptation of the methodology and their possible implementation in the normal maintenance process will be declared.

Keywords: Acoustic Emission (AE), transport products, AE monitoring, condition driven maintenance

2010-09-08 14:50 Room: Wilhelm Neusser Room
Session: AE Methods and their Practical Applications 1

Online Monitoring of Hot Die Forging Processes Using Acoustic Emission (Part-II)

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Abstract:
In part-I, the feasibility of using AE as an online monitoring technique for industrial forging processes has been investigated. The investigation considered monitoring the upsetting process of axis-symmetric specimens using a self-built data acquisition and analysis system up to 500 kHz. Two magnesium alloys and an aluminium alloy with three different geometries were used during these investigations. The experiments were performed under different thermomechanical loading conditions (temperatures, strains and strain rates). In addition, influences from machine noise, sensor positioning was also investigated and the achieved results were analysed. In this second part, the investigation was performed in the range 400-1600 kHz using the high-end professional acoustic emission system AMSY-5 (Vallen Systeme, Germany). In this second series of experiments, specimens of the same geometries but of larger size have been used in order to allow more flexibility in the loading scheme, assure minimum temperature drop during the test, facilitate both macro and microstructure analysis and most important to deliver more AE energy to improve the signal to noise ratio. The first part of this paper is devoted to describe the methodology used to reduce the hydraulic machine noise and discusses the different aspects considered during the choice of the front filters, adjusting the acquisition parameters and setting up signal-selection / rejection criteria. This will be followed by the main results achieved during the upsetting of the Al and Mg alloys specimens. Further, the methodology applied to correlate the obtained AE patterns to the test parameters is introduced.

Keywords: Acoustic Emission (AE), Online Monitoring, Hot Die Forging, Mg Alloys, High Strain Rate

2010-09-08 15:15 Room: Wilhelm Neusser Room
Session: AE Methods and their Practical Applications 1

Inspection of the pressure vessel used in petrochemical with AE examination

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Abstract:
Results of two pressure vessels AE tests done with 5 years interval are discussed in the paper. This experience shows the capabilities of condition monitoring of large integral industrial object with time evolving metal structure defects. This approach allows to define the main trends in defect development process and to make a decision about what kind of inspection should be done while object is under exploitation or exploitation should be stopped.In paper is shown that AE testing is able to determine the main factors of technological processing that cause the vessel metal condition change.It is presented that AE testing as an optimal inspection method from point of time saving in getting information about large-size vessels status. There are shown the results of same type defects development on the later stages of the other vessels.

Keywords: Acoustic Emission (AE), complex parameter, pressure vessel, blistering, lamination

2010-09-08 15:40 Room: Wilhelm Neusser Room
Session: AE Methods and their Practical Applications 1

A Study on Failure behavior of CFRP Bolted Joints with Cone Washers by Using AE Monitoring.

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Abstract:
Bolted joints are one of the common assembling methods for carbon fiber reinforced plastic (CFRP) members. During bolt tightening of CFRP members, cracks or plastic deformation likely occur around bolt holes when employing high fastening forces. To prevent these kinds of damages, the fastening force is controlled in low level. When an external joint load is applied to CFRP bolted joints, most of the external load is transmitted via a bolt. As a result, CFRP failure around bolt holes occurs by stress concentration, and the strength of a CFRP joint is reduced. To address this problem, we have tried to gain friction force between CFRP members by increasing a friction coefficient and a bolt-fastening force. To increase a friction coefficient, we have inserted a thin sheet having a high friction coefficient between CFRP members. On the other hand, to increase a bolt-fastening force without cause damages, cone washer which was proposed in previous paper was utilized. In this study, the joint strength and the failure behaviour of conventional and proposed joint were examined by finite element method analyses with degradation rules. The results show that the joint strength of the proposed joint was higher than that of conventional joint and the failure behaviour was different from that of the conventional joint. To investigate the joint strength and the failure behaviour of the actual proposed joint, the single-lap joint tensile tests with AE monitoring were conducted. The failure strengths of CFRP bolted joints with high-friction sheets and cone washers were higher than those of conventional CFRP bolted joints. Cumulative AE energy shows that the failure initiation load of the proposed joint was higher than that of the conventional joint, and the failure behaviour of the proposed joint was different from that of the conventional joint just like the finite element method analyses.

Keywords: Acoustic Emission (AE), Composite, Bolted joint, Failure behavior

2010-09-08 16:05 Room: Wilhelm Neusser Room
Session: AE Methods and their Practical Applications 1

AE monitoring in surface treatment of materials

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Abstract:
Ceramic thermal barrier coatings (TBCs) by atmospheric plasma spraying (APS) process have been widely used to add good heat resistance to metal base materials. It is well known that horizontal delamination cracks and vertical segmentation cracks occur in the coating during the APS process and these cracks affect the reliability of the coating. However, health monitoring of the APS process itself is very difficult because spraying machine emits large noise and high heat. In this study, a new AE system was developed to detect the cracks during the APS process. This system realized noncontact and noise resistance by utilization of laser interferometer and our original continuous waveform measurement and analysis equipment. All AE signal was continuously sampled and stored during the whole APS processing time. After that, several types of noise were cut and both delamination and segmentation cracks were detected from the continuous waveform by software signal processing.Shot peening is also one of the surface treatment methods to improve the materials properties such as fatigue strength by shooting of balls on the surface of products in order to generate a compressive stress. However, there are a few researches on quantitative evaluation between shot conditions and mechanical properties of products, and the optimal shot conditions are determined through a try and error process. In this study, acoustic emission (AE) signals were measured during shot peening and impact energy was evaluated in various shot conditions. AE source location technique was very useful to estimate the impact location of shot balls and also the number of impact was constituent with the detected number of AE signals. The theoretical equation of energy dissipation ratio could predict the relationship between impact velocity and detected AE amplitude. Quantitative source model for impact was proposed and the energy balance for each impact was analyzed using the inverse analysis of AE signals and experimental results of coefficient of restitution.

Keywords: Acoustic Emission (AE), Shot peening, process monitoring, Thermal spray

2010-09-08 14:50 Room: Mansard Room
Session: AE and Material Behaviour / Engineering 1

Correlation of Acoustic Emission And Fractographic Characteristics During Fatigue Crack Development

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Abstract:
Traditional methods of non-destructive testing (NDT) are used to check the growth of fatigue cracks on the final stages of their development, but in some cases they do not ensure necessary safety level in the process of dangerous object operation. The early detection of fatigue cracks may be performed by method of acoustic emission (AE).This research was carried out for an aircraft undercarriage leg where a fatigue crack was grown from an artificial stress concentrator during cyclic loading. In the process of testing, the AE signals were continuously recorded. After disruption, the leg break was exposed to fractal analysis.The analysis showed that the crack was growing irregularly. Particularly, its development practically stopped for several times, which was related to the initial growth of multiple microcracks and their consecutive amalgamation. Then all microcracks merged into a single main crack.It was observed that the total AE reflects the main stages of fatigue crack development. Particularly, depending on the number of loading cycles, there have been revealed several stages that differed by various velocities of AE accumulation. AE velocity changes may be used to check failure initiation and main crack growth. It is also shown that during the stages of quick crack development, AE signals in the loading cycle gradually become regular, which may be used to check the dangerous growth of the main crack.On the final stage of testing, a residual strength test was carried out. It is shown that the measurement of AE activity makes it possible to observe the crack development when the object of research is exposed to step-by-step loading, besides it can be used to prevent bench overload during object disruption.

Keywords: Acoustic Emission (AE), fractographic analysis, acoustic emission, fatigue crack

2010-09-08 15:15 Room: Mansard Room
Session: AE and Material Behaviour / Engineering 1

Health monitoring of reinforced concrete slabs during seismic tests using acoustic emission

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Abstract:
Under low-to-moderate intensity earthquakes, which are expected to occur several times during the lifetime of a building located in an earthquake-prone region, the reinforced concrete (RC) structures are designed to behave basically within the elastic range. Yet concrete cracking is certain to occur, since the tensile strength of this material is limited, and the cyclic reversals induced by the seismic action cause deterioration of the bond between concrete and reinforcing steel, leading to the slip of the reinforcement. Techniques that can alert as to the state of damage of a structure (concrete cracking and reinforcement slippage) without requiring regular and costly uncovering work are highly advisable. This paper describes the applicability of the AE (acoustic emission) technique for damage assessment of RC flat slabs subjected to seismic loads. It presents and discusses the AE recorded during a series of dynamic tests conducted with a 3x3 MTS shaking table installed at the University of Granada. The specimen represents, at the 1/3 scale, a flat slab supported on four box-type steel columns, and it was subjected to a simulation of the Campano-Lucano earthquake recorded at Calitri (Italy). The correlation between structural damage, expressed in terms of hysteretic strain energy, and the AE energy is discussed; and finally, some bases for developing formulae to evaluate the level of damage from AE measurements are suggested.

Keywords: Acoustic Emission (AE), Seismic Loads, Slab, Reinforced concrete, Damage evaluation

2010-09-08 15:40 Room: Mansard Room
Session: AE and Material Behaviour / Engineering 1

Fatigue Damage Analysis of Pultruded Glass Fiber Reinforced Materials with Acoustic Emission Methods

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Abstract:
Pultrusion is a process for manufacturing constant-section composite profiles. This technology allows to make parts through a matrix extrusion process, where the fibers are pulled; this allows a good alignment of the fiber before the matrix polymerizes. It is also a cost-effective and highly automated process. The material also allows a good rigidity/weight and strength/weight ratio. These features allowed to extend the field of use of these materials also to civil structures, as bridges, industrial sheds and anti-noise panels. However, the proliferation of these applications is delayed by the limited knowledge on fatigue strength and damage modes of these materials.For these reasons, an experimental study on pultruded materials has been developed. A traditional fatigue testing plan was supported by acoustic emission testing. Each specimen was monitored through all the test, recording acoustic emission events. It was also possible to localize events and to predict failure position thanks to the use of multiple sensors. Based on localization, it was possible to follow the damage evolution and to appreciate the accuracy of the measurements carried out by AE. A 3D a tomography of a part of the damaged specimen was made, making possible to correlate acoustic emission features (such as energy and amplitude) to damage modes (fiber or matrix failure, fiber slipping and delamination).Some structural monitoring criteria based on acoustic emission are also proposed. This allows to perform field tests and to reduce non-operative times due to inspections if a failure is detected: the localization methods may allow to use more precise testing methods in the possible area of failure.

Keywords: Acoustic Emission (AE), acoustic emission, damage, fatigue, pultruded materials

2010-09-08 16:05 Room: Mansard Room
Session: AE and Material Behaviour / Engineering 1

Effects of Material Structure of Concrete on Acoustic Emission Signal Parameters

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Abstract:
The paper deals with the effect of matter structure of concrete on the behaviour of acoustic emission. Concrete specimens made of several types of concrete structure modifications, having been prepared in compliance with the most frequent requirements of building industry practice, made the subject of our experiments. The specimens were subjected to flexural bending tensile load. The acoustic emission method has been applied to study acoustic phenomena arising in the material under test as a concomitant to the generation of micro-defects, which in turn results from the application of an external load.Both intact specimens and specimens which had been subjected to two different freeze-and-thaw degradation cycles were tested. The frequency of the acoustic emission overshoots, as recorded in the course of the measurements, has been processed using the cumulative curve method. Moreover, the Kaiser effect and the Felicity effect have been analyzed and evaluated. Analyses of our experiments furnish evidence for the acoustic emission signals to be able to reflect quite truly the degradation-induced crack generation and development processes.Another parameter to follow up was the frequency spectrum of the different acoustic emission events. It has been examined whether or not the frequency components which are typical of corroded-armature specimens occur also in our specimens. Frequency components which are significant for the armature corrosion and its consequences have not appeared in frequency spectra of plain concrete specimens.To verify the existence of correlation, if any, between the acoustic emission parameter changes and the specimen structure integrity deterioration, additional methods have been applied to the test specimens. Among them have been both non-destructive methods (change in the ultrasonic impulse propagation velocity, change in the dynamic modulus magnitude) and destructive methods (change in the flexural tensile strength, change in the compression strength). Our check-out measurements furnish evidence for the structure integrity deterioration to result from mechanical and thermal stressing and confirm the acoustic emission parameters to correlate with the material structure defect occurrence.

Keywords: Acoustic Emission (AE), frequency analysis, AE overshoot counts, flexural tensile stress, Concrete beams

2010-09-09 09:00 Room: Wilhelm Neusser Room
Session: AE Poster Presentation

Acoustic emission during three-point bending test of corroded galvanized steel

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Abstract:
The present paper addresses to a specific important technological topic like the identification and evaluation of damage in corroded and not corroded galvanized steel, analyzing particularly the effect of corrosion on this kind of coatings. With this purpose, the behavior of hot dipped galvanized samples with different sizes and submitted to three-point bending tests was studied. Acoustic emission was measured with piezoelectric 150 kHz resonant sensors. After the tests, the AE signals were analyzed by considering the AE classical features and applying the Ib-value index. It was observed that just when the plastification of the samples occurs, the minimum Ib-value is obtained. The study compares galvanized and black steel, and galvanized steel with and without corrosion. The present paper is part of a program designed to evaluate the adherence of commercial galvanized coatings obtained under different conditions and then submitted to various corrosion processes, in order to understand coating features related to adherence and to establish criteria for improving the manufacturing process.

Keywords: Acoustic Emission (AE), Coatings, Galvanized steel, Corrosion, Bending test

2010-09-09 09:00 Room: Wilhelm Neusser Room
Session: AE Poster Presentation

Acoustic emission technique for delamination detection in CFRP laminated materials

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Abstract:
Because of the wide application of composites in aerospace, civil engineering, vehicle industries, and other mechanical structural components, the online damage detection (Structural Health Monitoring) is necessary for safety. In particular, fiber-reinforced laminate are the most used composites in this kind of applications. The main goal of this work is the automatic detection of delaminations in carbon fiber-reinforced polymer (CFRP) laminate composite materials, by means the acoustic emission (AE) technique. Delamination between layers of a laminate is a typical and important defect of the CFRP structures, usually produced by impacts. This paper shows the results obtained in three points flexural tests carried out on samples of 31-layer carbon fiber-reinforced epoxi plates. Some samples were meaningfully delaminated at a specific position by inserting a teflon film between two layers during its preparation procedure before the curing in autoclave. Moreover, for comparison reasons, samples made only with epoxi resine and a bundle of carbon fibers were tested. Three kinds of AE sensors were tested: 150 kHz resonant, multiresonant, and wideband sensors with a very flat response. The results show a clear difference between the AE pattern of non-delaminated and delaminated samples. Moreover, some AE features were tested during the AE analysis procedure, in order to identify the AE signals produced by the delamination. The CFRP laminated were fabricated in the factory of EADS-CASA from "Puerto de Santa María" (Spain).

Keywords: Acoustic Emission (AE), delamination detection, CFRP materials, Composites

2010-09-09 09:00 Room: Wilhelm Neusser Room
Session: AE Poster Presentation

Diagnostics of high-voltage varistors by acoustic emission

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Abstract:
Varistors are usually produced from ZnO cylindrically-shaped structures and their quality depends on technological conditions at stages of their shape forming and firing. Therefore according to the industry standards they should be tested at the final stage of production measuring their leakage current at sufficiently high voltage. These tests are expensive and time consuming. A new method of non-destructive varistor testing before contact metallization is strongly needed. We have tried to use an Acoustic Emission (AE) phenomenon for this purpose.In the experimental phase some pieces of varistor structures before metallization for 280 V, 440 V and 660 V have been accurately selected from two sets of samples: good quality and produced with defected structure ones. They had each other quite different alternative parameters and characteristics (nonlinearity index, structure parameter tested by resonant ultrasound spectroscopy, granulation observed by Atomic Force Microscope)) deciding on their quality.The samples was measured using specially prepared system with linearly varied in time mechanical stress enabling to register the ultrasonic signals emitted during pressing the ZnO sample and detected by piezoelectric sensor and Vallen AMSY-5 recorder. The system registered in parallel the signal from the extensometer circuit proportional to the value of comprehensive stress. The measuring system will be described in detail in the paper.The characteristic AE signals as harmonic oscillations modulated in amplitude had local maxima in power spectral density about 300 and 500 kHz. Samples with good quality emitted ultrasonic signals with energy more linearly dependent on load than items having defected structure. Detailed, extensive results of AE measurements and compared with other methods results will be presented in the paper.

Keywords: Acoustic Emission (AE), high-voltage varistor, diagnostics

2010-09-09 09:00 Room: Wilhelm Neusser Room
Session: AE Poster Presentation

High temperature pressure vessels monitoring by acoustic emission technique

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Abstract:
The acoustic emission monitoring of pressure equipment operating at high temperature, presents a real challenge, given the complexity of interpreting the signals emitted by the structure and cost of implementation. The high temperature sensors are much less sensitive than standard sensors and their cost is very high. The use of waveguides, which allows the use of standard sensors, is an alternative to high temperatures sensors.The acoustic emission monitoring of this equipment requires firstly a good understanding of damage mechanisms involved and their mode of evolution and secondly, the knowledge of temperature effect on the propagation of acoustic waves in materials, in order to properly correlate the acoustic emission data with the defects actually detected in the structure.In the first part of the study, the temperature effect on Lamb waves propagation on two different materials (carbon steel and stainless steel) has been studied by using wave guide for the coupling of the sensor on the material.The correlation between experimental results and theoretical values calculated from dispersion curves of Lamb waves according temperature are showed.In the second part, mechanical tensile tests have been performed at different temperatures, for the two materials, in order to identify and characterise by acoustic emission the specific mechanisms occurring at different temperature stage.Cracking tests helped to identify the manifestation of the phenomenon of Portevin-Le Chatelier "PLC" in certain temperature ranges, for both materials studied, leading to a propagation of the crack by 'burst'. The analysis of acoustic activity in terms of rate, energy and also in terms of cumulative number of counts, are an effective way to detect the phase of damage and its advanced stage.

Keywords:

2010-09-09 09:00 Room: Wilhelm Neusser Room
Session: AE Poster Presentation

Monitoring of acoustic emission SIGNAL of loaded axial bearings

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Abstract:
The disclosure of initial stadium of contact fatigue of rotating machines is very difficult. At present, some methods which are suitable for diagnosis exist, such as vibration method, shock pulse method, acoustic emission and others. The article describes laboratory tests with axial bearings which are monitored by acoustic emission method.In the article the experimental stands, measuring devices and chosen types of axial bearings are presented. The exploitation of acoustic emission signal for the lifetime evaluation of selected bearings is shown with the characteristics as number of counts, rise time, maximal amplitude or duration of event. The bearing lifetime is separated to three stages and a representative sample in its time and frequency domain for each of them is chosen. Final failures of the bearings are shown too. The paper is focused also on examples of results obtained with continuous AE signal sensing.

Keywords: Acoustic Emission (AE), frequency domain, time domain, rise time, axial bearing, acoustic emission

2010-09-09 09:00 Room: Wilhelm Neusser Room
Session: AE Poster Presentation

Study of metal hydride electrodes for Ni-MH batteries by acoustic emission

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Abstract:
The study of the pulverization of metal hydride (MH) electrodes is essential for optimizing their performance in Ni-MH batteries. In this context, in-situ monitoring of the pulverization of MgNi and LaNi5-based alloys have been studied during their charge by coupling acoustic emission and electrochemical measurements. In both alloys, two populations of acoustic signals were detected during their charge: (i) a P1 population related to the MH particle cracking and characterized by short rise time (

Keywords: Acoustic Emission (AE), Hydride materials, acoustic emission, hydrogen embrittlement, batteries Ni-MH

2010-09-09 09:00 Room: Wilhelm Neusser Room
Session: AE Poster Presentation

Introduction to the mechanical characterization of reinforced plastic materials using the Acoustic Emission Technique

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Abstract:
Fiber-reinforced composites are extensively used as components in the manufacturing of various structures such as high-pressure-vessels, aerospace structures, marine vessels, transmission shafts in automobiles, support structures, etc. The aim of this work is to study the application of the Acoustic Emission (AE) technique when is used in the laboratory to characterize the mechanical behaviour of a reinforced composite material. Composite materials can produce different kind of acoustic emission when they are stressed. In the case of organic composite materials the specific mechanisms that can produce this emission are the fracture of the fiber, the interfacial delamination of the fiber, the plastic deformation of the matrix and the interlaminar delamination. In this work a mechanical test, using tensile loading, was performed in order to establish any reasonable relationship between the failure mechanisms and the AE. The analyzed specimens were obtained mixing an epoxy resin (DGEBA) with a diamine and some specimens were reinforced with glass fiber. All of them were postcured at high temperature in order to obtain a highly rigid material.In this work we will analyze different combination of some acoustic parameters in order to interpret the obtained results and to characterize the (micro)mechanical events into the composite. It is expected that polymeric materials emit sounds with lower amplitude and longer duration than the inorganic fibers used as reinforcement. More over, in the case of the energy, the sounds emitted in the process of cracking of the matrix is hoped to give lower energy values than the fiber ones. We will study the distribution of AE results when they are showed in different combination of parameters (Amplitude, Duration, Energy, frequency, etc).

Keywords: Acoustic Emission (AE), fiber, epoxy, mechanical characterization, Acoustic emission

2010-09-09 09:00 Room: Wilhelm Neusser Room
Session: AE Poster Presentation

Ultrasonic C-Scan Imaging of Porcelain Tiles

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Abstract:
Traditional methods of quality control are difficult to use when many affective factors in the event of defect evolution. Ultrasonic testing is one of the most widely used NDT techniques for quality control because of its relatively inexpensive cost and appropriate data for decision. Ultrasonic material analysis is based on a simple principle of physics: the motion of any wave will be affected by the medium through which it travels. It would be advantageous to detect defects in short time and nondestructively. In this paper, C-scan ultrasound was employed to detect defects of porcelain tiles. To this purpose, different size and sort defects were imbedded in standard porcelain tile granules before pressing. After sintered at 1200°C, tiles were inspected with ultrasonic C-scan system which provides two-dimensional presentation of defect-distribution. An immersion and 6-12 MHz frequency focused transducer was used to differentiate defects. Place of different sized aluminum foils, paper, different shaped plastics in tiles were determined and their sizes were measured.

Keywords: Acoustic Emission (AE), Ultrasonic, C-scan, defect detection, porcelain tile, quality control

2010-09-09 09:00 Room: Wilhelm Neusser Room
Session: AE Poster Presentation

Analysis of fracture resistance of tool steels by means of Acoustic Emission

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Abstract:
The usage of advanced high strength steels (AHSS) in structural automotive components has been broadened in the past few years to satisfy the strict specifications of the automotive industry. Besides showing excellent strength to eight rations, AHSS have several limitations due to the high loads required in cold forming and cutting tools, which decrease considerably the tooling performances. Therefore, these important forces of impact provoke unforeseen breakage of the dies.The aim of this research is to study the micromechanical behavior and fracture mechanisms (nucleation and crack propagation) during fracture of tool steels using the acoustic emission (EA) technique. To do that, bending testing specimens of different tool steels were monitored in order to establish a relationship between AE signals and their mechanical behavior (carbide breakage, cracks emanating from them and crack propagation through the metallic matrix).

Keywords: Acoustic Emission (AE), pattern recognition, automotive, materials characterization,

2010-09-09 09:00 Room: Wilhelm Neusser Room
Session: AE Poster Presentation

Acoustic and electromagnetic methods for wood

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Abstract:
The basis of our work was to examine the relations between the wood properties and the responses of non-destructive methods with emphasis on spectroscopic analyses of distributions and gradients. The main goals were to develop improved methods and equipment for monitoring and characterisation of the internal properties of wood. Acoustic emission technique has been studied especially for monitoring wood drying. Electromagnetic spectral techniques have been studied including frequencies from mHz to GHz region. Electrical impedance spectroscopy (EIS) based methods have been studied using electrical model analyses for evaluation of moisture content and moisture gradient. Novel electrical models and techniques were studied and portable EIS equipment was developed for moisture gradient analysis. Combination of acoustic and EIS method has been studied for monitoring drying of wood including different types of heat modifications. A new method and a prototype have been developed. The method is based on using electrical method for moisture gradient monitoring and acoustic emission method for detection of micro-cracking during wood drying. In the method, electrodes are used to create electric field in drying wood and measure the electric complex spectrum using the impedance spectroscopy method while at the same time measuring acoustic emissions from drying wood. When the responses are determined at the same time, it is possible to estimate both the main reason for the drying stresses (moisture gradient) and the outcome (micro- and macro-cracking). Thus the results may be used to advantage in controlling drying in order to achieve wood products of high quality.

Keywords: Acoustic Emission (AE), electrical impedance spectroscopy, drying, Wood

2010-09-09 09:00 Room: Wilhelm Neusser Room
Session: AE Poster Presentation

Comparison of Acoustic Emission Signal and X-Ray Diffraction at Initial Stages of Fatigue Damage

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Abstract:
This paper deals with evaluation of degradation processes, which occur at cyclic loading of samples of Al alloy EN AW-2017. Two basic NDT procedures - acoustic emission method and X-ray diffraction topography were used for detection of microstructure changes during stages of fatigue damage cummulation and microcracks initialization. These measurements were completed with analysis of loading frequency changes of the fatigue test device.AE signal records obtained with use of the newly developed AE analyser with continual recording of signal are commented in detail. Compared to the up to date commonly used AE analyser devices, the major advantage of this type of analyser is that it is capable of continually sampling and storing the whole AE signal for as long as there is space to store it.The acoustic emission method identifies changes passing in the material during the damage accumulation period. Here the main problem is to define the type of changes, of course. When identifying these sources of acoustic emission, monitoring the structure by means of X-ray diffraction is a very significant source of information. The results of presented experiments indicate the connections between changes of acoustic emission signal and changes of so called mosaic blocks of the crystal structure identified by means of X-rays.

Keywords: Acoustic Emission (AE), aluminum alloy, X-ray diffraction, fatigue bend test

2010-09-09 09:00 Room: Wilhelm Neusser Room
Session: AE Poster Presentation

Damage detection in a multilayer composite tube by guided waves ultrasonic testing

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Abstract:
The tubes are used in several application areas. They are found in petroleum, chemical, nuclear ... These tubes, usually metal, are heavy to carry. In addition, they are subject to damage primarily related to the development of the general corrosion in their surfaces. The Multilayer Composite Tube (MCT) is always seen as the best substitute. Despite these qualities well recognized, it does not escape the rules and standards of quality and safety. The Nondestructive Testing (NDT) of these structures is of prime necessity in order to ensure their functionality and durability in service. The Guided Wave Ultrasonic Testing (GWUT) is well suited technical for the health monitoring to this type of geometry structures. These performances of GWUT are relatively limited especially when the structure is large and/or very thick. In the present work, we succeeded with this technique to detect an artificial damage induced in a MCT (10mm section thickness). Promising results for inspection of thicker structures will be exposed

Keywords: quality control, localisation of damage, damage detection, Guided Wave Ultrasonic Testing

2010-09-09 09:00 Room: Wilhelm Neusser Room
Session: AE Poster Presentation

Acoustic Emission method as a Comparative Tool for Results Obtained Using Impedance Spectroscopy - Applied for Cementing Compound Specimens with Various Capillary Porosity Levels

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Abstract:
The paper deals with an application of the acoustic emission method to cementing compound specimens featuring different capillary porosity levels. The experiment has been intended to contribute another method of checking the impedance-spectroscopy method results. The different capillary porosity levels of the cementing compound have been confirmed and distinguished successfully

Keywords: Acoustic Emission (AE), Polarization Losses, Loss Factor, Conductivity Losses, Dielectric Losses, Impedance Spectroscopy, Acoustic Emission

2010-09-09 09:00 Room: Wilhelm Neusser Room
Session: AE Poster Presentation

Use of advanced signal processing technique for analyzing the Acoustic Emission signatures from mechanical transmissions

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Abstract:
The application of Acoustic Emission (AE) in condition monitoring of rotating machines has been well documented. The majority of research works in this field has involved the use of conventional time domain analysis for processing the AE signals from the machines and there has been little attention given to application of more advanced signal processing methods. This research presents the several case studied in which some advanced signal processing techniques such as Wavelet and Spectral Kurtosis (SK) has been applied to offer improved diagnosis.

Keywords: Acoustic Emission (AE), wavelet, signal processing, fatigue damage, structural health monitoring (SHM), Condition Monitoring, Acoustic Emission, Gear, Bearing

2010-09-09 09:00 Room: Wilhelm Neusser Room
Session: AE Poster Presentation

Use of AE monitoring in laser cutting and resistance spot welding

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Abstract:
Laser cutting and resistance spot welding are frequently used of techniques in automotive industry and production of white goods. The paper describes possibilities monitoring process quality of laser cutting and resistance spot welding based on measured AE signals. The results of AE signals measured during and after laser cutting are shown. The measured results confirm that laser cut quality based on measured AE signals could be predicted. It is shown that different conditions in laser cutting front influence the laser cut quality and consequently measured AE signals. Also continuous AE signals during current flow in RSW are analyzed. Selected welding parameters often cause excessive energy input which leads to excessive heating of welded material that can cause unwanted expulsions and electrode tips damages. This is why users want different sensor why systems to monitor and control the welding process to attain optimal conditions. In the paper continuous AE signal during current flow were analyzed in time and frequency domain. AE waveform during current flow at RSW with expulsion of material and simultaneous changes of electrical parameters that characterize the welding process was studied.

Keywords: Acoustic Emission (AE), RSW, burst emission, continuous emission, laser cutting, PZT sensor, dross

2010-09-09 09:00 Room: Wilhelm Neusser Room
Session: AE Poster Presentation

Propagation of Acoustic Emission and Acousto-ultrasonic Waves in Wood Materials

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Abstract:
Acoustic emission (AE) and acousto-ultrasonic (AU) signal waves depend on the character of the wave source where a deformation or crack is generated and properties of the material through which the wave propagates. In wood, the species, anisotropy, moisture content, and natural variability affect attenuation of AE/AU waves. Differences in AU propagation properties in wood were observed in Japanese larch (Larix leptolepis Gord.) and red lauan (Shorea sp.). Breaking of pencil lead was used as an artificial AE source and broadband (0.1 – 1 MHz) AE transducers were used to measure one-dimensional AU wave propagation. For observing two-dimensional propagation, resonant AE transducers, a 150-kHz transmitter, and a 150-kHz receiver were used. Longitudinal components of AU waves arrived first, followed by transverse-wave components. These components were distinguished clearly only in longitudinal propagation. Attenuation was greater for transverse waves than for longitudinal waves. The features of AU wave forms that traveled the same distance in the same specimen differed with the alignment of the AE transducers. The attenuation of AE/AU waves as they propagated through wood was illustrated by schematic contour maps of AU signal amplitudes. In Japanese larch, AU waves propagated along the grain, primarily through the latewood. The longitudinal attenuation of AU waves was affected by wood density, primarily by microfibril angle. Attenuation of AU waves was greater in red lauan than in Japanese larch because of the absence of latewood. Attenuation was also greater in water-soaked red lauan.

Keywords: attenuation, acousto-ultrasonics (AU), wood drying

2010-09-09 09:50 Room: Wilhelm Neusser Room
Session: AE Methods and their Practical Applications 2

Application of acoustic emission method for brickwork diagnostics

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Abstract:
Acoustic emission (AE) method becomes more and more widespread in construction industry. Also it is necessary to develop and standardize new methods of non-destructive testing which enables evaluation tests for anchors fixed in brickwork. This paper describes practical application of the acoustic emission and cyclic loading method to evaluate load-carrying capacity of an anchor fixed in the brickwork.

Keywords: Acoustic Emission (AE), anchoring binding, cyclic loading, destruction, AE emission, brickwork diagnostics

2010-09-09 10:15 Room: Wilhelm Neusser Room
Session: AE Methods and their Practical Applications 2

Quality Prediction of Foil Capacitors by Acoustic Emission Signals

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Abstract:
Quality and endurance of foil capacitors is determined by their working conditions and potential failures made at various production stages. New, cheap and fast methods of element quality prediction are strongly recommended. The paper presents the measurement results of an acoustic emission signal induced by mechanical stress of capacitor wound foil as a quality indicator. A modified method of capacitors quality is presented. The method allows to detect whether the metalized foil is not properly adjusted to the sprayed metalized contact heads. A tested capacitor is polarized by electric pulses having a repetition frequency about tens of kHz. Vibrations are caused by electrostriction within continuously depolarized dielectric layers of the wound foil and can be measured by an acoustic sensor attached slightly to the capacitor enclosure.

Keywords: Acoustic Emission (AE), quality control,

2010-09-09 10:40 Room: Wilhelm Neusser Room
Session: AE Methods and their Practical Applications 2

Characteristics of Acoustic Emission from Impact-Damaged CFRP Pressure Vessel during Pressurization Test

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Abstract:
This study examined the applicability of acoustic emission method for the impact damage evaluation of CFRP pressure vessels. AE signals were detected during pressure proof tests of a CFRP pressure vessel before and after the impact test. The impact test was conducted by using a drop-weight impact tester. After the impact test, AE event rate during pressurization and pressure-holding period became higher compared to those detected before the impact test. Frequency components of AE signals were also changed after the impact test. From these results, it is assumed that AE method can be used for the impact damage detection of CFRP pressure vessels. Furthermore, location of impact damage might be estimated by AE method since most AE signals were first detected by the AE sensor near the impact damage.

Keywords: Acoustic Emission (AE), non-destructive evaluation, CFRP, impact damage, pressure vessel

2010-09-09 11:30 Room: Wilhelm Neusser Room
Session: AE Methods and their Practical Applications 2

Monitoring the Thermowood process by means of Acoustic Emission technology

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Abstract:
Thermowood is produced by heating timber at 212 ºC for several hours while it is shielded from oxygen to prevent pyrolysis. In this way, material properties like biological durability and dimensional stability are improved, yet unwanted side-effects like the loss of strength and the formation of internal cracks are also observed. During this research, the Thermowood process was monitored using acoustic emission (AE) technology, so as to reveal which wood properties and which phases of the process are most critical with regards to crack formation. Acoustic emissions were measured on 300 mm long timber samples using piezo-electric sensors, which were connected to amplifiers and a computer outside the treatment kiln. Using two parallel measurement channels, one flawless wood sample could be compared to a sample with different material properties with regards to e.g. knottiness, initial moisture content or thickness. Apparent emission trends could be observed throughout the process, whereby material properties like the presence of knots and initial moisture content were found to affect the emission patterns significantly. During most runs, the highest AE count rates and amplitudes were observed during the final conditioning phase and it is hypothesized that this phase is most critical with regards to crack formation.

Keywords: Acoustic Emission (AE), materials characterization, Acoustic emission, wood, thermal modification, thermowood

2010-09-09 11:55 Room: Wilhelm Neusser Room
Session: AE Methods and their Practical Applications 2

Fatigue Testing of Ship Building Material with Acoustic Emission

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Abstract:
Corrosion damages and fatigue cracks are the main causes of structural failures in all surface transport products like ships, road tankers and railway tank cars. Both types of degradation, i.e. the degradation of material and structure, are the subject of investigations carried out within the framework of a collaborative project of the 7th Framework Programme (Transport) entitled “Cost effective corrosion and fatigue monitoring for transport products”. In this paper, the first fatigue tests using acoustic emission (AE) performed on ship building materials have been demonstrated. AE enables us to monitor the crack propagation during low fatigue tests performed on specimens under asymmetric three-point bending loading. It was ex-pected that fracture behaviour would move from Mode I to Mixed-Modes I/II, which would be closer to reality. For reference, tests were also made in liquid to obtain and evaluate the differ-ences in AE signal propagation in liquid and in material directly contacting this liquid. The data obtained during fatigue tests will be included in a database used in pattern recognition analysis to separate the signals due to fatigue crack propagation and corrosion damages from background noise.

Keywords: Acoustic Emission (AE), pattern recognition, railway, corrosion testing, fatigue damage, wave propagation, localisation of damage, crack propagation, transport products, Fatigue test, AE monitoring

2010-09-09 12:20 Room: Wilhelm Neusser Room
Session: AE Methods and their Practical Applications 2

A case study for crack detection within a gas cylinder using acoustic emission testing

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Abstract:
Requalification tests of gas cylinders with acoustic emission testing are applied since many years. The most advantageous way to do so is pneumatic testing. As for every application the measurement is exploited twofold: 1.to ensure safe pressurisation and 2.to analyse found indications after the test in more detail. Messer Austria operates at Herzogenburg site a semi-automatic testing rig for cylinder requalification. At the EWGAE conference held in Cracow two years ago several examples of rejected cylinders from this site have been shown. Acoustic emission data was given as well as results of follow-up for comparison. The content of this contribution shows one further example where the test has proven to be best choice. Follow-up revealed that a well developed crack filled with corrosion product has been detected. Details regarding detection and follow-up activities are presented in this new case study.

Keywords: Acoustic Emission (AE), corrosion testing, fatigue damage, structural health testing

2010-09-09 13:45 Room: Wilhelm Neusser Room
Session: AE Methods and their Practical Applications 3

Examination and Generation Condition of Screech Tone Detected during Gas Leakage on Pipe Using Acoustic Emission Technology

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Abstract:
Acoustic emission (AE) technology has been applied in monitoring and inspection of flaws specifically on gas leakage from pipeline installations through research in the field and laboratory. We have chosen four types of artificial defects such as straight-, stepwise-, truncated cone- and slit-type pinholes to quantify the smallest possible defect from the material flaw that could be emanated in actual pipe installations. One of the advantages in this research study is the possibility to characterize the different AE signals generated during gas leakage and eventually enhance the accuracy in the analysis of defect development during actual monitoring and inspection of pipelines. The purpose of this study is to characterize and analyze the generated AE signals during gas leakage on pipe with these artificial defects. The main objective is to examine and make clear the generation condition of the screech tone that is characterized as the feedback loops driven by large-scale instability of waves of gas flow near the outlet. When this gas pressure is reached at the critical level of 220 kPa based on the assumption that the gas flow velocity reached to its sound velocity, the shock cell is developed in which the screech tone simultaneously takes place. In the case of the only straight- and slit-type pinholes, the AE signals showed a decreasing peak frequency after reaching the critical gas pressure. The pressure where the screech tone occurred depended on the pinhole shapes. In the case of the truncated cone-type pinhole, the screech tone did not occur because of stability of gas flow through the defect. The characteristics of the screech tone have been discussed in detail.

Keywords: Acoustic Emission (AE), Leak Testing (LT), FFT, Gas Leakage, Screech tone and pipes

2010-09-09 14:10 Room: Wilhelm Neusser Room
Session: AE Methods and their Practical Applications 3

Low-cost USB acoustic emission system for damage monitoring in fibre reinforced composite materials

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Abstract:
An increased utilisation of fibre reinforced composite (FRC) materials as structural components in aerospace and automotive applications has been observed in recent decades; this is primarily due to their excellent stiffness- and strength-to-weight ratios. However, barely visible damage in the form of matrix cracks, delamination and fibre fracture can dramatically reduce the load-bearing capacity of these components. As such, the requirement for low-cost online monitoring technologies is of paramount importance in order to infer damage in real-time. The first part of this paper discusses the feasibility of using a low-cost USB acoustic emission (AE) system for online monitoring of damage development in fibre reinforced composite (FRC) materials; conventional piezoelectric sensors were surface-mounted to woven carbon fibre/aluminium specimens. The FRC/aluminium specimens were evaluated using a quasi-static tensile test procedure. Samples were loaded until failure and AE was acquired continuously. The system demonstrated successful detection of AE signals corresponding to damage initiation and final failure. Initial signal processing was carried out using AEwin™ software. A simple method of locating acoustic emissions using two USB nodes/sensors was applied and is also discussed. The second part of this paper reports on the use of advanced signal processing for analysis of the data acquired from the composite mechanical tests in order to identify and separate composite failure mechanisms as a function of applied load. This was achieved through analysis of signal frequency content using wavelet transforms. Furthermore supervised and unsupervised pattern recognition schemes were also applied to the test data with the aim of further discriminating failure mechanisms in FRC's. The possibility of using Noesis signal processing software for semi real time source classification in composites is discussed.

Keywords: Acoustic Emission (AE), emission, fibre-reinforced composite, damage, pattern recognition

2010-09-09 09:50 Room: Mansard Room
Session: AE and Material Behaviour / Engineering 2

Reinforcement effect on the ultrasonic pulse velocity in concrete, depending on the sounding method and measuring device

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Abstract:
In practice it is often required to determine the technical condition and the load carrying capacity of reinforced concrete. The quality of the constructions is also characterized by the structural properties of the concrete. However, sometimes the obtaining of the full value concrete specimens from such structures is problematic to carry out further researches with the material destructive test methods. It is known that physical and mechanical properties of concrete are best characterized by the density, porosity and strength of the structure. The integrity of such properties can be assessed by using material nondestructive test method ― by applying the ultrasonic pulse velocity measuring devices. At the same time, it is also known that there are several factors that influence the ultrasonic pulse propagation velocity in the concrete and the reinforced concrete structures. The earlier performed investigations have established that presence of the reinforcement located close to the surface of the tested concrete increases the ultrasonic pulse velocity. Reinforcement effect is also described in the notes to various standards. In practice the concrete structures of many different building objects have been tested with specific ultrasonic devices, and obtained results leads to the doubts about the relevance of reinforcement effects. To explore this question, 5 model specimens were manufactured with different diameter of reinforcement rebars. Diameters of the rebars used for specimens ― 6; 8; 12; 16 and 22 mm. For reinforced concrete structures, which are necessary to test in a larger area, reinforcement diameter normally does not exceed the greater of the above mentioned size. Furthermore, determining of the rebars dislocation in large areas is very time-consuming process, even if for this purpose corresponding device has been used before ultrasonic velocity measurements. In present research performing measurements in the zones direct over the rebars and in the rebar-free zones (in plain concrete), different ultrasonic measuring devices show a comparatively different results. It is concluded that the reinforcement effect on the ultrasonic pulse velocity in concrete depends on both sounding methods and technical parameters of the measuring device.

Keywords: Acoustic Emission (AE), ultrasonic pulse velocity measurements, nondestructive test method, concrete structures, effect of reinforcement

2010-09-09 10:15 Room: Mansard Room
Session: AE and Material Behaviour / Engineering 2

Acoustic Emission Monitoring of the Expansion of Fatigue Cracks in The Rolling Mill

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Abstract:
An acoustic emission (AE) method has been developed for monitoring of the expansion of fatigue cracks on the 08GDNFL steel. The method is based on the fracture mechanics, raster electronic microscopy, quantitative fractography and mathematical statistics. In the course of research seminatural patterns of 6T-CT type and 150 mm thickness were used. A connection between the AE signals and the parameters of the expansion of fatigue cracks has been found out.The present method allowed to conduct monitoring of the expansion of fatigue cracks on the rolling mill "5000" with the help of multi-channel AE system within the period of eight years. Findings of the AE monitoring have been justified by the results of periodical ultrasonic tests.

Keywords: Acoustic Emission (AE), fatigue damage, localisation of damage, fracture mechanics, rolling mill, monitoring, fatigue destruction, microcrack, crack, Acoustic emission, raster electronic microscopy, quantitative fractography and mathematical statistics

2010-09-09 10:40 Room: Mansard Room
Session: AE and Material Behaviour / Engineering 2

AE-SiGMA Analysis in Brazilian Test and Accelerated Corrosion Test

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Abstract:
The moment tensor analysis of AE waveforms detected for one AE source is available to identify cracking kinematics of a location, a crack-type and a crack orientation.
The procedure has been implemented as the SiGMA (Simplified Green's functions for Moment tensor Analysis) analysis. Thus, mechanisms of cracking in concrete can be visually and quantitatively investigated. The procedure is applied to the Brazilian test of concrete, since the tensile strength of concrete is normally evaluated by this test. In order to clarify generating mechanisms of macro-scale tensile failure in concrete, crack nucleation in the meso-scale is quantitatively studied by the SiGMA analysis. Then, the generating mechanisms of corrosion-induced cracks are studied in reinforced concrete. Because high AE activities are observed twice during the corrosion process at the onset of corrosion in rebar and the nucleation of cracking in concrete, the SiGMA analysis is applied to an accelerated corrosion test of a reinforced concrete beam to clarify kinematics of corrosion-induced cracks in the second high AE activity.

Keywords: Acoustic Emission (AE), SiGMA analysis, Concrete, Brazilian test, Corrosion in reinforced concrete

2010-09-09 11:30 Room: Mansard Room
Session: AE and Material Behaviour / Engineering 2

Inclusion Fracture in Model Aluminium Alloy Characterized by Acoustic Emission and X-Ray Tomography

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Abstract:
Coarse spherical zirconia particles were incorporated into an age-hardenable 2124 aluminium alloy by powder metallurgy methods in order to obtain a model material for the study of inclusion fracture by both means of acoustic emission and X-ray tomography. Tensile samples were strained in situ at the European Synchrotron Radiation Facility in Grenoble, ID19 line, while the Mistras device of EPA was used to monitor and localise the AE bursts. X-ray tomography enabled to discriminate between metal, zirconia and void and therefore characterize damage at a voxel scale of 2.83 µm3, providing a very accurate description of particle cracking. Experimentally, damage occured by multiple fracture of the coarse particules, with high-energy AE events for the first fracture (largest released elastic energy) and softer further events that could be discriminated by classifiers (k-means method). A good match between the location of fractured particles and the AE events was evidenced. Furthermore, the release of elastic energy was computed by finite elements and found fairly proportional to the AE burst energy. A better macroscopic match occured between the cumulated AE energy and the cumulated fractured surface perpendicular to the stress axis. Finally, the distribution of AE event energies was found to follow a power law, with an unusual exponent of 1.We wish that these experimental results will contribute to the acoustic modelling of the recording chain.

Keywords: Acoustic Emission (AE), strain damage, metal matrix composites, inclusion fracture, material behaviour

2010-09-09 11:55 Room: Mansard Room
Session: AE and Material Behaviour / Engineering 2

Is it Possible to Applied Acoustic Emission Method during Concrete Hardening?

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Abstract:
Concrete is essential material for civil engineering. It is the most used material in the world. Its properties depend on mixture components (cement, sand, water, chemical admixtures and etc.) and its curing. Physical and chemical processes (guided heat release) proceed into concrete during hydration and hardening, at which concrete obtains mechanical strength and hardiness and creates chemical stability in material. Cracks rise in concrete over its lifetime especially in initial stage. Temperature and structural changes are sources for crack initiation. These changes can locate by help acoustic emission method. However set up the method is not easy.The article will describe experiments on concrete samples 10 cm width 10 cm high and 40 cm longer. Acoustic emission system LOCAN 320 uses four acoustic emission sensors to indicate acoustic emission hits - two on a sample. Simultaneously these sensors serve as guard. Acoustic emission sensitivity is obliged to be set high but so that acoustic emission hits are a little above noise. Temperature into samples was measured too. Two samples ware measured simultaneously. Article describes some result from chosen measurement.

Keywords: Acoustic Emission (AE), civil engineering, materials characterization, concrete

2010-09-09 12:20 Room: Mansard Room
Session: AE and Material Behaviour / Engineering 2

Electromagnetic and Acoustic Emission in PEEK/Carbon Nanotube Composites

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Abstract:
Besides acoustic emission phenomenon, the creation of cracks is accompanied by electric charge redistribution due to loosened chemical bounds. Electric charge on a crack wall creates dipole or quadrupole moments. Vibrations of crack walls produce time-dependent dipole moments and, consequently, electric and magnetic fields are generated. This phenomenon is called electromagnetic emission (EME). In last decades, great attention has been paid to the application of EME from rocks and minerals being exposed to mechanical stress, both in connection with earthquake and volcanic activity prediction and in rock mechanics. Whereas, the application of EME to study the behavior of a polymer-based material exposed to mechanical stress has been very rarely covered in the literature recently, although this is an advanced structural material, featuring a high application potential in mechanical engineering. Our research deals with experimental study of the electromagnetic and acoustic emission signals in non-conductive PEEK/carbon nanotube composites. Experimental setup has been assembled to suppress effects of external electromagnetic and acoustic fields in order to amplify extremely low electromagnetic signals during the crack formation. The experiment was carried out on tensile specimen.

Keywords: Acoustic Emission (AE), electromagnetic emission, acoustic emission, polymer composite

2010-09-09 13:45 Room: Mansard Room
Session: AE and Material Behaviour / Engineering 3

Identification of The Early Mechanisms Damages Of Multilayer Composite Materials By The Mean of The Acoustic Emission Testing

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Abstract:
Composite materials have important assets compared to traditional metallic materials. They have many functional advantages and enhanced mechanical properties (e.g. lightness, high ultimate tensile strength, high flexural modulus, as well as great temperature resistance). These materials develop today practically in all the fields and are in the origin of significant challenges particularly in aerospace, aeronautical and transports industries. However, the structural health of these materials must be controlled and monitored in order to insure their durability and functionality. Nevertheless, specific problems affect composites health during manufacture process or in service for example porosity, discontinuity of carbon fibres, fibers pull-out, matrix cracking, carbon fibers rupture, Shock, impact or delamination.In service, the assessment of the defects is the control key point of the composites durability and reliability. Accordingly, identification of the various early damages mechanisms by a Non destructive testing (NDT) proves a great importance in order to guarantee in service the safety and the use of these materials.To resolve this problematic, the NDT by the Acoustic Emission (EA) was proved to be well adapted. Encouraging results treating the application of this technique for defects control and for the identification of early damages indicators of composite under various experimental conditions (tension failures, shock, impact and repeated cyclic stresses) will be presented.

Keywords: Acoustic Emission (AE), Composites materials, Damage prediction

2010-09-09 14:10 Room: Mansard Room
Session: AE and Material Behaviour / Engineering 3

Acoustic emission of conifer sapwood becomes weaker after each dehydration-rewetting cycle

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Abstract:
Acoustic emission (AE) during dehydration at ambient temperature was compared between fully saturated fresh Norway spruce (Picea abies (L. Karst.)) sapwood and sapwood exposed to two dehydration-rewetting cycles in order to get information about the differences in dehydration stress. AE testing was performed within a frequency range of 35-100 kHz (R6) and 100-1000 kHz (WD). Total numbers of AE became lower and mean AE energies weaker after each dehydration-rewetting cycle. During the first dehydration run, highest mean AE energies were detected at the beginning of dehydration. In rewetted wood, highest mean AE energies were however detected towards the end of dehydration. AE of rewetted wood was also characterized by a higher percent of AE with frequencies >70 kHz and 100-175 kHz, as detected by R6 and WD transducers, respectively. It is concluded that fresh never-dried sapwood is more prone to dehydration stresses than pre-dried sapwood. Differences in AE number and AE features might be due to micro-mechanical failure that decreased after each dehydration-rewetting run. Dehydration stress might also decrease because the membrane of bordered pits, which acts as a valve to avoid the breakage of the water columns inside the conduits, becomes weakened after each dehydration-rewetting run.

Keywords: Acoustic Emission (AE), average frequency, peak amplitude, wood drying, dehydration stress

2010-09-09 14:35 Room: Mansard Room
Session: AE and Material Behaviour / Engineering 3

Non- Destructive Acoustic Test (NDAT) to determine elastic modulus of polymeric composites

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Abstract:
Today acoustic has a wide field of activities in scientific and technological experiments and services such as medicine, medico assessment equipments, etc. Similarly, we investigated the use of acoustic in determination of physical and mechanical properties of polymeric materials. For this purpose three different fiber polyester composites (carbon fiber, glass fiber and hemp fiber) were separately prepared via pultrusion methods. Then, a Non Destructive Acoustic Test (NDAT) based on longitudinal free vibration was utilized to measure viscoelastic properties of resultant composites. This method as explained as bellow, have no damage and undesirable effects on the test specimen; moreover, the viscoelastic properties of sample specimen could be determined with high accuracy and precision in a short time. As shown in Fig. 1, first each test specimen was held from its center by a holder, and it was hit by a wooden hammer at the end of specimen. A microphone in the other side of the specimen receives the sound which created by vibrating the specimen after hitting. This sound including loudness, frequency and time was recorded by Audacity software as a wave-format file. At last, the recorded sounds were analyzed by the means of Fast Fourier Transform (FFT) and therefore the sound loudness vs. frequency was depicted for each sound in a separate figure. Finally, by the aid of these figures, elastic modulus of each composite was calculated.The results showed a tremendous agreement between destructive mechanical methods and NDAT method based on longitudinal free vibration. Furthermore, this method revealed an excellent repeatability.

Keywords: Acoustic Emission (AE), Elastic modulus, Fast Fourier Transform (FFT), Non Destructive Acoustic Test (NDAT), Polymeric materials, Fiber composites

2010-09-10 09:00 Room: Wilhelm Neusser Room
Session: AE Methods and their Practical Applications 4

Buckling detection within subsea pipeline laying using Acoustic Emission technique

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Abstract:
Pipes are of major importance for transport of liquids and gas mainly for natural gas and oil either in shore or offshore. In sub marine pipeline assembly is laid from a vessel into a body of water by passing the pipeline through the water in a substantially vertical path for a substantial portion of its descending travel. In installation the most critical factor in the operation is control of stresses (e.g. buckling, bending, fatigue) in pipeline as it travels from the pipeline laying barge to the ocean floor. Hence, online monitoring for pipeline laying is an important task for early detection for abnormal situation that may lead to catastrophic accident. The source of the acoustic emission energy is the elastic stress field in the material. Without stress, there is no emission. Therefore, an acoustic emission (AE) inspection is usually carried out during a controlled loading of the structure. This can be a proof load before service, a controlled variation of load while the structure is in service, a fatigue test, a buckling test, or a complex loading program. AE inspection is used because it gives valuable additional information about the performance of the structure under load. Other times, AE inspection is selected for reasons of economy or safety, and a special loading procedure is arranged to meet the needs of the AE test. This paper focuses on early detection of buckling stresses produced by the subsea pipeline at the laying operation using AE technique. The sensing configurations and signal analysis will be carried experimentally into a pipeline system in the lab. The conclusion and suggestion will be illustrated.

Keywords: Acoustic Emission (AE), signal processing, structural health monitoring (SHM), Critical loads, Signal Conditioning, Pipeline deformation, Buckling

2010-09-10 09:25 Room: Wilhelm Neusser Room
Session: AE Methods and their Practical Applications 4

The use of Acoustic Emission method for detection and location corrosion damages on railway steel bridges

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Abstract:
The railway steel bridges are very often the objects with large lengths, and currently in Poland a lot of exploiting objects is after long time exploitation and the condition of them is bad. These objects require the appropriate diagnostics. Mostly the visual diagnostics is used, and in exceptional cases in some places of objects the other nondestructive testing are performed. Therefore the opinion about condition of bridge is inexact and it is necessary to study the effective method, which will enable on more exact diagnostics of steel bridges. The Laboratory of Applied Research which is the part of Cracow University of Technology together with Kielce University of Technology and Warsaw University of Technology realized the project funded by Polish Ministry of Science and Higher Education for the work out of diagnostic method the steel railway bridges with use of acoustic emission method (AE). During realization of this project the investigations with AE method for study of AE procedures detection and location of fatigue cracks as well as detection, location and evaluation of degree of corrosive degradation material was performed. The Laboratory of Applied Research of Cracow University of Technology realized the works for solution of corrosive damages problem. In article there will be presented the results of laboratory tests with AE method on elements (truss joint) from railway steel bridge. These investigations were performed both on elements without and with loading in corrosive environment. The AE signals from corrosive damages acquired during performed tests were used to build the preliminary classifier in VisualClass application. The first tests carried out with applying of the classifier on real object for checking the correctness of received measuring methodology will be also presented.

Keywords: Acoustic Emission (AE), railway, corrosion testing, bridges

2010-09-10 09:50 Room: Wilhelm Neusser Room
Session: AE Methods and their Practical Applications 4

Acoustic emission analysis used to investigate the spalling effect of concrete under fire load

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Abstract:
High performance concrete (HPC) is often used as a material for tunnel walls. However, it shows usually an unfavourable behaviour being exposed to fire due to explosion like spalling effects. In experiments using standard temperature gradients similar to those in case of tunnel fires the cracking behavior of HPC and standard concrete is monitored by acoustic emission (AE) techniques. By the use of AE techniques damage processes in concrete can be observed during the entire fire history, detecting the initial spalling. This will enable to locate and characterize the micro-cracking behavior. The paper will describe the concept and first results of the experiments.

Keywords: Acoustic Emission (AE), Concrete, micro-cracking, fire

2010-09-10 10:40 Room: Wilhelm Neusser Room
Session: AE and New Developments of Equipment and Software

Velocity sensitivity calibration of AE sensors using the through wave method and laser interferometry

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Abstract:
Acoustic emission sensors are generally designed to respond to motion normal to the surface and are predominantly manufactured as resonant devices to increase sensitivity around a frequency range of particular interest. The resonant design is usually assumed to provide a resistance controlled velocity response, particularly around resonance. This simple approximation is usually fairly accurate and is adopted when stating sensitivities, with resonant sensors having their sensitivity stated in terms of voltage output per unit velocity, whilst broadband, mass controlled (damped) sensors are usually stated in terms of voltage output per unit displacement. Although it is possible to calibrate a sensor for its displacement sensitivity, given the popularity of resonant type sensors this paper considers a method for the calibration of AE sensors for their velocity response, using a through-calibration (or P-wave) method. In the method, a broadband transducer is coupled to a large test block, and used to excite a plane wave pulse on the opposite face of the block, which is then directly referenced to velocity using a heterodyne laser interferometer. This paper demonstrates the through-calibration method, and shows velocity sensitivity calibration results on an AE sensor between 100 and 1.4 M Hz, along with discussion about the sources of uncertainty. The method discussed will form the standard method adopted by the UK's National Physical Laboratory.

Keywords: Acoustic Emission (AE), AE sensor, calibration, sensitivity

2010-09-10 11:05 Room: Wilhelm Neusser Room
Session: AE and New Developments of Equipment and Software

New developments in the field of AE systems, sensors & software

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Abstract:
This presentation will give an overview about the completion of developments presented in 2008 and 2006 as well as ongoing developments and planned achievements till 2011

Keywords: Acoustic Emission (AE), Embedded Code Processor, AE Software, AE Sensors, AE Systems, Linear 3D

2010-09-10 11:30 Room: Wilhelm Neusser Room
Session: AE and New Developments of Equipment and Software

Bar-Wave Calibration of Practical AE Sensors

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Abstract:
We will report on experiment on calibrating AE sensors commonly available and utilized. Many AE applications need to detect plate waves, but no calibration scheme for these waves is available. We developed a new device where bar waves are utilized with a long metal bar. The bar waves are excited using a transmitter (an ultrasonic transducer, AET FC500) attached on one end of the bar with a short pulse of high voltage. Displacements at different positions are characterized with a laser interferometer. Displacement signals lasting over several hundred μs are generated at 50 to 65 cm away from the transmitter, where the uniformity across the width is good (1 dB). Main parts of the bar waves at the position of sensor calibration correspond to plate waves for the bar thickness/width. Since the ultrasonic transducer used has a low-frequency resonance, strong sub-100 kHz components are present. Segments at 100 kHz to 1 MHz show systematic variations in intensity, but the changes are smooth enough for calibration purpose. However, signals above 1 MHz are too weak; a different combination of pulser/transducer is needed above 1 MHz. Signal processing for sensor characterization used FFT, WT and deconvolution procedures. In our calibration setup, sensor response signals can last nearly 2 ms, even low-frequency sensors can be characterized. Different manners of sensor response reporting will be discussed as power spectral density alone is inadequate to describe the properties of a sensor.

Keywords: Acoustic Emission (AE), deconvolution, laser interferometer, sensor characterization, bar waves

2010-09-10 11:55 Room: Wilhelm Neusser Room
Session: AE and New Developments of Equipment and Software

Characterization of Broadband Acoustic Emission Sensors

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Abstract:
To deduce a physical description of AE sources from recorded waveforms, a well characterized AE sensor is required. A sensor converts elastic waves into electrical signals. The electrical output signal depends on the sensitivity, directivity, and frequency response of the sensor. An ideal AE sensor should be able to measure over the full frequency bandwidth of the signals. The majority of sensors used in AE measurements are made of piezoelectric materials such as PZT ceramic. This kind of sensor is resonant and therefore very sensitive at its resonant frequency. Broadband sensors used in AE of capacitive type or laser interferometers, are not sensitive enough. In our AE measurements, we have made a compromise between bandwidth and sensitivity. The sensor (type Pz35-D7-TH5) uses a piezoelectric disk of a lead-metaniobate ceramic with an aperture of 7 mm and a thickness of 5 mm. In comparison with PZT ceramic, the element has a low mechanical quality factor, a low dielectric constant, no planar coupling factor, and lower sensitivity. The transient response of the sensor is evaluated in this work. The low mechanical quality factor causes high internal damping of elastic waves in the piezoelectric material and a broad resonance peak. The material is primarily used where a clear impulse response is required and the amplitude of AE events is relatively large, which is true with e.g. rock materials.

Keywords: Acoustic Emission (AE), physical quantity, moment tensor, transfer function, AE sensor, capillary fracture

2010-09-10 12:20 Room: Wilhelm Neusser Room
Session: AE and New Developments of Equipment and Software

Latest improvements on Freeware AGU-Vallen-Wavelet

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Abstract:
AGU-Vallen Wavelet is a free of cost tool available to everybody to analyze AE waveform data using wavelet analysis. The presentation starts with a general overview, compares different time-frequency transforms and finally discusses how to use Choi-Williams Transform to improve results in time and frequency domain.

Keywords: Acoustic Emission (AE), wavelet, Modeling and Simulation, signal processing, software,

2010-09-10 13:45 Room: Wilhelm Neusser Room
Session: AE and Applications in Other Fields

Acoustic Emission Monitoring of Tensile Tests on Welded Wood-Joints

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Abstract:
Wood welding is a relatively recent procedure for preparing joints between pieces of wood that shows promising potential for avoiding some of the problems related to conventional adhesive jointing of wood. Tensile testing on selected specimens has indicated capacities of welded wood joints to reach 10 kN. Even though this is lower than the capacity achieved of similar joints with adhesive bonding, wood welding may be useful in specific applications. As a first step towards more extensive characterization of their damage behaviour and of the failure mechanisms, tensile tests on welded wood joints have been monitored with acoustic emission (AE). The AE and mechanical properties are compared to those obtained from adhesively bonded wood-joints made from the same type of wood. First results are presented and discussed in this comparative case study.

Keywords: Acoustic Emission (AE), Welded wood, failure mechanisms, tensile test, strength

2010-09-10 14:10 Room: Wilhelm Neusser Room
Session: AE and Applications in Other Fields

AE Analysis of Damage Process in Thin Film Solar Cells under Mechanical Strain

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Abstract:
In order to develop more flexible and durable solar cells, it is important to understand their failure mechanism and its impact on the performance of solar cells under mechanical strain. Response of thin film solar cell to flexural loading has been reported. However concrete conclusion explaining degradation mechanism of flexible solar cells was not obtained. The purposes of the present work are to develop the technique for monitoring the mechanical damage accumulation AE measurement and to understand the relationship between AE signals, mechanical failures and their effects on the electrical performance of the flexible solar cells in order to clarify the degradation mechanism.Tensile tests of commercially available a-Si:H flexible solar cells (structure; PET film (~125 μm)/Polyimide substrate (~10 μm)/Al back electrode/a-Si:H/TCO/Grid electrode/PET film, dimension; 112×14×0.3 mm) were carried out under Xe-lamp irradiation and mechanical damage accumulation was evaluated by AE technique. Simultaneously, open circuit voltage (Voc) was measured during the test. The specimens were observed during and after the tests by a digital microscope and a scanning electron microscope, respectively. AE signals were classified by their frequency ranges based on projected wavelet transform analysis so that AE signals corresponding to each failure modes could be identified. Onset of the degradation of the Voc was observed at strain of ~0.9% and at the same time cumulative AE energy with frequency range of 600-800 kHz began to increase. In addition, it was observed that back electrode-TCO through-wall cracks perpendicular to loading direction took place. As tensile strain increased to 11 %, Voc decreased to ~0 % and cumulative AE energy especially with frequency range of 800-1000 kHz increased. Simultaneously, cracks perpendicular to loading direction in the grid electrode were observed. Mechanical damage accumulation in a-Si:H solar cells under tensile strain was successfully monitored by AE technique and corresponding damages were observed. Consequently, fundamental and critical implications for the characterization of flexibility of a-Si:H solar cells were obtained in the present work.

Keywords: Acoustic Emission (AE), Damage Accumulation, AE Wavelet Analysis, Thin Film Solar Cell, Flexibility, Amorphous Silicon

2010-09-10 14:35 Room: Wilhelm Neusser Room
Session: AE and Applications in Other Fields

Acoustic Emission for monitoring two-phase flow

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Abstract:
This paper presents an investigation into single bubble dynamics detection in a liquid-filled column with AE, and, correlations of Gas Void Fractions in two phase gas-liquid flow with Acoustic Emission (AE). Furthermore, this paper demonstrates the feasibility of employing AE technology as on-line process monitoring tool for bubble detection in two phase gas-liquid flow.

Keywords: gas bubble activities, gas bubble, cavitation, Acoustic Emission (AE)

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Measurement of Mixture Mass Ratio by Acoustic Emission Method

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Abstract:
The article deals with solid particle flow measurement by acoustic emission method (AE). The particle, that impacts a waveguide, generates impulse AE. AE signal, measured by a piezoelectric wide-band sensor mounted at the end of the waveguide, carries information about parameters of impacting particles (specific mass, velocity, dimensions). The article is a follow-up to formerly performed measurements that were focused on a research of a correlation between input particle parameters and measured frequency spectrum of AE signal. The article expands this problematic by a study of measured frequency spectrum of two-component mixture, which consists of materials with a different mass ratio. On basics obvious theoretical presumption, it is possible to obtain information about mutual mass ratio from measured signal by statistic analysis. Practical experiments were completed to prove these theoretical presumptions. In the first part of performed experiments, two materials with different granularity were poured from a hopper placed on laboratory stand to a suitably shaped waveguide. Materials with different granularity (diameter) had the same specific mass and were impacted on the waveguide with the same velocity. In the second part of the measurement, five different mixtures consisted of particles of the same granularities as in the first part were created and possibility of obtaining of information about mix composition was examined from frequency spectrum of measured AE signal. The presumption that it is possible to differentiate between created mixtures was confirmed by performed measurements. In case that all the defined conditions will be fulfilled, this method could be used in practice as a simplification of measurement of particle size distribution.

Keywords: Acoustic Emission (AE), particle size distribution, frequency spectrum, acoustic emission, Solid particle flow

2010-09-10 09:25 Room: Mansard Room
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Observation for Proportion of Super-elastic Martensitic Transformation in Cu-Al-Ni Shape Memory Alloy with AE Simulation

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Abstract:
AE analysis has the possibility to conduct the dynamic monitoring of material behaviors such as martensitic transformation, micro cracking or some kinds of phenomenon. We aim the extension of AE method for certain and qualitative analysis that can adapt to materials research field. The martensitic transformation in Cu-Al-Ni shape memory alloy shows bulky and stable AE signal that is appropriate to the experimental study for material behavior with AE method. In this study, we prepared three shapes of Cu-Al-Ni shape memory alloy single crystal specimens that will show the proportion differences of martensitic transformation in growth. They are the arc-narrowed shape with thickness t=0.6 mm, the arc-narrowed shape with t=1.8 mm and the notch-narrowed shape with t=1.8 mm that generates super-elastic martansitic transformation, B1-B1’ phase transformation, during tensile deformation. The nucleating proportions of super-elastic martensitic transformation in Cu-Al-Ni shape memory alloy single crystal was tried to estimate by the acoustic emission (AE) method utilizing numerical simulation in finite element method (FEM). The AE source location was estimated clearly from the distribution of stress calculated by static implicit FEM. And the AE waveform was simulated by dynamic explicit FEM to decide the AE parameter related to AE source proportion. From the AE waveform simulation, it was confirmed that the wavelet coefficient of the early AE waveform at specific frequency includes only zeroth-order S mode Lamb wave, and shows 14 % differences as largest value by changing of AE source location along in-plate of 1.8 mm thickness in notch-narrowed shape specimen. The effects due to AE source conditions such as the behavior of rise time and the peak force were also considered by the AE waveform simulation. Reviewing the AE signals from actual super-elastic martensitic transformation in Cu-Al-Ni shape memory alloy single crystal with the threshold provided with consideration by above FEM simulation, the similar tendency was shown in three shapes of specimen with differences of the thickness or the stress concentration. As a result, it was estimated that there is not relationship between the proportion of martensitic nucleation and stress concentration or large area for martensitic transformation. It estimated that there is one nature of nucleation of the super-elastic martensitic transformation.

Keywords: Acoustic Emission (AE), materials characterization, finite element method, super-elastic martensitic transformation, Cu-Al-Ni shape memory alloy

2010-09-10 09:50 Room: Mansard Room
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Comparison of acoustic emission behavior of various oxide and fiber composite ceramic systems

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Abstract:
AE can be used in characterization of oxide ceramic and ceramic matrix fiber composites. In oxide systems the acoustic activity was influenced by chemical composition, sintering temperature and structure development. AE activity was increased from kaolin to pottery mixture as a result of the developing a stronger structure with incorporation of a second phase in the matrix, while decreased in fly ash composites due to weakening of the structure and formation of cracks. In kaolin ceramics, there was a clear Kaiser effect, while pottery mixture and the kaolin–fly ash and brick clay composites were acoustically active during the second loading. AE examination in cement composites showed that increase of fly ash addition increases acoustic activity probably as a result of sub-critical crack growth due to fly ash particles. Fibre ceramic matrix composites indicated that fibre composites present higher AE activity since, matrix sub-critical events, fracture of the fibres, fibre-debonding or fibre pull out from the matrix may produce a comparatively large amount of AE events. Increase of sintering temperature produced composites with higher AE activity for similar reasons to that of powder ceramics. Increase of the volume fraction of fibres increased the AE activity. In these systems the Kaiser effect was observed in all composite ceramics irrespective of the kind of the fibres, a fact which indicates that the sub-critical activity during loading is not a reversible process. AE examination under loading could give useful information about the strength, structure and the sintering techniques used during manufacturing of ceramic systems.

Keywords: Acoustic Emission (AE), oxide ceramics, bricks, cement, fiber composites

2010-09-10 10:40 Room: Mansard Room
Session: AE Signal Detection and Processing

Intelligent AE signal filtering methods

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Abstract:
One problem of the acoustic emission testing is a great number of noises affecting the diagnosis results. Electric noises, electromagnetic interference, background acoustic noise, rubbing noises are far from the full list of noises present under measurements. At the high level of noises the operator has to increase the recording threshold of the acoustic emission impulses through reducing the testing sensitivity. False determination of AE parameters can result in wrong location and false determination of the AE source danger level. To improve the noise immunity of the acoustic emission system, the data filtering algorithms are to be used.

Keywords: Acoustic Emission (AE), signal processing, AE noise control, AE signal processing, AE data filtering

2010-09-10 11:05 Room: Mansard Room
Session: AE Signal Detection and Processing

Evaluation of Increasing Damage Severity In Concrete Structures by Cluster Analysis of Acoustic Emission Signals

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Abstract:
AE technique gained increasing interest in the last decade as a monitoring methodology and as an assessment tool for safety and reliability evaluation of reinforced concrete structures, historic and masonry buildings. There are several established statistical methods (z, RA, b and Ib value) which can be used in analysing AE data with the aim to evaluate damage status of a structure subjected to a particular loading condition. Artificial neural networks (ANN) has recently applied as a tool to reduce data redundancy and to optimize feature set of AE signals. In this paper cluster analysis to separate set of parameters into several classes reflecting internal condition was adopted to analyse acoustic emission data obtained during 4-points bending tests on concrete beams, under cycling and constant load condition, at increasing loads. Two kinds of unsupervised clustering methods were used: the principal component analysis (PCA) and the self organized map (Kohonen map). Combining the results of these techniques, it has been possible to quantify the damage severity occurred to study the evolution of the damage itself during the test.

Keywords: Acoustic Emission (AE), civil engineering, damage, concrete, Kohonen map, principal component analysis

2010-09-10 11:30 Room: Mansard Room
Session: AE Signal Detection and Processing

Discrimination of Acoustic Emission hits from dynamic tests of a reinforced concrete slab

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Abstract:
In the evaluation with Acoustic Emission (AE) of the damage and state of a concrete structure under a dynamic force, the most relevant information come from the AE hits produced by cracking processes. But, unfortunately, there are other sources of AE which are not related with the damage state of the specimen, as the closing of cracks, friction between different elements, or noise from the testing equipment. So, the discrimination between AE hits from cracking processes and the other sources is very useful in order to have an accurate evaluation.In this paper the classification of AE hits with several signal processing techniques is investigated. Several dynamic test were carried out with a reinforced concrete slab attached to a 3´3 MTS shaking table, and during these experiments the AE hits were recorded. The specimen represents, at the 1/3 scale, a flat slab supported on four box-type steel columns, and it was subjected to a simulation of the Campano-Lucano earthquake recorded at Calitri (Italy). After the test, the AE transients were extracted and classified according with several signal parameters. For each AE temporal signal it was calculated its autocorrelation, wavelet power, kurtosis, RMS in different parts of the signal and the aproximate entropy. A comparison and evaluation of the different classifications according each parameter is presented in the paper.

Keywords: Acoustic Emission (AE), localisation of damage, transient classification, concrete structures, AE signal detection and processing, dynamic test.

2010-09-10 11:55 Room: Mansard Room
Session: AE Signal Detection and Processing

Neural Network AE Source Location Apart from Structure Size and Material

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Abstract:
AE localization procedures using artificial neural networks (ANN) represent extremely effective alternative to classical triangulation methods. Nevertheless, their application always requires full-scale, time consuming ANN training on each specific structure. Disadvantage for particularly trained ANN algorithm is its non-transferability to any other object. A new ANN-based AE source location approach is proposed in this paper to overcome such limitation. The method replaces standard arrival time differences at the ANN inputs by so called signal arrival time profiles, independent on material and scale changes. The ANN training can be also performed theoretically on geometrical models (i.e. without any experimental errors) and learned ANN is then applied on real structures with different dimensions and materials. Such approach enables considerable extension of ANN application possibilities. The use of new AE source location method is illustrated on experimental data obtained during aircraft structure part testing.

Keywords: Acoustic Emission (AE), structural health monitoring (SHM), localisation of damage, AE source location, Artificial neural networks, Arrival time profiles

2010-09-10 12:20 Room: Mansard Room
Session: AE Signal Detection and Processing

Frequencies and Amplitudes of AE Signals in a Plate as a Function of Source Rise Time

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Abstract:
Based on some preliminary studies that showed a potentially strong dependence of AE signal peak amplitudes on the source rise time, a detailed study was undertaken. The study used a validated finite element code to model the source operation and subsequent wave propagation up to a distance of 480 mm in a 4.7 mm thick plate with large transverse dimensions. To obtain the large propagation distances with sufficient transverse dimensions so that plate edge reflections did not arrive during the direct AE signal, it was necessary to use an axi-symmetric code. The buried dipole AE sources were located at three different depths (0.243, 1.32 and 2.35 mm) below the top surface of the plate, where the pseudo AE sensors were located. These sensors provided the out-of-plane displacement as a function of time. The rise times for the different finite element runs varied from 0.5 μs to 15 μs. The resulting data was high-pass filtered at 40 kHz and resampled with a time step of 0.1 μs. The peak amplitude dependence was determined as a function of the source rise time for the three different source depths. Also, the attenuation of the signal peak amplitude (due to geometric spreading and dispersion) as a function of distance was determined as well. In addition, the Fast Fourier Transform was calculated for the signals. An exponential increase in peak amplitude was found as the source rise time decreased from 2.3 μs to 0.5 μs. As expected, the higher frequencies were not present in the AE signals as the source rise time increased. There were also relatively large losses in peak signal amplitude over the propagation from 60 mm to 480 mm.

Keywords: Acoustic Emission (AE), Source rise time, Plate, Frequency, Amplitude

2010-09-10 13:45 Room: Mansard Room
Session: AE Signal Detection and Processing

Using PCA in Acoustic Emission Condition Monitoring to Detect Faults in an Automobile Engine

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Abstract:
Automobile industry is an important industry in many countries. Monitoring the operating conditions in automobiles is a big challenge not only when the product leaves the factory but also during the after sale maintenance programs. This paper proposes a new approach in acoustic emission based condition monitoring and fault detection that uses wavelet method. The fault that was investigated in this study is related to ignition system of the automobile, more specifically speaking the operation of the sparks. The sampled dataset includes sound samples collected in repair shops. Noise was a major problem for this work. Recording the sound signals in repair shop will include unwanted noise. Human voice, sound of the wind and the sound made by other operating automobile engines are also recorded in the sampled sound record, where, some of them may include arbitrary and random noise. Energy, RMS, Kurtosis, Skewness, Marse, Crest Factor, Zero count Minimum count and Maximum count features are calculated from recorded sound signals. Principal Component Analysis (PCA) is used for dimension reduction. These new orthogonal features are used for classifying recorded data. As a proof for generalization capability of the method, 10% of the dataset was uniformly selected for the training dataset and the remaining 90% are used for the test. 150 sampled records from the acoustic emissions out of similar models of a car (Kia Motors under license products) were recorded; one sample record for the healthy engine and one sample for the faulty engine (300 sampled records in total). Accuracy of the proposed method is above 70% percent.

Keywords: Acoustic Emission (AE), PCA, Wavelet, Fault Diagnosis, Acoustic Emission

2010-09-10 14:10 Room: Mansard Room
Session: AE Signal Detection and Processing

Identifying Acoustic Emission Events with Similar Transfer Functions

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Abstract:
A special similarity measurement for acoustic emission events based on sampled signals from multiple channels was developed. Data from pairs of channels is processed in a way that events with different source functions, but the same source mechanism and transfer functions show large correlation. The evaluated X22-correlation can be used for clustering and sub-clustering. Additionally, a double time difference is evaluated, which can be used for double difference location also called relative location. An additional application of this similarity measurement is the comparison of measured signals to the ones calculated by simulations.

Keywords: Acoustic Emission (AE), cross-correlation, clustering, relative location, double difference location

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