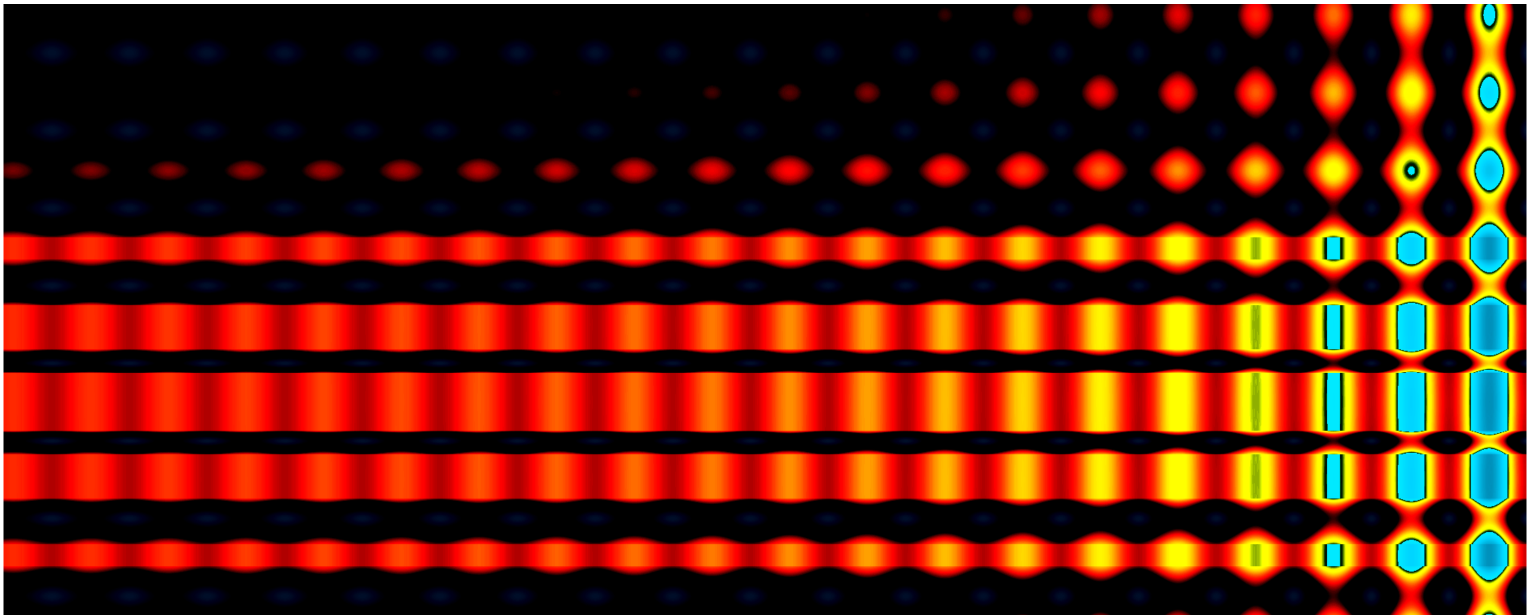
January 2022 | Vol. 2

# ACOUSTIC EMISSION WORKING GROUP [AEWG]

*Annual Newsletter of Acoustic Emission Developments and Ideas!*



## WELCOME NOTE FROM THE AEWG EXECUTIVE COMMITTEE!

We would like to welcome you all to the second issue of AEWG newsletter. We did not have the AEWG meeting in 2021 due to pandemic; however, this newsletter provides an opportunity to share news with the AE community. We would like to thank the contributing authors to the second issue of AEWG digital newsletter. We have worldwide cutting-edge research articles in addition to international and academic/industry collaboration news. The content of this issue includes

- Remembering Allen Green
- Update on AEWG-63
- AEWG Executive Committee Conference Participation: SHMII-10 Roundtable Discussion
- Worldwide AE Research News: Europe, US, Japan and Egypt
- International Collaboration on AE: Japan and Turkey
- University-Industry Collaboration on AE Sensor
- AE e-Textbook
- News from AE Manufacturers
- Conference and Meeting Announcements


| Chairman | Vice Chairman | Secretary | Past Chairman & Archivist |
|---|---|---|---|
| Dr. Didem Ozevin<br>Professor<br>Dept. of Civil and Materials Engineering<br>University of Illinois at Chicago<br>+1 (312) 413-3051<br>dozevin@uic.edu | Dr. Valery Godinez<br>MISTRAS Group, Inc.<br>+1 (609) 716-4055<br>valery.godinez@mistrasgroup.com | Dr. Antonios Kontsos<br>Professor<br>Dept. of Mechanical Engineering and Mechanics<br>Drexel University<br>+1 (215) 895 2297<br>antonios.kontsos@drexel.edu | Dr. David Kosnik<br>CTL Group<br>+1 (847) 440-4509<br>dkosni@ctlgroup.com |


*Newsletter Designed by: Sarah Malik, Drexel University*

# REMEMBERING ALLEN GREEN

**Allen T. Green**, Acoustic Emission pioneer, of Sacramento, CA, passed away June 13, 2021. He was 87 and is survived by his wife, Carolyn, by his four children, Keri, Leah, Brady and Natanya, and four grandchildren. He was internationally known for his lifelong devotion to acoustic emission research and development. After graduating from University of Illinois with an aerospace engineering degree (1956), he joined the Aerojet team that successfully used AE for steel and fiber-composite missile motorcases, the first such an engineering achievement globally (1960-1970). It is remarkable that despite joining Aerojet project mid-way, he was the lead author of their 1964 paper in Modern Plastics (volume 41 (No. 11), 137). When you read it, you'll find technologies well ahead of the vacuum-tube-to-transistor generation, a wavelet-like spectrograph, for example. After a short stint at Dunegan Research, Allen founded Acoustic Emission Technology Corp. in 1972, guiding AE instrumentation development, from laboratory units to multichannel industrial installations. When AET Corp was eventually absorbed into a large corporation (1991), he shifted to AE consultancy and distributing AE instrument with Acoustic Technology Group, retiring from business in 2009.


He was one of the founding members of Acoustic Emission Working Group when it was formed in 1967. He served as its Chairman in 1971-1972, covering the 7th to 9th AEWG meetings. His AE reputation and business skills led to two successful international conferences at Lake Tahoe in 1985 and 2007. Both of them also filled AEWG coffer well. He also organized three other AEWG meetings, five altogether; the most in the AEWG history. AEWG has recognized his varied contributions with the Charter Fellow (1982), the Gold Medal Award (1983) and the Special Recognition Award (2000), the latter for his lifetime AE achievement. He served as a global AE missionary, giving an AE short course in Israel in 1983 and invited lectures at two inaugural international conferences in Japan (1972) and in China (2011) among many others. These two conferences continue today. Allen also served as Honorary President of the Chinese conference. In addition to AEWG, he was member of ASNT (Fellow) and ASME (Fellow, Dedicated Service Award). He will be dearly missed by his family, friends and colleagues from around the world.

Kanji Ono, Tom Drouillard and Gordon Schneider

Further Information
AEWG News at http://aewg.org/
IIIAE News at http://iiiae.org/

# AEWG-63
# DATE TO BE DETERMINED
# HOUSTON, TX

Thank you to Stress Engineering for Hosting!

We are closely watching the pandemic. We are excited to see some conferences started to be in person. We will announce the dates of AEWG-63 in late January.  Due to the worldwide travel restrictions, we aim to have in person and virtual participation options.

AEWG-63 will be hosted by Stress Engineering in Houston, Texas. The meeting chair will be Napoleon Douglas.

The tentative schedule is as follows:

(Monday) – Primer on Acoustic Emission in Oil and Gas Industry at AM, Welcome
reception & Social at PM

(Tuesday) – Technical presentations, panel discussions, session for vendor
presentations, dinner at PM

(Wednesday) - Technical presentations, panel discussions, AEWG business meeting
ending by 5:00pm, tour

# AEWG EXECUTIVE COMMITTEE PARTICIPATED SHMII-10 ROUNDTABLE DISCUSSION

Roundable Discussion

ANTONIOS KONTSOS
Professor
Dept. of Mechanical Engineering and Mechanics
Drexel University
+1 (215) 895 2297
antonios.kontsos@drexel.edu

Three members of the AEWG Executive Board including Chair Dr. Didem Ozevin, Vice-Chair Dr. Valery Godinez and Secretary Dr. Antonios Kontsos were among the panelists of a round table discussion on Nondestructive Evaluation (NDE) of Structural Materials which took place in the 10th International Conference on Structural Health Monitoring of Intelligent Infrastructure (SHMII-10), an online event organized by the University of Porto, Portugal, in June 30th-July 2nd, 2021. The discussion in this round table focused on NDE and its use in Structural Health Monitoring (SHM) via the combination of diagnostics data obtained by nondestructive testing (NDT) with prognostics information created by both physics-based simulations, as well as data-driven machine learning and artificial intelligence methods (ML/AI). Issues related to data management, use of NDE data in reliable numerical modeling (e.g., using the Finite Element Method) in addition to coupling NDE with modern ML & AI methods in digital twin operations, were discussed. The AEWG representatives in this round table provided further comments in cutting-edge issues such as the use of modern NDE sensor technologies in Industrial Internet of Things (IIoT) applications in SHM. An additional topic explored in this discussion involved the role of Acoustic Emission in the emerging NDE 4.0 paradigm, a term used in parallel with the transformative Industry 4.0 concept, which is part of the growing digital transformation processes implemented worldwide.

# RECENT ADVANCES IN AE MONITORING OF CORRODING REINFORCED CONCRETE STRUCTURES

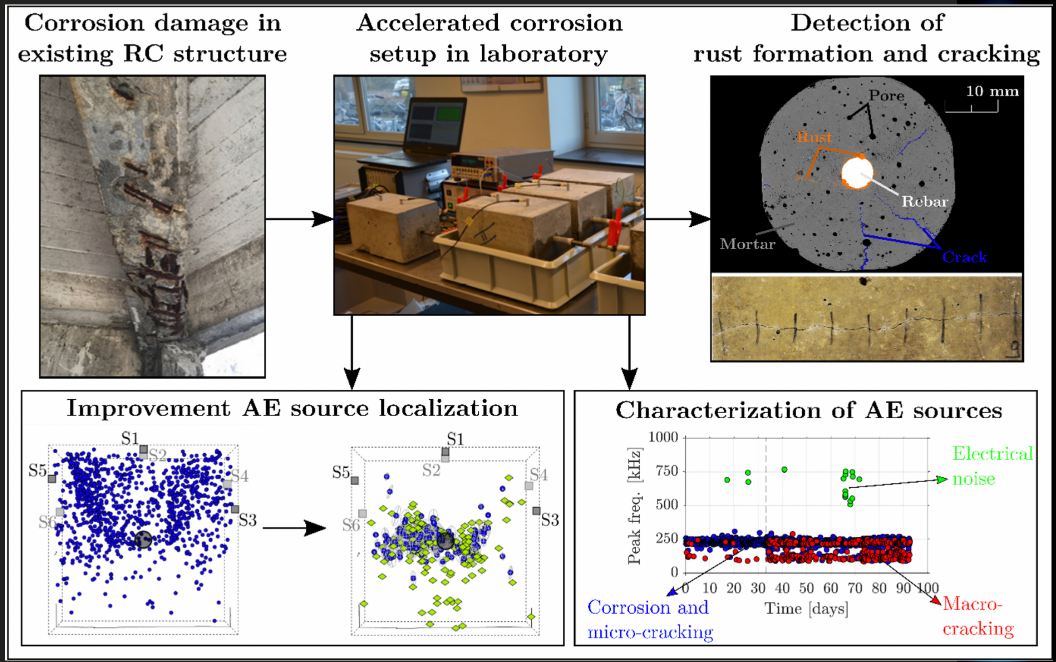
Research Spotlight

PROF ELS VERSTRYNGE & DR.CHARLOTTE VAN STEEN
Materials and Constructions Division, Department of Civil Engineering
KU Leuven, Belgium

Corrosion of the reinforcement is a major deterioration process in existing reinforced concrete (RC) structures. It causes large economic losses and jeopardizes the structural safety. The process starts internally and the steel section loss is accompanied by the formation of corrosion products. These exert a pressure on the surrounding concrete, eventually leading to concrete cracking and spalling. The AE technique is a valuable method for corrosion damage detection, as it allows to monitor internal damage progress in the structure before damage can be observed on the surface.

Current research at the Materials and Constructions group at KU Leuven focuses on detection, localization, and characterization of corrosion-induced damage in RC. An extensive experimental program is performed on three samples scales, and data processing protocols are integrated in an AE analysis toolbox. Tests include accelerated corrosion tests on small samples, concrete prisms and beams, as well as on-site monitoring on bridge girders. AE results are validated with other NDT techniques, such as crack width measurements and X-ray computed tomography, the latter in collaboration with the XCT Core Facility at the Materials Engineering Department at KU Leuven.

The test program has shown that the AE technique is able to successfully detect corrosion damage in reinforced concrete. However, dedicated filtering proved to be necessary to reliably localize and characterize AE sources. Therefore, a post-processing protocol is developed which significantly improves the localization results. The corrosion process as well as concrete cracking can be identified from cumulative AE curves, and characterized from signal-based analysis. Moreover, it is shown that the AE technique is able to determine the onset of concrete cracking earlier than a visual inspection. Finally, a signal-based clustering algorithm is developed for automatic characterization of AE sources.




Further Reading: Van Steen, C., Verstrynge, E. (2021). Degradation Monitoring in Reinforced Concrete with 3D Localization of Rebar Corrosion and Related Concrete Cracking. Applied Sciences, 11 (15), Art.No. 6772. doi: 10.3390/app11156772

# AE STUDY ON SEISMOLOGY

JESSE HAMPTON, PHD
Assistant Professor
Geomechanics and Damage Group (GeoD) geod.wisc.edu
Geological Engineering, Civil and Environmental Engineering
University of Wisconsin-Madison
jesse.hampton@wisc.edu

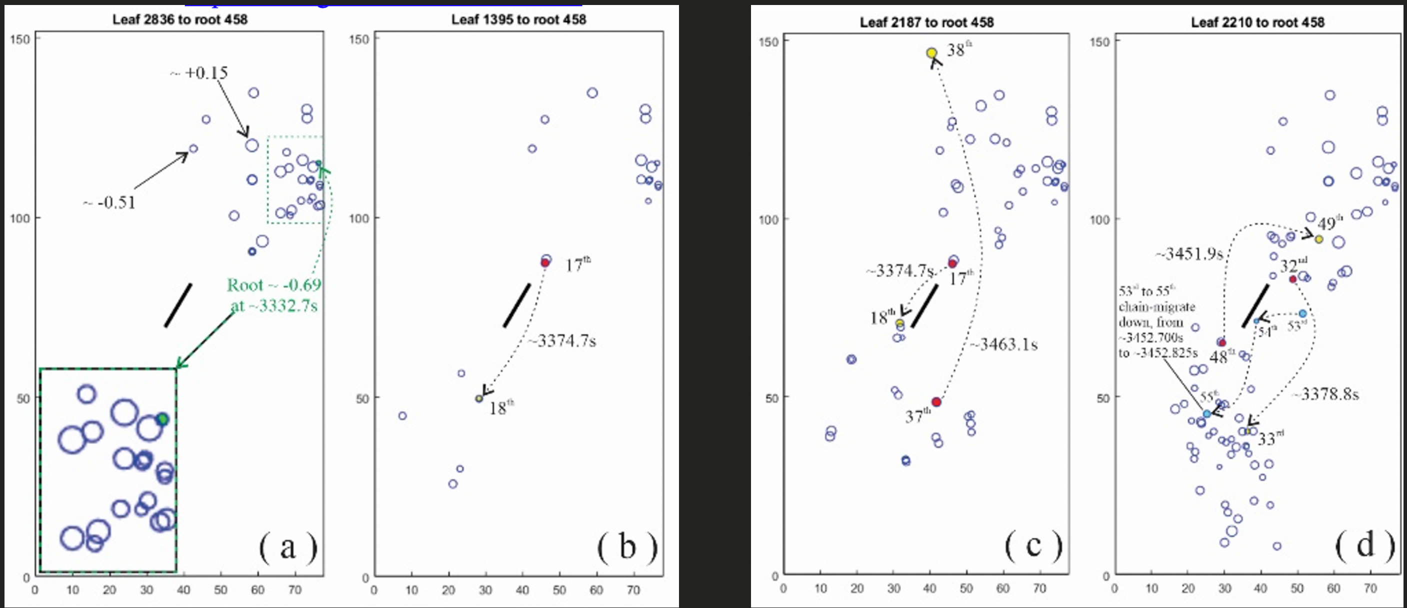
Research Spotlight

Quantifying the interaction between microcracks has far-reaching implications in the fields of damage mechanics, fault mechanics, induced seismicity, and many others. The interaction between microcrack localizations in rock/concrete impacts the progression and evolution of fracture development and eventual macro-scale fracture coalescence. In damage mechanics, quantifying the influences of fracture interactions can increase the accuracy of effective property predictions via constitutive frameworks and continuum-scale models (e.g., macro-scale effective stiffness of a material due to the existence, and interaction, of microcracks). In subsurface engineering (e.g., deep Earth geothermal), induced seismicity is an active area of research, where the interaction and causative mechanisms of rupture are difficult to interpret.

The GeoD group is actively working in both the areas of damage mechanics and induced seismicity associated with subsurface engineering. To that end, a recent discovery has shown, for the first time at the laboratory scale, the triggering/triggered relationships between individual microcrack events near and far from one another in space and time. A topology analysis typically used for seismic catalogs attributing to the seismogenic structures is introduced into the analysis of the AE releasing structure, i.e., the AE-genic zone. This method identifies the most probable trigger for of a concurrent event by seeking one of its previous events having formed the minimal event-pair metric with that concurrent event in normalized time and space. This model seeks violation of the null hypothesis that events are occurring randomly with a rate given by the Gutenberg-Richter law. A topological network can be built dynamically for an entire rock fracture process upon the real triggering-triggered relationships for the subsequently occurring new events from the AE genic zone. The figure shows one result from the AE analysis on a Carrara marble specimen containing a pre-cut flaw, where individual events induce non-local microcrack localizations in a cascading and chain-reaction type phenomena. Here we see the progression of triggering where triggered microcracks can migrate within one fracture system (a), traverse across the large-scale flaw (b), traversing back and forth between upper- and lower-fracture systems (c), and progressively migrate across the flaw (d).

The discovery of nonlocal triggering at the lab-scale has direct implications for understanding stress chains and future work can be used to better interpret field-scale seismicity. We are actively working in damage mechanics and induced seismicity in geothermal environments.

Further Reading: Xiong g, Q., & Hampton, J. C. (2020). Non-local triggering in rock fracture. Journal of Geophysical Research: Solid Earth, 125, e2020JB020403. https://doi.org/10.1029/2020JB020403.



# NON-CONTACT AE MEASUREMENT SYSTEM AND ITS APPLICATION

TAKUMA MATSUO
Associate Professor
Department of Mechanical Engineering
Meiji University
e-mail: matsuo@meiji.ac.jp

Research Spotlight

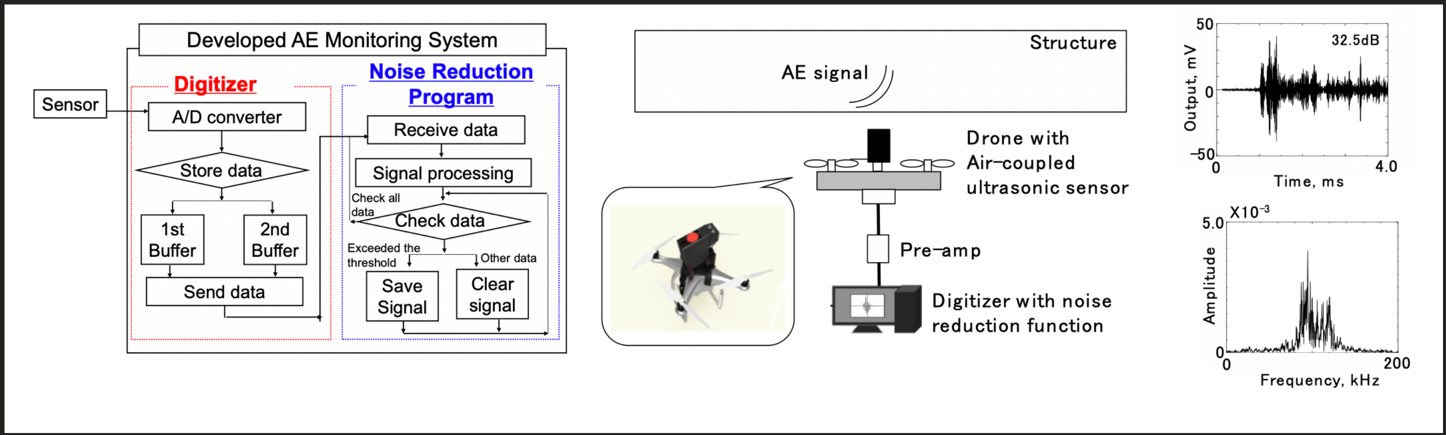
A non-contact AE monitoring system is under development. The system consists of a digitizer with a real-time noise reduction function developed in our laboratory and an air-coupled ultrasonic sensor. By reducing the noise, it is possible to detect weak AE signals, even by using air-coupled ultrasonic sensors, which are less sensitive than contact-type AE sensors. Example applications of this system are given below.

1. Measurement of AE signals generated by bending fatigue in a rotating component: The fatigue monitoring of rotating components during operation is difficult because the attachment of a sensor to the surface of the rotating components is difficult. Therefore, AE signals excited with the initiation and propagation of cracks resulting from rotating bending fatigue were measured using the system being developed. When a contact-type AE sensor was installed on the bearing housing, AE could be detected only just before fatigue failure; however, the developed system was able to detect AE signals at an earlier stage.

2. Detection of packing error occurring during the packaging of cookies: Product packing errors are a serious problem in food factories because of food safety issues. In particular, small pieces of baked products often cause packing errors in factories that produce baked goods when the products are wrapped with a cover film and the film is sealed. In this study, the developed system was used to detect AE signals caused by packaging errors by placing the sensor above a film. It was possible to detect AE signals excited by the fracture of small pieces of cookies caused by the packaging film.

3. Non-contact remote AE detection system using a drone equipped with a sensor: Mounting the sensor of the developed system on a drone made it possible to develop a flight-type AE measurement system that can be used for monitoring at high altitudes. The noise reduction function reduced the noise generated by the drone blades, and the system could detect AE signals with stable sensitivity, even during drone flight. It was then possible to detect AE signals excited by the rust fracture on a steel plate with the system in flight.

In the future, it is planned to design a sensor shape to improve the sensitivity and develop an optimal noise reduction algorithm to create a system that can measure AE in various locations.




Developed system(left), Overview of the drone-based system (center) and Waveform and its frequency spectrum detected by developed system with drone from rust fracture of steel plate (right).

# ACOUSTIC EMISSION WAVE PROPAGATION IN COMPLEX SANDWICH PANELS

Research Spotlight

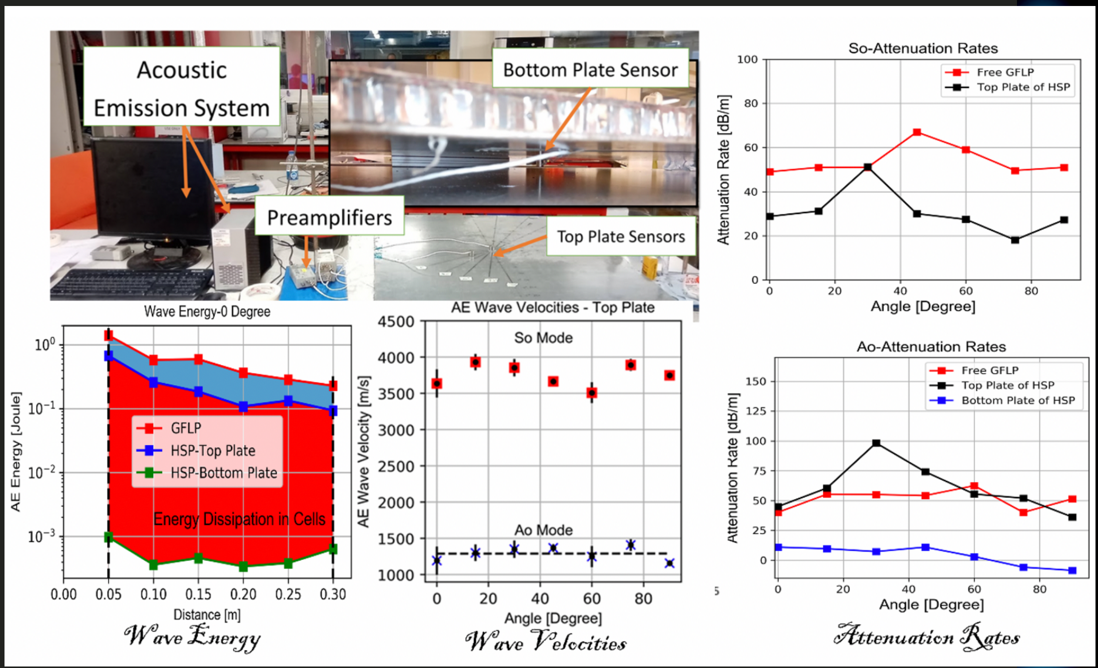
AHMED HESHAM ABDULAZIZ, PHD
Assistant Professor
Design and Production Engineering Department
Center for Sound, Vibration and Smart Structures (CVS3)
Faculty of Engineering - Ain Shams University - Egypt
Email: ahesham@eng.asu.edu.eg
Website: https://eng.asu.edu.eg/staff/ahesham

The honeycomb sandwich panel is usually used in the design of wind turbine blades and aircraft wings due to their excellent mechanical properties such as stiffness to weight ratio, and high compressive strength. It consists of two thin stiff plates with embedding aluminium honeycomb core between them. Due to the complexity of that structure, it poses many challenges for acoustic emission technique to be used on wind turbine blades that consist of such panels. Therefore, it is important to understand the AE wave propagation mechanism in such structures.

Recently, and through a PhD joint supervision research project between the Center for Sound, Vibration and Smart Structures in Egypt and Cardiff University Structural Performance Laboratory in the UK under the supervision of Prof Karen Holford and Dr John McCrory, the acoustic emission wave propagation was studied on a honeycomb sandwich panel consisted of two uni-directional fiber glass plates and aluminium honeycomb core. The study was conducted using Hsu-Nielsen technique and laser vibrometry scanning. Furthermore, the study considered the estimation of AE through-thickness propagation from one plate to the other, which is a real-world monitoring problem for situations where AE instruments are only permitted on one surface such as inside the airfoil of wind turbine blades.

The results of this study show that the AE wave mechanism is Lamb wave with its distinguished symmetric (So) and asymmetric (Ao) modes. Some wave energy is transmitted through the aluminium honeycomb from one plate to the other. This causes AE wave energy leakage into the cells and as a result to this phenomenon the symmetric mode of the Lamb wave attenuation becomes severe. Furthermore, the “Insertion Loss” is introduced to quantify the effects of the honeycomb core on the wave propagation.

Interestingly, it is hypothesised that this departure from the usual, fiber-direction-dependant velocity profile of the So mode in the fiber glass plate is affected by the honeycomb layer ribbon direction.




Further Reading: Ahmed H Abdulaziz, Mohamed Hedaya, Adel Elsabbagh, Karen Holford, John McCrory, ”Acoustic Emission Wave Propagation in Glass Fibre Aluminium Honeycomb Sandwich Structures”, Journal of Composite Structures, vol. (277), (December 2021).

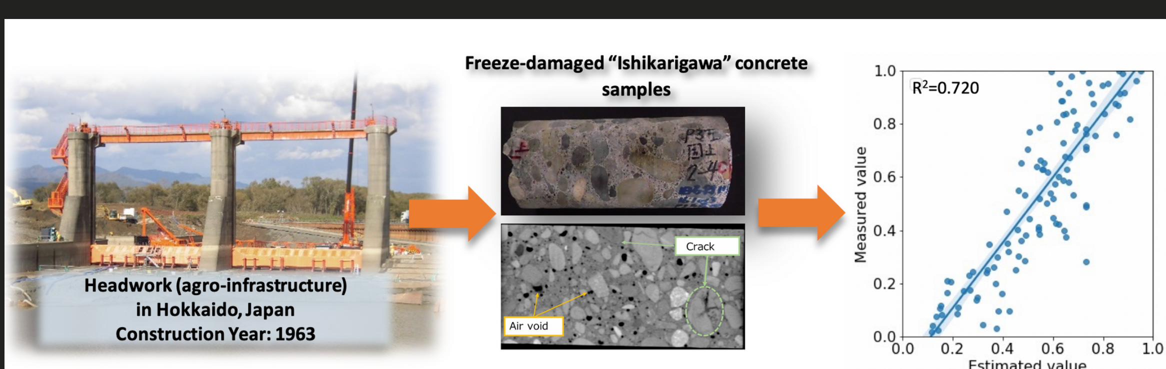
# INTERNATIONAL COLLABORATION: JAPAN AND TURKEY

## THE DEVELOPMENT OF NON-DESTRUCTIVE DAMAGE EVALUATION METHODS FOR INSPECTING WATER INFRASTRUCTURE

International Collaboration

A joint research project between Japan and Turkey will be funded by the Japan Society for the Promotion of Science under the Fund for the Promotion of Joint International Research: Fostering Joint International Research program. The research focuses on the development of non-destructive damage evaluation methods for inspecting water infrastructure in earthquake prone countries. Acoustic Emission and Machine Learning methods will be of particular interest in the joint study. "Water infrastructure" represented by “agricultural water” and “water and sewage” is an indispensable infrastructure for human society. Damage accumulation in these structures may lead to failure during an earthquake which may result in such problems as water supply disruptions, agricultural losses, contamination due to sewage leakage and so on. Therefore, robust and reliable damage monitoring and detection methods are in need to assess these structures. For this purpose, laboratory and field tests will be carried out on concrete by utilizing AE and Machine Learning algorithms will be used for damage evaluation from AE data. Numerical studies will also be carried out for simulating the behavior.

The research team consists of 6 researchers, Prof. Tetsuya Suzuki and Prof. Kazunari Inaba from Niigata University, Dr. Yuma Shimamoto from Tokyo University of Agriculture and Technology, Prof. Toshiaki Iida from Iwate University, Japan, Prof. Ninel Alver and Dr. Sena Tayfur from Ege University, Turkey. The project duration is 40 months starting from December 2021.




Preliminary results of the project: Stress levels estimated by the random forest method using clustered AE activities of freeze-damaged Ishikarigawa concrete samples under uniaxial compression tests

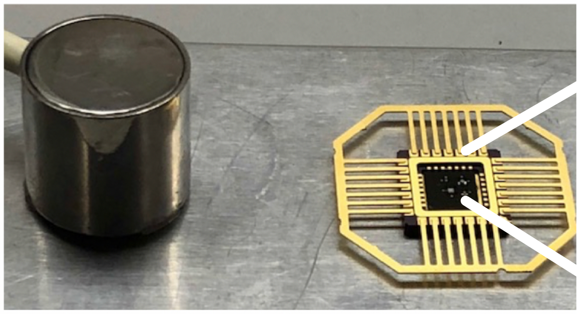
# UNIVERSITY-INDUSTRY COLLABORATION: UIC AND MISTRAS GROUP

## MEMS ACOUSTIC EMISSION SENSORS

Prof. Didem Ozevin received an NSF Partnership for Innovation Technology Transfer (PFI-TT) funding to bring MEMS AE sensors into commercial level. Dr. Valery Godinez from MISTRAS Group is the entrepreneur mentor to develop a technology transfer plan. Dr. Talha Khan, post-doctoral researcher at UIC, involved the project as the technical lead.

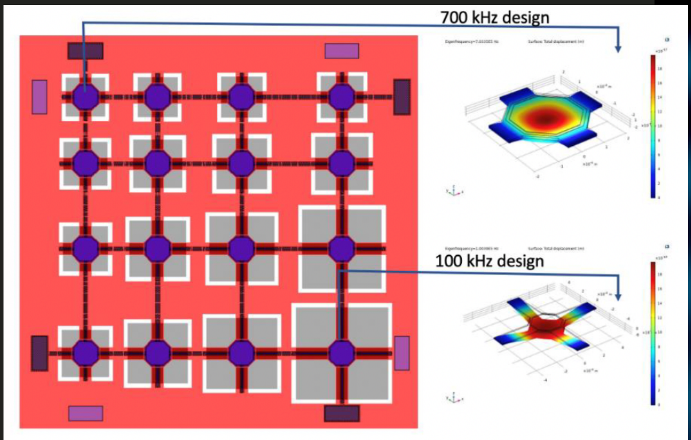
Mass manufactured, low-cost and low-power MEMS acoustic device will transform the AE sensing technology into the next level. The innovation will be benefitted by installing voluminous sensors into structural systems for detecting the initiation and the progression of damage before they become critical to structural integrity. In this research, the sensors are manufactured using a thin-film piezoelectric layer sandwiched between the pad metal layer and the doped silicon layer. Aluminum nitride is used as the piezoelectric material. New generation design has the series connection of piezoelectric resonators ranging from 100 kHz to 700 kHz.

University-Industry Collaboration



Conventional Bulky Piezoelectric AE

Multi-frequency MEMS Device




New generation multi-frequency MEM AE Sensor

# OPEN ACCESS
# ACOUSTIC EMISSION E-TEXTBOOK

AE e-Textbook

Under the leadership of Dr. Ronnie Miller, a new AE e-Textbook is being prepared. The book will have the following chapters:

Chapter 1. Acoustic Emission Source Mechanisms
Author: Antonios Kontsos

Chapter 2. Wave Propagation in Solids
Author: Joseph Rose

Chapter 3. Finite Element Modeling of Acoustic Emission
Authors: Marvin Hamstad and Markus Sause

Chapter 4. Machine Learning and Data Mining Methods for Acoustic Emission
Author: Arvin Ebrahimkhanlou

Chapter 5. Acoustic Emission Hardware and Software
Author: Valery Godinez

Chapter 6. Source Location of Acoustic Emission
Author: Ronnie Miller

Chapter 7. Standard Acoustic Emission Applications
Author: Ronnie K. Miller, Ph.D

Available chapters are open to access and review (use Forum section) at **AE e-Textbook**


we moved

Vallen Systeme GmbH
Buergermeister-Seidl-Str. 8
82515 Wolfratshausen

+49 8171 38391-0
info@vallen.de

# NEWS FROM AE MANUFACTURERS

## VALLEN SYSTEME

The Vallen Systeme Dashboard is an add-on feature to the Vallen structure health monitoring solution. It provides external access to relevant measurement data without direct log-on to the monitoring- or measurement system.

The automatic data upload to the dashboard server is realized by Vallen Software VisualAE “Export Processor” together with an upload program. The Export Processor is integrated into the powerful and flexible data processing of VisualAE. The Vallen Dashboard displays the information in a user-defined layout. The dashboard can be easily adapted and customized by the user. Information can be displayed in bar charts, scatter plots, heat maps, and line charts. Alarm thresholds can be defined in the dashboard and notifications about alarms and “on line” status of the SHM system can be send automatically. Vallen Dashboard is designed for access by Web browsers on PCs or mobile devices. It can be hosted on any Linux Ubuntu server. Dashboard user management allows the administrator to manage the access and configuration rights in a flexible way.

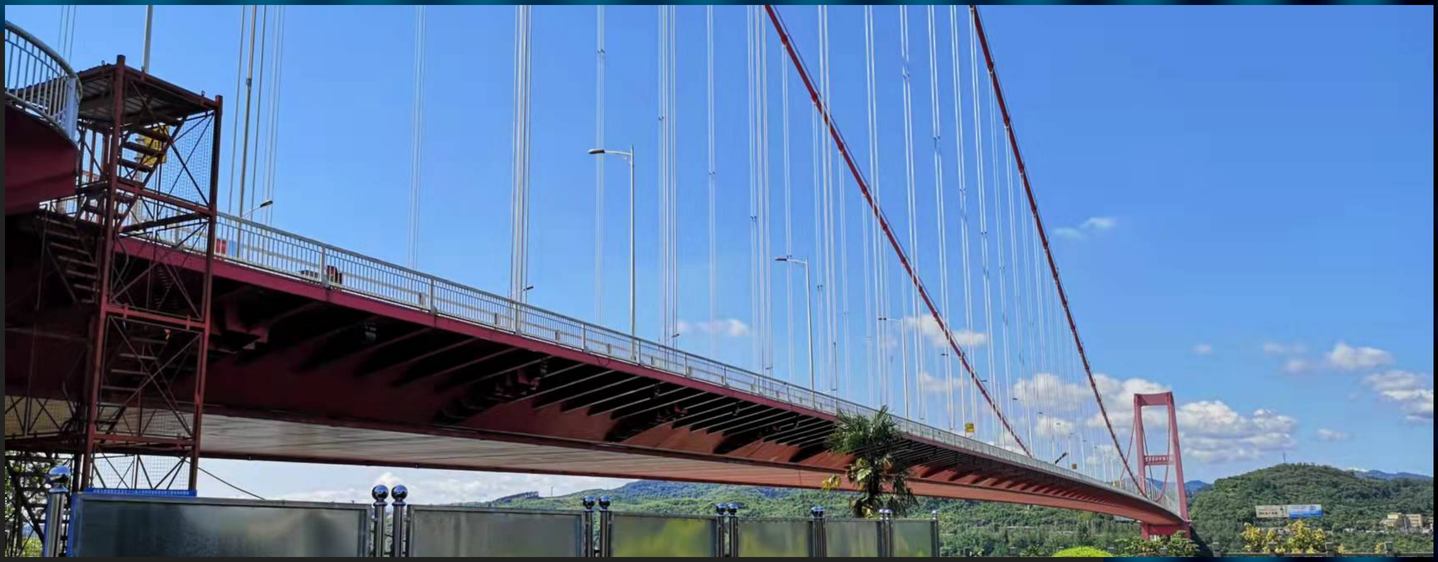

# MISTRAS LAUNCHES SENSORIA™: A NEW PLATFORM FOR MONITORING WIND TURBINE ROTOR BLADES

MISTRAS GROUP

Through Acoustic Emission Technology and the Sensoria™ Insights Data-Driven Web Application, Mistras' Sensoria blade monitor empowers wind turbine blade operators to gain complete visibility the condition and integrity of the blades.

Sensoria includes advance AE hardware and newly developed AE sensors permanently installed on each blade. Sensoria Identifies different type of damage, visible and hidden, such as lighting strike damage, skin perforations, cracks, and delaminations.

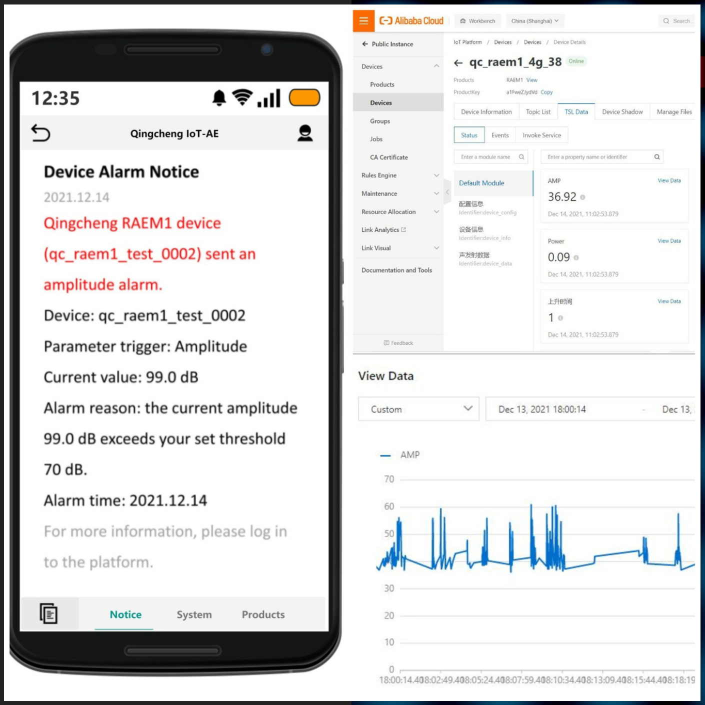
For more Information visit https://sensoriawind.com



# MONITORING BRIDGE SUSPENSION CABLE AND STEELWORK BY IOT-AE

QINGCHENG AE INSTITUTE

RAEM1, an IoT-AE system, was installed permanently on several bridges for monitoring bridge suspension cables and steelwork health, unattended and on-line 365 days per year. Any single wire of the bridge cable broken will be detected and reported to clients by cellphone messages and displayed on the cloud server immediately. The same applies to any steelwork cracking.


MORE INFO PLEASE CONTACT SALES2@AE-NDT.COM, QINGCHENG AE INSTITUTE.

# CONFERENCE AND MEETINGS ON AE

**10th EWSHM**
**Palermo - Italy**
European Workshop on Structural Health Monitoring
July 4-7, **2022**

Abstract due January 14, 2022
Website: https://www.ewshm2022.com/
Special session on AE

## European Conference on Acoustic Emission Testing

13th - 16th September 2022 - Ljubljana, Slovenia

Abstract due March 31, 2022
Website: https://ewgae2022.si/

### *Important Dates*

*Abstract submission deadline:* ***May 31, 2022***
*Paper submission deadline:* ***July 30, 2022***

### *Conference venue*

*Kawasaki City is located in the northeast of Kanagawa Prefecture. It adjoins Tokyo across the Tamagawa River to its north and Yokohama City to its south.*
*Kawasaki Station is little more than ten minutes by train from Haneda International Airport and Tokyo Station. Also, the Musashi-Kosugi station in the city directly connects via railway to Narita International Airport. Kawasaki City thus allows excellent transport access to places inside and outside the country. The city is also serviced by highway networks to guarantee easy access from principal cities.*


### *Steering Committee*

***Chairman***

| | |
|---|---|
| *T. Matsuo* | *Meiji University* |

***Vice-chairman***

| | |
|---|---|
| *K.Ito* | *National institute for Materials Science* |

***Member***

| | |
|---|---|
| Y. Mizutani | Tokyo Institute of Technology |
| K. Ohno | Tokyo Metropolitan University |
| H. Yuki | The University of Electro-Communications |

### *Conference Secretariat*


*Shuhei Yasoshima*
*The Japanese Society for Non-Destructive Inspection*
*yasoshima@jsndi.or.jp*


***We are looking forward to meet you in Kawasaki in November 2022 !***

JSNDI 一般社団法人 日本非破壊検査協会
The Japanese Society for Non-Destructive Inspection

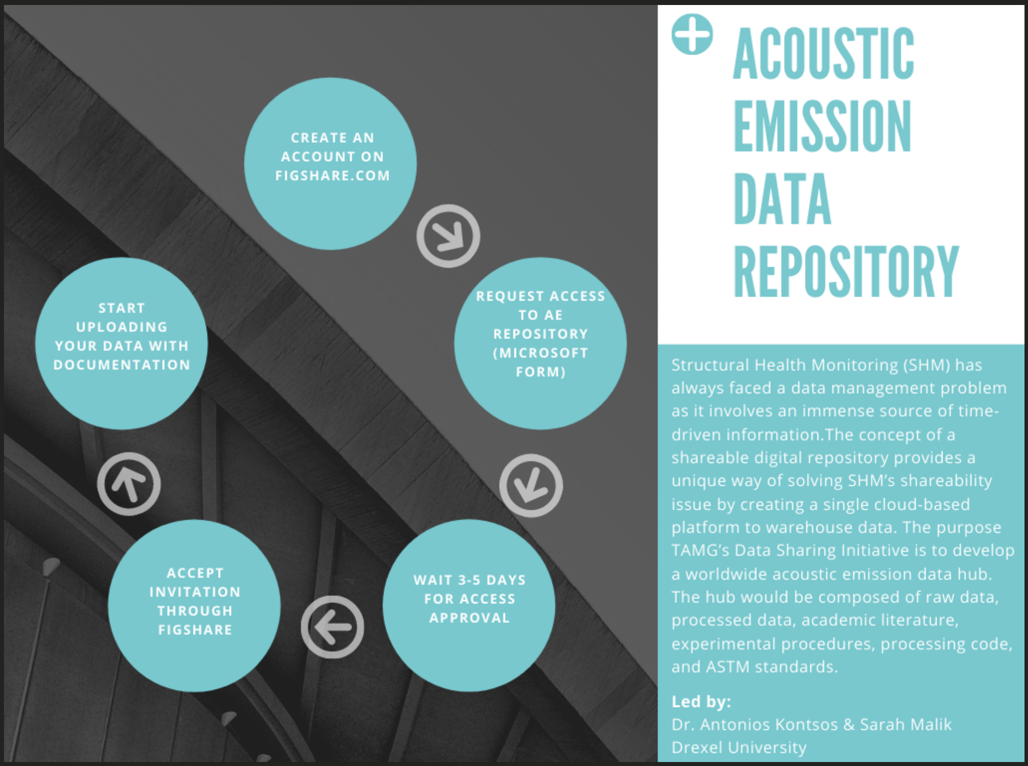
## 26th International Acoustic Emission Symposium (26th IAES)

To be held in Kawasaki Japan,
10/31-11/2, 2022
Kawasaki City Industrial Promotion Hall

The symposium will be conducted as a hybrid on-site and online meeting.

# AE DATA REPOSITORY

Share & Access AE Group Data!




- Create an account: https://figshare.com/
- Request access: https://bit.ly/2XFROJx
- Wait 3-5 days for access approval
- Log in to Figshare and accept invite
- Start uploading your data (any file accepted) with respective testing details (examples in Figshare titled 'Monotonic Testing' and 'Compact Tension Fatigue Testing with AE')

# CONTACT AEWG

Contact AEWG if you have any comments, questions and news to share in next issue via email

executive_committee@aewg-us.org