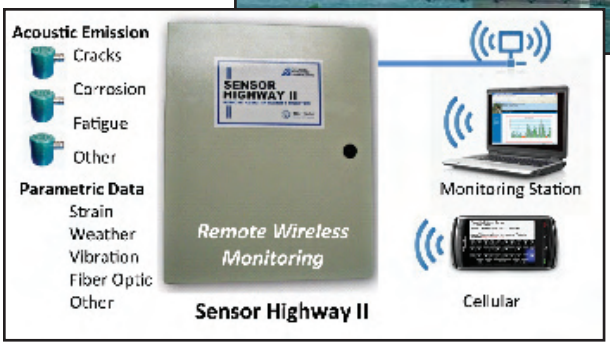
MISTRAS GROUP, INC. | *Products & Systems Division*

Total Asset Protection Solutions for Structural Testing & Monitoring of Bridges

Rising demand for ensuring the integrity and performance of our nation's aging bridges and infrastructure may sometimes require more than typical visual inspection for evaluation of structural conditions by using advanced inspection technologies. Structural integrity in bridges is challenged by a large inventory of decaying bridges. These inspections are performed by utilizing nondestructive testing (NDT) technologies. The additional information obtained from our solutions can provide input to authorities and assist in making informed and effective decisions with regard to planning for maintenance, repair, rehabilitation or replacement. In addition, On-line Monitoring and Sensor Fusion can cover failure mechanisms including unpredictable deterioration.

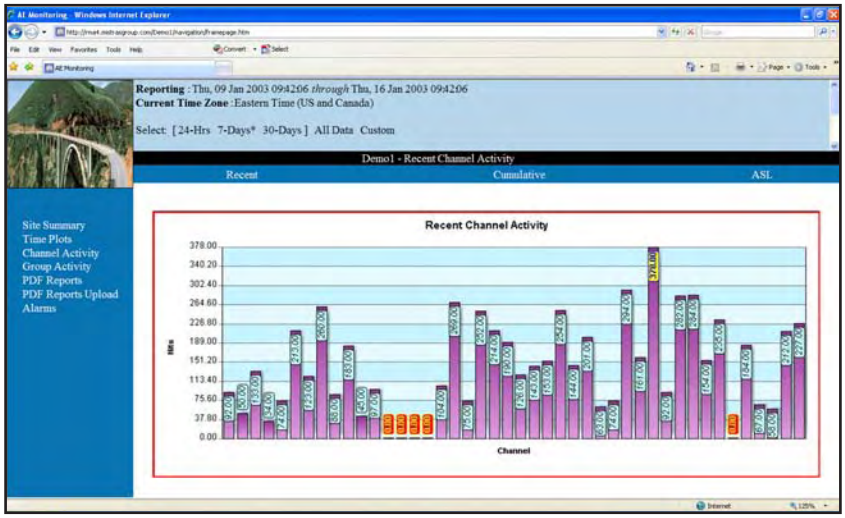


Cutting Edge and Carry Over Technologies

With 29 PhD's and more than 100 engineers and highly skilled certified technicians, each and every one brings a wide range of experience to MISTRAS. With backgrounds ranging from civil engineering; aerospace with FAA, Boeing and NASA applications; nuclear reactor monitoring; materials sciences; turn-key systems solutions for Department of Defense (DoD) contracts to medical applications such as heart valve and prosthetic implants testing, we have the qualifications to solve your unique application needs.

After providing one of our nuclear customers with a specialized Acoustic Emission system to monitor his reactor at a cost of half of our closest competitor, he said, "*all of the work that you do with the DoD, bridge testing, OEMs, petro-chemical, aerospace and medical carry over into our field.*" Our 30 years of practical application experience allows us to provide low cost, mature and extremely versatile systems to our civil Infrastructure customers.

We have developed real-time, on-line, intranet based monitoring paired with remote and/or wireless acoustic emission (AE) systems. In addition, we are developing MEMs and PZT film sensors and have produced the first combined AE/Vibration sensor for Navair/Bell Helicopter on the V22 Osprey. We have implemented sensor fusion for corrosion monitoring under a FHWA contract to link these magnets to ph-resistant AE and optical sensors and are working on the next generation of data acquisition systems. This helps DOT's and bridge authorities solve their problems as well as save money.



Remote Web Based Monitoring

MISTRAS' global network employs seasoned professionals, specializing in NDT products, on-line monitoring, field inspection, and research and applications development. The Group's headquarters in Princeton, NJ are tasked with R&D, product design, engineering and manufacturing.

Serving DOTs, Engineering Firms and University Transportation Centers

Since 1972, we have been serving the infrastructure community with many innovative technology firsts to the infrastructure industry. We monitored main lift cables for the Dumbarton Bridge over the San Francisco Bay and since then have supplied systems to FHWA, DOTs, Virginia Transportation Research Council, Columbia, University of California SD, University of Pittsburgh, Tulane, University of South Carolina as well as several engineering firms that have become our close partners in bridge testing.

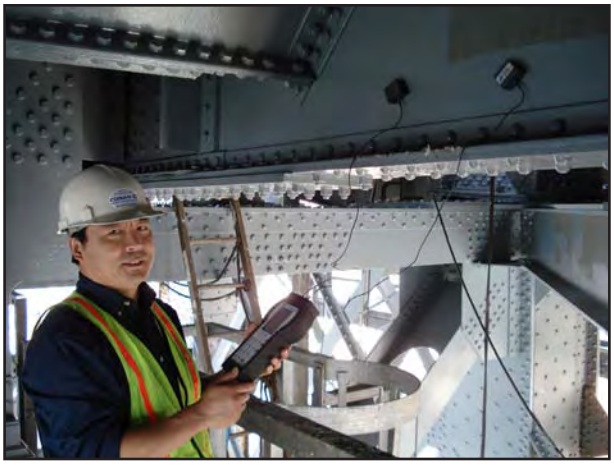
We have provided structural health monitoring and inspection of bridges, viaducts and structures and have tested or monitored bridges, parking garages, dams and structures throughout the world. We are also engaged in the use of other NDT methods including: Acousto ultrasonics (AU), Ultrasonics (UT), Advanced ultrasonics, Electromagnetics, Vibration, X-ray/Gamma-ray, Magnetic Particle, Liquid Penetrant, Resistivity, Eddy Current, Metalography, Chemical Analysis, Hardness Testing, GPR and many others. Our diverse knowledge ensures that you are getting the best technology for your application.

Experienced and Certified

To add to our staff of highly trained Ph.Ds in acoustic emission, we have 17 American Society of Non-Destructive Testing (ASNT) Level III's, a certification similar to a PE certification, in non-destructive testing. Many of our Level III's have multiple ASNT certifications in x-ray, ultrasonics, acoustic emission, eddy current and thermography. Before recommending a technology for your application, we review it with our Level III's, in which tests are usually performed by a Level III accompanied by one of our many Level II certified technicians.

Acoustic Emission Technology

There are a variety of different sources that can be detected by AE in various materials. For metals, typical sources include crack initiation, crack propagation, fretting (between crack faces, bolts), movement of dislocations, slipping (e.g. bearings) and fractures. For concrete and composites, sources include corrosion spalling, cracking, tendon or fiber breakage, debonding and delamination. For bridge structures, AE detection may be a result of crack initiation and/or growth, crack opening and closing (i.e. fretting/rubbing of crack faces and bolts), and/or dislocation movement in steel components. AE has also been successfully used for monitoring bearings in swing and lift bridges, deteriorating reinforcing steel, concrete decks, concrete cracking and corrosion of substructure components.



In previous work with the FHWA, AE was used to determine whether or not identified cracks were propagating in areas without retrofits or whether those areas with retrofits had completely arrested the cracks. While stresses in the areas of the crack may be below the elastic design limit, the regional area around the crack tip may have large local stresses due to excessive deformation or movement. This rise in local stresses may cause the crack tip to propagate and acts as the source for acoustic emission waves. This transient elastic stress wave radiates from the discontinuity (or other damage area) and is detected as a waveform at the surface of the material using high frequency AE sensors that are mounted directly to the structure.

Benefits of Monitoring

Establishes:

- If active damage is occurring
- Where active damage is occurring
- When active damage is occurring
- What type of damage is occurring
- The rate and/or frequency of damage

Additional Benefits:

- Predictive maintenance tool in RBI (risk based inspection)
- Optimization of maintenance budget for repairs
- Reduction in failures (active defects are detected early)
- Increased confidence in structure integrity
- Increase in safety through reduction in confined space entries and other access
- Remote monitoring - reduces need for site visits

AE Monitoring Applications for Structural Health Monitoring (SHM)

- Condition Ranking
- Continuous Remote Monitoring
- Real Time Damage Location (e.g. crack, wire rupture)
- Assist in Locating Hidden/Buried Defects
- Inspection of Inaccessible Areas
- Can be Combined with External Parametric Sensors (e.g. strain, displacement, temperature, pressure, etc.)
- Reduce Unnecessary Maintenance Repairs
- Prolong Remaining Useful Life, SHM can help to keep structures in service longer;
- Prioritize Future Repair, Rehabilitation or Replacement Decisions.

Sensor Highway II for Short-term and Long-term Monitoring

The Sensor Highway II system supports 16 high speed AE monitoring channels, that handles multiple parametric sensor inputs (+/- 10 volts). The Sensor Highway II has been developed for un-attended "Asset Integrity Monitoring" management and condition monitoring applications. The system is housed in a rugged outdoor case; capable of operating in extreme weather and factory conditions.

The key feature of the sensor highway system is its highly flexible sensor fusion interface for input and processing of almost any variety of sensors. This interface is accomplished inside the Sensor Highway II system through the use of standard industrial, DIN Rail mounted signal conditioning modules, with options for proximity probes, pressure transducers, load cells, thermocouples, environmental sensors, strain gages, etc.

Local, Remote and Online Monitoring

MISTRAS continuously develops new on-line software technologies for implementing acoustic emission, vibration and other sensor-based instrumentation for remote applications. Based on customer needs and available connection capabilities, we provide:

- Web Browser - Internet based remote monitoring
- Wireless LAN - Intranet & Network based remote monitoring
- Modem and direct phone line - Direct to modem remote monitoring

Internet based data acquisition, monitoring, analysis and alarm services include:

- Installation of a remote AE (or NDT) system that is then provided with a connection to the Internet for automatic and continuous downloading of summary and statistical data, alarm status information and parametric (environmental) data. We also monitor for alarm conditions, alerting and contacting the appropriate personnel in case of an alarm or emergency.
- An Internet website, where the client may login to a secure Webpage (portal) for reviewing the status of the system, alarm information, etc. The secure website can be accessed from any location with Internet access, 24 hours a day, 7 days a week.
- On a pre-arranged/contracted basis (daily, weekly, biweekly, monthly, etc.), we offer retrieval of the raw AE (NDT) data from the remote system, analysis of the data on a regular basis and can provide an analysis report that is uploaded to the client web site for review.
- Providing daily monitoring engineering services as required or requested by the client to determine severity of a problem, or provide Fitness for Service (FFS) assessment.

Automated & Ultrasonic Portable Solutions

Our Pocket UT™ is an innovative, handheld Ultrasonic System used for thickness mapping of gusset plates on steel bridges. This system can provide measurements and inspection data faster for future trending comparisons.

Our Pocket UT™ Ultrasonic System uses an encoded scanner to gather continuous thickness measurements versus distance and present a color picture of the inspection results. This increases the amount of data being recorded and completes the inspection much faster.

The Pocket UT™ can not only complete the inspections of gusset plates in a fraction of the time, but also instantly displays the data for real time evaluation.

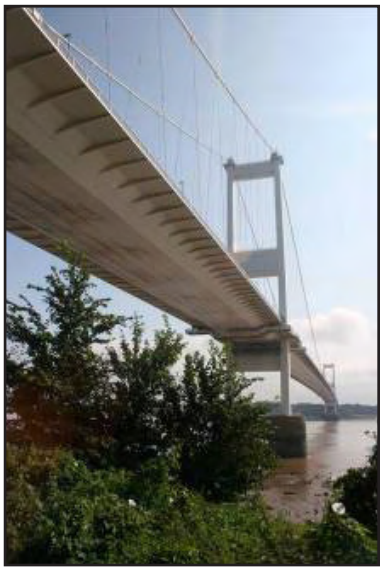
Wireless Sensing Solutions

Knowing that cabling can be the most expensive part of instrumenting a bridge, 15 years ago MISTRAS invested in designing wireless monitoring solutions and have been using these devices ever since. Our Model 1282, is the newest generation in low-power wireless sensor nodes, that communicates to a base station using the Zigbee protocol. The 1282 has been installed on many prominent bridges, including one in New York, for over four years.

Applying Technology Solutions

Suspension Bridges

AE systems have been on suspension cable bridges for over 10 years. We installed an AE system on a suspension bridge in Pennsylvania to monitor, record, interpret, identify and report possible wire breaks and other activities (e.g. vandalism) on main suspension cables. In addition to this work, we also perform diagnostic checks, maintenance, calibration and upgrades, as needed and necessary, to maintain the operation and performance of the AE system.



Monitoring the main cables of Severn Suspension Bridge

Since each bridge is unique in design and construction, we work closely with clients to meet their needs with online monitoring and development of AE classifiers to distinguish AE sources, such as wire breaks, traffic, rain, hail, etc. from one another.

Concrete Bridges

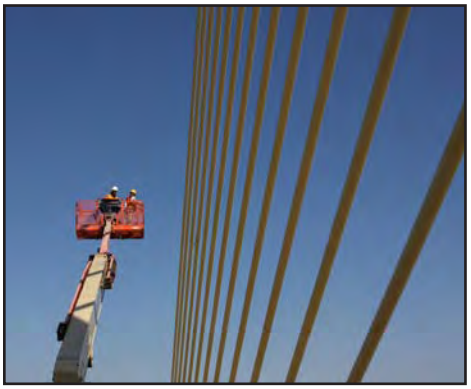
AE testing of concrete beams in controlled field conditions has been successful for sorting good from bad beams. As traffic load is applied, our systems can distinguish between background noise, new cracking, existing cracks, wire breaks in tendons and corrosion in tendons.

Cable Stay

We have successfully monitored cable stay bridges by finding broken wires in cables. We work with DOT, a Transportation Research Center and a University installing other systems to access the condition of bridge cables.

Steel Bridges

Over one hundred bridges have been tested using Acoustic Emission by MISTRAS Group, Universities and bridge authorities. Using the Kaiser Effect, which has been incorporated into many ASTM, ASME and other codes and standards, AE can determine if load ratings for bridges are within safe load conditions.



Steel Corrosion in Concrete

AE has been used successfully to grade corrosion activity in over 8,000 large petroleum storage tanks. In this application AE can hear corrosion from as far as 70 meters away. Corrosion of reinforcing steel in reinforced concrete structures is a major serviceability problem. AeCORR™ detects microscopic damage occurring within the concrete due to the formation of corrosion at the steel/concrete interface. As corrosion initiates, the expansive products generate micro-cracks in the concrete, detectable on the surface by piezoelectric transducers. The collection interpretation and analysis of these emissions is the basis of the AeCORR™ technique.

Homeland Security

In 2006, a main tendon on an aging cable stay bridge was nearly severed by vandals. The problem was found before it became critical but only after $2 million in damages. The bridge was instrumented with our system and now alarms authorities in real-time if various acts are in progress.

Pipelines, dams, buildings as well as bridges can be monitored with single or multiple sensor technologies to detect problems before they happen. After a natural disaster such as an earthquake or hurricane would the structure be fit for service? Our systems can answer this within hours instead of weeks of inspection.

MISTRAS is a team of skilled researchers, engineers, technicians and manufacturing personnel dedicated to the development of practical and cost saving solutions for your challenging inspection and monitoring needs.

For additional information, please contact our Princeton Junction headquarters at 609-716-4000.

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