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MATERIAL TECHNOLOGIES, INC.
TECHNOLOGIES FOR THE DETECTION OF FATIGUE CRACKS IN METAL INFRASTRUCTURE

MATECH - The Company

Formed in 1985, Matech is an engineering and technology company that researches and develops non-destructive testing (NDT) devices to dramatically improve the maintenance of metal infrastructure by detecting growing fatigue cracks in load-resisting structures. The Company has exclusive rights to seven patents specializing in the most advanced technologies to measure microscopic fractures in metal structures and to monitor metal fatigue in real time.

Since Matech's inception its founder and president, Robert M. Bernstein, has obtained federal sponsorship, benefited from US Air Force's assistance in developing the technologies, and received support from the US Federal Highway Administration. Having proven the viability of its technologies, Matech launched its marketing thrust on the domestic and international markets in 2006.

MATECH'S TECHNOLOGIES - An Overview

Infrastructure assets are expected to perform over long periods of time in an environment that is not conducive to their longevity. For most metal assets (e.g., bridges, tank cars, rails, CWR joint bars, etc.), repeated loadings cause significant and rapid deterioration. This degradation in performance is neither new nor unexpected as it is part of intended use; yet, when unmonitored the deterioration can frequently lead to catastrophic system failures. The true task, then, is to effectively manage the problems associated with fatigue. Since reducing loading magnitudes or frequency is generally considered impossible, the most effective management approach comes in the form of advanced warning and early detection of fatigue damage.

Very often steel bridge inspections are performed by specialists using visual means alone to satisfy the federally mandated biennial inspection. According to the Federal Highway Administration, 90% of fatigue cracks are missed by visual inspectors, and 56% of bridge ratings, that is, the long term structural quality of the bridge, are incorrect. This results in either having to conduct numerous and unnecessary repairs – just to be on the safe side – or, conversely, in missing signs of dangerous metal fatigue. Indeed, if a crack is small yet growing, it is a harbinger of a serious problem that needs to be addressed in the near term.

To considerably improve the results of metal structure maintenance, **Matech** is marketing two of its unique technologies: the Electrochemical Fatigue Sensor (**EFS**) and the Matech Fatigue Fuse (**FF**).

MATECH'S ELECTROCHEMICAL FATIGUE SENSOR - An Advanced Solution to Detect Metal Fatigue

The feature of the Electrochemical Fatigue Sensor (EFS) is its ability to detect very small, growing cracks in load-resisting structures that are cyclically loaded, such as bridges, highway sign structures, rail tie bars, and oil rigs. It enables owners to make informed decisions to repair cracks based on accurate determination of whether or not the crack is growing. Such a decision can quickly translate into millions of dollars saved by either not repairing cracks that are static and using those funds for more urgent needs, or repairing small growing cracks before they become major and costly problems.

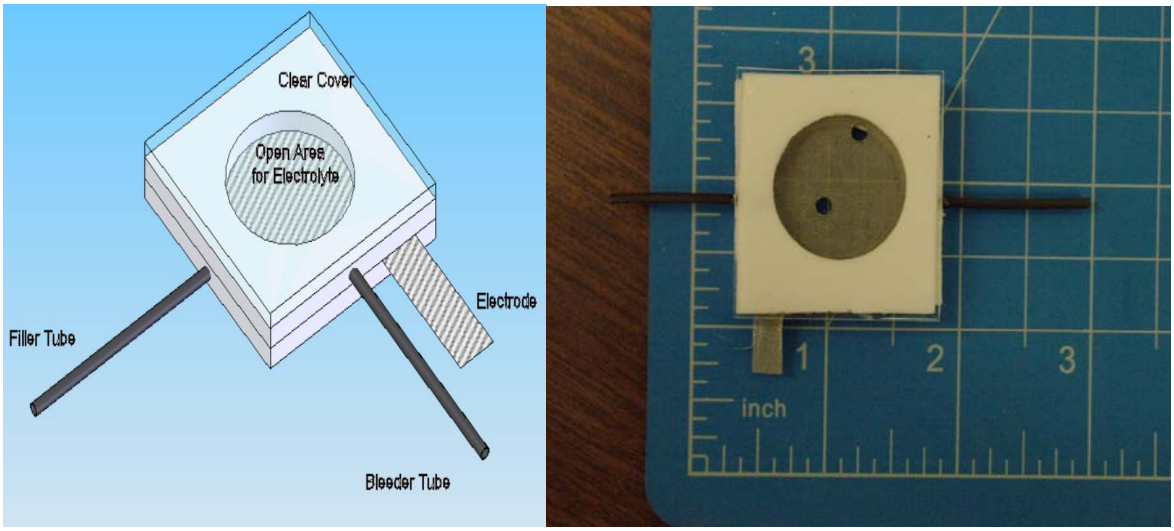
The EFS is also useful in verifying that fatigue crack repairs are effective. After amelioration, if the crack is no longer growing, the repair was successful; if it is still growing then the repair was ineffective.

In practice, the EFS phenomenon is embodied in an electrochemical cell which is attached to a metal component undergoing cyclic stress. The component being inspected is part of the inspection system, not only as the item of interest but also as part of the sensing system – typically as the anode of the electrochemical cell. In total, the electrochemical cell is comprised of a container filled with a gelled electrolyte and two electrodes. When the other electrode is added to the system and a constant voltage is applied in a constant stress environment, a constant current will flow. If, however, the stress varies, the current also varies in a complex dependence upon the stress and fatigue condition. The current variation, which is called the EFS signal, provides the measure of fatigue damage.

The current, produced within and by the EFS phenomenon in the presence of a fluctuating stress, contains components associated with two different mechanisms. First, a fluctuating current is generated that is directly associated with elastic strains. This fluctuation has a frequency content that is the same as the global strain conditions. Second, a fluctuating current is generated from micro-plasticity resulting from locally high strains at a crack tip. This micro-plasticity brings fresh, un-passivated steel atoms into contact with the EFS electrolyte. These atoms are immediately passivated, causing a change in the electrochemical cell and the associated current readings. The difference between the two components of the fluctuating current is a direct measure of fatigue damage.

Fundamentally, fatigue crack propagation causes enhanced cyclic plasticity which also happens to increase as the crack length increases. This plasticity occurs both at the point where the crack breaches the surface and at the crack tip, meaning that both surface breaking and subsurface cracks can be detected. This fundamental basis and the practical application of the EFS system means that cracks as small as 0.01 in. can be detected. Further, the nature of the EFS system means that crack growth will be detected, allowing repair/replacement/rehabilitation efforts to be targeted to the most important areas – those where cracks are actually growing. If the crack is not growing, the EFS will not provide the fluctuating current, and the crack can be safely ignored.

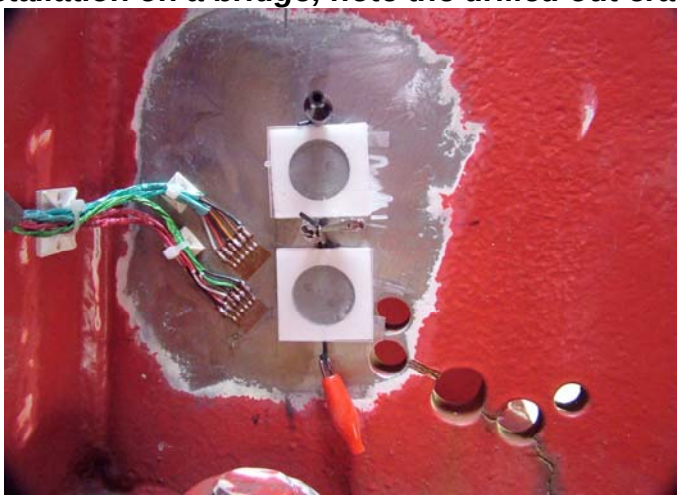
Matech's EFS system is portable, does not require highly skilled technicians, and can test difficult to access areas; it does require arms' length access to clean the area being examined and to install the sensors. The system consists of sensors, electrolyte, a potentiostat and a remotely located standard computer. Inspection results can be viewed by a team present at the testing site or can be transmitted over the Internet to a different place and, therefore, the information can be shared in real time. The system also enables the infrastructure owner to retain inspection results for future comparisons and monitoring.



(a) Schematic ***(b) One configuration***

The Electrochemical Fatigue Sensor

(c) Installation on a bridge; note the drilled out crack ends



MATECH'S FATIGUE FUSE - Another High Performance Metal Fatigue Technology

The Fatigue Fuse (FF) is a passive sensor designed to be affixed to fatigue sensitive areas to give warnings as pre-selected portions of the fatigue life are used up – essentially acting as a measure of accumulated fatigue damage. In practice, the Fatigue Fuse can be used as an active maintenance/repair management tool. For example, when a specific component has been measured to have used up 80% of its design fatigue life, an asset owner could proactively choose to replace or repair that component before it fails.

The Fatigue Fuse consists of a thin piece of metal with a series of parallel strips integral to a common base. Each strip has a unique geometric configuration that defines its fatigue behavior. Once engineered, the fatigue life of each strip is finite and predictable. When the fatigue life of a strip is reached, the strip simply fractures. By engineering a variety of different geometries on a single Fatigue Fuse, different increments of fatigue life are observable – typically every 20%. By mechanically bonding a properly engineered fatigue fuse to the area of interest, each fuse undergoes the same loading history as the component of interest. Therefore, breakage of one of the Fatigue Fuse strips indicates that an increment of the fatigue life of the component has been reached. Remote means of detecting fracture of individual strips is available.

Matech's Fatigue Fuse

MARKETS - Matech's Clients

Matech has successfully completed orders to test metal bridges in the states of California, New York, Pennsylvania, Ohio and Colorado. Pending orders include the

state of Massachusetts and additional bridges in Pennsylvania. We have inquiries from several other states at the current time.

Recognizing the importance of proper metal structure monitoring and the necessity to prioritize repairs to better manage state and federal budgets, the United State Congress passed a bill that significantly increases the standards of infrastructure inspections. Currently, we believe only Matech's technology meets those standards.

Moving forward on its planned application expansion, Matech is currently working with the Association of American Railroads and the Federal Railroad Administration to demonstrate its EFS system at the Transportation Technology Center, Inc (TTCI) in Pueblo, CO. The TTCI facility is a unique world-class research, development, and demonstration facility that serves the primary research needs of AAR member railroads. Matech successfully completed inspections using EFS on three different rail structures, and was able to detect growing cracks. When previously tested by other than EFS means, these same cracks had been designated as static.

Matech continues to expand its US domestic markets and is launching its international markets in Fall 2006 for both metal bridge and rail inspections.