soundprint™ Acoustic Monitoring

Bridges & Structures

Structural Monitoring Systems

SoundPrint® is a patented innovative monitoring technology that can detect and locate failures in high-tensile steel wire, strand or cable. Whether these materials are used as reinforcement in post-tensioned structures, or as supporting elements in cable-stayed or suspension bridges, they can corrode and fail without any external evidence, leading to potential structural deficiency.

In order to ensure the long-term integrity of these structures, there is a need for a method of determining if, when and where deterioration is occurring so that engineers can make informed decisions about maintenance or repair requirements. SoundPrint fulfills this need continuously, non-destructively and cost-effectively.

- **Collects acoustic information from widely distributed sensors**
- **Determines the time, location and frequency of wire failures**
- **Monitors entire structures and pinpoints localized problem areas**
- **Helps develop accurate maintenance budgets**

Proven Performance, Expert Service and Research & Development Excellence

Pure Technologies is the largest commercial continuous infrastructure monitoring agency in the world, and its patented technology SoundPrint has been in use as a structural monitoring system since 1994. SoundPrint has effectively provided continuous health monitoring solutions for over 200 bridges and structures with locations spanning the globe. With a database of over 2000 wire break events to date, Pure Technologies continues to offer reliable and valuable services to its many long term customers. Money-saving repairs have been carried out on most of the monitored structures based on information directly generated by SoundPrint. The system has saved the owners of these properties millions of dollars on non-destructive testing and pre-emptive repairs or premature decommissioning.

Public agencies as well as private owners have discovered the peace of mind that SoundPrint continuous monitoring can provide. Instead of the uncertainty normally associated with identifying and quantifying hidden structural deterioration, these managers can now plan maintenance strategies that will ensure the long-term integrity of structures in their care. Where deterioration is difficult or impossible to address, timely repairs to the structure can be planned.

pure™ TECHNOLOGIES

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Suspension Bridges

The main cables and suspender ropes of suspension bridges are often subject to aggressive environments. Hidden corrosion of the wires in these components can occur, leading to potential reduction in structural safety factors and expensive large-scale repairs and rehabilitation.

SoundPrint provides complete, continuous surveillance of cable components on suspension bridges so that areas of active corrosion can be pinpointed. Engineers can now identify where cable inspections should be concentrated, and where and when repairs are required.

Pure Technologies has once again advanced the state of the art, allowing for monitoring of large suspension bridge main cables, including the anchorages, using a single SoundPrint system.

Cable-stayed Bridges

The increasing use of cable-stayed technology presents special problems for bridge inspectors, as the condition of wires in stay cables is particularly difficult to determine. Other inspection techniques are expensive, cumbersome, and unable to detect flaws within the anchorage zones, where most damage typically occurs.

The SoundPrint acoustic monitoring system offers solutions for all of these issues, and when combined with an optional complementary vibration monitoring system, provides a complete continuous remote health monitoring solution for stay-cables. Corrosion or fatigue-induced failures can be detected long before they compromise the integrity of the stay. Because the system can track the actual number of dynamic cycles the stays experience, realistic fatigue performance can be compared with theoretical assumptions.

A single SoundPrint system can be applied to monitor all the stays of even the world's longest cable-stayed bridges.

Post-tensioned Bridges

Suspect grouting practices and poor detailing has led to concerns about the durability of post-tensioned bridges and their susceptibility to corrosion-induced tendon failure.

Conventional NDE techniques are ineffective for determining the location and extent of corrosion damage and this has led some bridge owners to de-commission suspect bridges because of structural safety concerns.

SoundPrint has been used to provide assurance about the condition of post-tensioned bridges since 1997. Comprehensive testing of the system by the U.K.'s Transport Research Laboratory on behalf of the Highways Agency has proved that its sophisticated acquisition and event filtering capabilities can reliably detect low energy wire breaks in fully-grouted tendons in noisy environments.

Whereas constraints due to cost and equipment usually led engineers to settle for monitoring of a "typical span", latest advances in acoustic monitoring technology have made instrumenting and monitoring entire viaducts, up to 5 km long, a reality. Fully grouted, partially grouted, and ungrouted post-tensioned concrete structures can now be remotely monitored.

Non-destructive Structural Monitoring

Bridges

With SoundPrint®, bridge owners and engineers finally have a tool that helps ensure the long-term integrity of post-tensioned, pre-tensioned, suspension and cable-stayed bridges. SoundPrint detects and locates tensioned wire failures through continuous, non-intrusive remote monitoring.

Because it continuously monitors for failure of tensioned steel elements, SoundPrint saves money on other bridge inspection and NDE techniques. Once SoundPrint has generated an understanding of the frequency and location of wire failures, other investigative techniques can be more cost-effectively applied to further evaluate the extent of deterioration. Information generated by the system can be integrated into the owner's Bridge Management System.

Buildings and Parking Structures

Moisture can enter the tendon system of unbonded post-tensioned structures at any time before, during or after construction, causing corrosion-induced failures. Resultant concerns about the presence, rate and extent of deterioration can have a negative impact on property values. Only SoundPrint can effectively quantify these concerns. Current non-destructive evaluation (NDE) techniques are ineffective for evaluating the condition of unbonded post-tensioned systems. While useful in the initial assessment of a structure, intrusive inspection of strands provides only a sampling of strand condition.

SoundPrint continuously monitors every strand in a building and will identify the time and location of wire failures. Since SoundPrint can also determine the frequency of wire failures, statistical techniques can be used to estimate future rates of failure on different slabs within a building.

Information on Demand

Through the SoundPrint web site, clients can now access data from their structures directly. Using the intuitive interface, managers can custom-design their own reports, generated in real time. Acoustic events can be examined and replayed in real audio format, and presentation-quality reports for multiple sites can be viewed and printed. Comprehensive security ensures that only authorized individuals can access specific sites.

Using our powerful and versatile GIS-based Management Interface, information from other instrumentation systems can also be integrated into the SoundPrint acquisition and processing system. Information from entire infrastructure management networks can be viewed on the client's custom web site. This provides managers with desktop access to a single-source, reliable service for all instrumentation requirements, providing information where it's needed, when it's needed.

The Process

SoundPrint uses an array of sensors to measure the dynamic response of a structure caused by the energy released when tensioned wires fail. The energy is transmitted from the wire to the surrounding medium. For example, in a concrete structure, sensors are typically mounted on the underside of the concrete slabs. On suspension bridges, sensors are placed on the cable bands.

When a prestressing wire fails, the energy released by the event is transmitted through the concrete to the sensors. The sensors are connected to a data acquisition system located in or near the structure. As there is no need to have sensors in direct contact with inaccessible wires or strands, the system is non-intrusive and is ideally suited to applications on existing structures. Hardware filtering and real-time pre-processing reject spurious acoustic events caused by ambient activity, such as traffic or impacts.

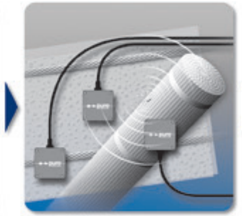
Data from events that pass a primary filtering process are automatically transmitted to a data-processing centre by means of Internet file transmission protocol. Sophisticated proprietary software analyzes this data to determine the time, location and classification of each event. Automatic alerts are generated for authorized users of any wire break activity. Reports can be generated summarizing activity in a structure over a specified period. Remote diagnostics and dedicated operations staff ensure optimum system operation.

3D interface used by SoundPrint customers to monitor their structures in real time.

State-of-the-art solar-powered wireless sensor technology eliminates the need for data communications cabling, and further reduces installation.

How it Works

1 SoundPrint Acoustic Monitoring system is installed on a Bridge or Structure



2 Sensors measure the dynamic energy release when tensioned wires fail.

3 Onsite Data Acquisition Unit performs preliminary hardware filtering and real-time pre-processing rejecting superfluous acoustic event data.

4 Data from events that has passed preliminary filtering processes is transferred to our data-processing centre to be further examined.

5 Through a combination of applied proprietary software, and highly trained professional analysis, acoustic events are assigned a time, location, and specific classification.

6 If and when the event is classified as noteworthy, electronic alerts are sent, via email, to the client. The data is immediately accessible on the 3D GIS website, and reports can be custom generated.