Continuous Acoustic Monitoring of Infrastructure

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Summary

The 2001 Report Card for Americas Infrastructure as reported by the American Society of Civil Engineers has suggested an average grade of D+ for our nations key infrastructure.� The estimated cost to upgrade this infrastructure has been projected to $1.3 Trillion over the next five years.� This problem will require a proactive approach on the part of state officials to allocate the required resources to meet this growing challenge.� In addition to establishing budgets for new construction and rehabilitation of the nations key infrastructure we must begin to look to technology to assist with the management of these assets.

This abstract summarizes the development of the SoundPrint� acoustic monitoring system to evaluate and monitor Infrastructure.

SoundPrint� Continuous Acoustic Monitoring - How does it Work?

When a tensioned wire fails, its stored energy is released suddenly, causing a dynamic response in the structure. Other ambient events may also cause a response. The monitoring system utilizes acoustic sensors distributed about a structure that detect the response at different points in the structure. On-site processing of the data at the data acquisition system eliminates most irrelevant ambient activity. Events that meet pre-set criteria are recorded and transmitted over the Internet to a central processing facility where proprietary processing software is used to generate reports summarizing the time, location and classification of the recorded events. Long term monitoring can provide comprehensive information about the nature and extent of the deterioration so that informed management decisions can be made.

Buildings

In 1993 Pure Technologies began the development of a technology to assist with the condition assessment of Infrastructure.� The first installation was on a post-tensioned parking structure that had been inspected and found to have corrosion problems on the embedded tendons.� A SoundPrint� acoustic monitoring system was installed to record any future wire breaks that may occur within the post-tensioning system.� To date over four million square feet of post tensioned buildings and parking structures have a continuous monitoring system installed.� Owners and managers of these structures find the acoustic monitoring system instrumental in maintaining their structures.

Bridges

Long span bridges such as the Fred Hartman cable stay bridge in Baytown Texas are aesthetically pleasing and critical for the efficient flow of people and goods over the nations transportation corridors.� The Texas Department of Transportation has taken a proactive position in protecting the states key infrastructure.� In 2001, Texas Department of Transportation commissioned Pure Technologies to instrument the stay cables with a health monitoring system.� The acoustic monitoring system was designed to provide close to real time information on the condition of the stay cables on these structure.� If the stay cables deteriorate and wires begin to break, the health monitoring system will identify the time and location of these events so that a permanent log on the bridges performance can be established.

In addition to cable stay bridges the acoustic monitoring system has been installed on Suspension Bridges and segmental post tensioned bridges.� In the case of suspension bridges the system monitors the health of the main cables and locates wire breaks anywhere along the main cable and through the cross section of the cable.� Likewise, wire breaks in external or internal tendons in segmental bridges can now be monitored and wire events can be documented over the life of the structure.

Pipelines

Prestressed Concrete Cylinder Pipelines have a unique application for the acoustic monitoring systems.� Since 1996, hydrophones have been deployed in these critical structures to determine the time and location of deterioration.� The acoustic system configuration for a prestressed concrete pipeline differs from a building installation. In this case, sensors are inserted into the operational pipeline at existing valves or other appurtenances. The sensors are attached to a long cable that is deployed into the pipeline through a pressure sensitive fitting. Once in the flow of the pipe a parachute is deployed to tow the cable into place up to 6000 feet downstream of the insertion point. The length of the array selected to monitor a given pipe section will depend largely on other inline obstructions or bends that may restrict complete deployment of the cable. In this case, multiple hydrophone arrays may be required to monitor the selected pipeline section. Other system configurations are available for other pipeline systems depending on site logistics.

While the acoustic monitoring system provides valuable information on the rate of deterioration of the pipeline it provides only limited information on the existing condition of the structure.� Recently developed electromagnetic technologies can be used to assess the existing number of wire breaks that have occurred.� The P-Wave electromagnetic technology is used to survey long sections of prestressed pipe.� Once inside the pipe, the survey is performed with equipment that electro-magnetically excites the outside windings of the prestressed wire and reports a signal back to processor.� This information can be used to determine how many wires have broken and location of deterioration along each spool of pipe.

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Conclusions

Continuous acoustic monitoring of structures offers reliable and confirmable data about the rate of breakage of prestressing wires. Repairs can be planned and budgeted based on observed rates of breakage. Within a structure, there can exist local areas that exhibit higher breakage rates than surrounding areas. The acoustic detection of these breaks allows stakeholders to identify and repair localized areas of potential structural deficiency, and to identify and remedy the conditions which are causing the localized corrosion. This strategy can help to prolong the life of a suspect pipeline while minimizing the potential for catastrophic failure.

If you have any questions, please contact **Dr. C.Vipulanandan**