Acoustic Monitoring of Prestressed Structures

Mark Holley

Abstract

Summary

Corrosion of prestressing wire in Prestressed Structures including Bridges, Buildings, Parking Structures and Concrete Cylinder Pipe (PCCP) is a widespread concern for owners and managers of these facilities. The general inaccessibility of the prestressing wire makes evaluation difficult, costly and often inconclusive. Random examination of prestressing wires in these structures gives only a very localized knowledge of the prestressing wire condition, conventional investigations can be misleading, often resulting in an underestimate of the extent of corrosion, deterioration or wire failure. The operation of a continuous acoustic monitoring system to detect and locate corrosion-induced failures of prestressing wire will be discussed.

Introduction

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

Continuous acoustic monitoring to track the failure of unbonded post-tensioning strands in concrete building and parking structures are being used. The size and complexity of these structures required the development of specialized equipment and software to collect, manage, and analyze the large amounts of data flowing from these sites. These programs, techniques and equipment designs have been applied to the monitoring of other structures. To date over 3 million square feet of post-tensioned structures have been monitored in real-time throughout North America.

Pipelines

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 have been developed to be used on various pipeline systems depending on site logistics and the information required have been developed.

Bridges

Hidden corrosion of tensioned steel elements in bridges has been a continuing concern for bridge owners and engineers. In the United Kingdom, corrosion of grouted post-tensioned tendons in bridges has led to restrictions of the use of this construction method in new bridges. With cable-stayed and suspension bridges, assessing the condition of the high-strength steel wires in the stays, main cables and suspender ropes is difficult, intrusive and expensive. The problems highlight the need for practical and cost effective methods of assessment. An evaluation of a system on a grouted post-tensioned structure, suspension bridge and cable-stayed structure are presently underway.

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**

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