

Early Detection and Control of Termite Infestations Destructive to Covered Bridge Structures Using Acoustic Emission

More than 1,500 covered bridges remain in the United States, and most are potentially subject to decay and termite damage. Nearly all termite damage to timber bridges in the United States occurs through subterranean termite colonies (especially *Coptotermes* and *Reticulitermes* species), which require contact with the soil or some other constant source of moisture. Severe internal decay of timbers used for bridge members is caused by “white rot” or “brown rot” fungi and promotes, if not attracts, subterranean termites. External surface decay, especially in ground contact areas, may also be caused by “soft rot” fungi. Other fungi, such as mold and sapstain fungi, may produce superficial discoloration on timbers but are generally not of structural significance. Advanced fungal decay can also act to attract termite infestations by “wetting the wood structure” and softening the substrate for termite infestation.

Background

Traditional visual inspections for termites by trained pest control professionals are both expensive and time consuming. The two current approaches to termite control for timber bridges both require visual on-site termite inspections, accompanied by control measures when activity is detected. However, because some termite species can rapidly cause structural damage, annual on-site inspections may be insufficient. Expensive on-site inspections on an annual or other periodic basis may no longer be needed if wireless sensor systems can monitor moisture and structural bridge health from remote locations and transmit the data via



Workers of subterranean termites under the bark of an infested support member.

cell phone systems. Acoustic emissions (AE) provide an additional monitoring method to evaluate the health status of a bridge or some of its important components. The development of sensors with low initial costs and the development of integrated wireless systems will substantially advance the field of monitoring structural bridge health.

Objective

Our research project intends to test integrated wireless sensors for daily monitoring of the wooden structure for moisture, fungal decay, and termite attack. On-site inspections would only be initiated when the monitoring sensors detect wood-moisture changes or termites directly and send that information by data acquisition back to a central computer system. To accomplish this we need to identify the electronic signature of a typical termite colony during actual wood damage and

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Cubicle brown-rot decay and termite damage to the support members masonry contact under covered bridge.

use this termite-specific signature to identify and confirm termite damage at remote bridge locations. Detecting termite presence by moisture monitoring and acoustic emission in laboratory timbers will provide proof of concept for the full system outdoors on a larger scale.

Approach

New methods need to be developed to maintain the existing covered bridge infrastructure in a constant yet cost-effective time frame. Modern termite detection strategies promise good return for investment but also demand higher levels of technical input from both owners and pest control managers. New technologies could include thermal imaging cameras, microwave detection devices, acoustic emissions detection of insects, moisture sensors, videoscopes, and/or resistographs. An early warning system that continually monitors the bridge system is needed to aid owners and users in deciding when to carefully inspect the bridge on site before any structural damage occurs.

Expected Outcomes

This study will result in (1) development and testing of cutting edge acoustic emission sensors for use in early detection of Eastern subterranean termites by identifying the signature of the living termite colonies in structural wooden members, (2) recommendations



Termite damage to an existing structural bridge member.

for placement of moisture and acoustic sensors to monitor the structural health of existing timber and covered bridges, (3) preparation of a comprehensive final report on the study findings, and (4) transfer of technology via presentations at national and international meetings.

Timeline

Preliminary system design will be completed by fall 2013. Key benchmarks will include recording the termite's signature acoustic emissions in a controlled laboratory environment and then transferring that integrated system of acoustic detectors to an outdoor bridge or equivalent structure for remote sensing sent back to FPL by telephonic communication. The research will be completed by September 2014.

Cooperators

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