DRISI
Caltrans Division of Research, Innovation and System Information

Research Results

Maintenance

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Project Title:
Underwater Inspection of Bridge Substructures Using Imaging Technology

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DRISI provides solutions and knowledge that improves California's transportation system

Underwater Inspection of Bridge Substructures Using Imaging Technology

The study provides recommendations that support the expansion of sonar technologies for bridge inspections.

WHAT WAS THE NEED?

The Federal-Aid Highways Act of 1968 required establishment of a national bridge inspection standard and a program to train bridge inspectors. In 1987, the Federal Government implemented revisions to the National Bridge Inspection Standards (NBIS) that mandated underwater bridge inspections.

According to the 2011 National Bridge Inventory (NBI) data, there are approximately 500,000 bridges in the United States that span waterways. Additionally, state highway agencies oversee approximately 31,000 bridges with submerged substructures that required underwater bridge inspection. Since bridges are a vital transportation link in the infrastructure, it is imperative that they are inspected to ascertain the condition and make any needed repairs to ensure functionality and safety for the traveling public.

Site conditions adverse to dive inspections (i.e. limited underwater visibility, high velocity currents, submerged debris, and extreme water depths to name a few), exist at many bridge sites. Because these types of adverse conditions can limit a diver's ability to inspect a bridge below water and can also be characterized as hazardous conditions, acoustic imaging technology has supplemented dive inspectors to improve the bridge inspection process and diver safety.

WHAT WAS OUR GOAL?

Federal Highway Administration initiated the Transportation Pooled Fund Research Study (TPF-5 (131)) to support development of guidance for the use of acoustic imaging for underwater inspection of bridges. The objectives of this research study was to:

1. Describe the quality of data that commercially available acoustic imaging devices produce, especially in adverse conditions, and
2. Demonstrate how these data compare with inspection findings documented by a qualified underwater inspection diver.

WHAT DID WE DO?

A field evaluation program was developed to deploy and evaluate sonar technologies for underwater bridge inspection. Design of the field program considered appropriate technology, field test conditions, and site selection. Based on the need for a comparative reference of existing conditions within the same time period, field test sonar imaging results are compared to inspection results obtained by qualified inspection divers.

The technologies available in the marketplace at the time of this study were analyzed and rated based on a set of criteria. The ratings were a qualitative tool to identify the best technologies for field evaluation. The three technologies with the highest ratings were then field tested and the resulting data was verified by conducting a Level 1 underwater inspection by a diver.

WHAT WAS THE OUTCOME?

The tested sonar technologies were effective at providing representations of three types of relevant features of bridge stability: 1) bed forms/scour, 2) objects, and 3) material defects. Sonar imaging technology demonstrated broad capability for revealing large scale structural conditions and stream bed conditions.

The results of this study lead to two broad conclusions. First, sonar inspections have not demonstrated the ability to identify some smaller scale elements of substructure condition that may be important in assessing the bridge and recommending maintenance. Second, sonar technologies offer significant opportunities for improving underwater bridge inspections, especially in adverse environments or to inspect extensive areas.

The findings and conclusions of this study lead to recommendations that support the expanded use of sonar technologies to improve the safety of bridges. The development of guidance or benchmarking information for the use of sonar technologies in underwater bridge inspection is recommended. In addition, the study recommends training for bridge inspectors in the use of acoustic technologies to supplement their extensive training in the protocols for inspection of bridges and the types of findings that are relevant to report.

WHAT IS THE BENEFIT?

The expanded use of acoustic technologies for bridge inspections will improve the inspection of the underwater substructure for bridges over waterways, a vital link in the transportation network, and reduce the necessity of diver inspections in adverse site conditions.

LEARN MORE

Pooled Fund: Underwater Inspection of Bridge Substructures Using Imaging Technology, and FHWA Final Report.

To view the evaluations:
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IMAGES

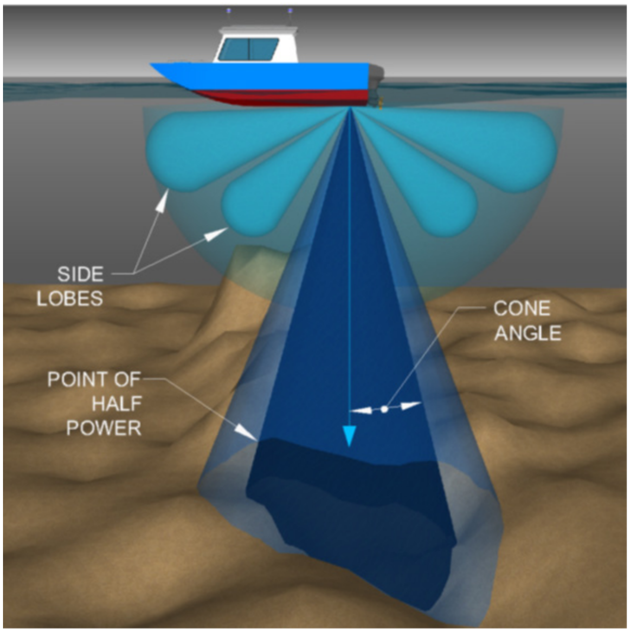

Figure 1. Sonar cone angle and side lobes.

Figure 2. Side-scan sonar mounting positions for structural imaging (right) and bottom scanning (left).