ADAPTIVE ENERGY SUCCESS STORY

Protecting Critical Concrete Infrastructure

Helping a Japanese engineering firm assess the safety of dams and retaining walls

The Challenge

The Japanese landscape is dotted with large-scale infrastructure such as concrete dams, highway retaining walls and earthen dams, many of them built in the 1980s. For example, many communities have grown around the base of large hillsides and mountains now classified as landslide zones. Retaining dams have been built to protect these communities, using earth and stone, concrete and aggregate materials.

The system is easily able to penetrate through these thick concrete structures and provide critical information about their condition. As a result, the government can take appropriate steps to repair or replace infrastructure items to mitigate risks to public safety

Large dam structures are subject to a continual bearing load as they hold back the water of an entire river or the dirt of entire hillsides, resulting in millions of pounds of pressure per cubic foot. Seismic events are always a possibility in Japan, so national infrastructure must be maintained to withstand this additional stress.

Due to alkali reactions with the cement used in the concrete mix, small pockets of air had formed in the concrete structures. Over time, water seeps into these pockets and starts to erode the concrete. During the winter as the water freezes, cracks form, worsening year after year.

A Japanese dam like those tested using the Adaptive Energy solution

Industry: Infrastructure / Materials

Technology: Ultrasound

Products & Services: Concrete inspection / Crack detection

Customer Profile: An engineering firm contracted by the Japanese government

Business Challenge: Inspecting aging concrete dams and highway retaining walls across Japan to protect public safety

Solution: An ultrasonic composite and concrete testing system for large grain and structural materials, capable of penetrating up to 10 meters of solid cement

Benefits:

- Thorough and accurate structures testing to detect cracks and alkali reactions
- Preservation of vital national infrastructure and efficient use of national construction resources by determining the best plan to repair, maintain or replace each structure
- Protecting communities from potential disaster from landslides or structural collapse

After more than 20 years of use, the Japanese government conducted preliminary tests, extracting core samples from existing structures, using ultrasonic testing to detect the presence of alkali-aggregate reactions, and then subjected the cores to a compression load. These cores failed the test, and many structures were deemed to be sub-par, posing potential risk to public safety in the event of a collapse. More intensive testing would be needed to fully assess the status of each structure and determine the most appropriate path, whether repair or replacement.

Each at-risk dam or wall needed to be inspected throughout its entire structure. The most significant challenge was that existing X-ray inspection technologies could not penetrate all the way through these massive structures, some of which are as much as nine meters thick in places. Traditional X-ray imaging couldn't capture a view of the structures because it was impossible to access the "back" side that abutted a hill or other solid earth formation.

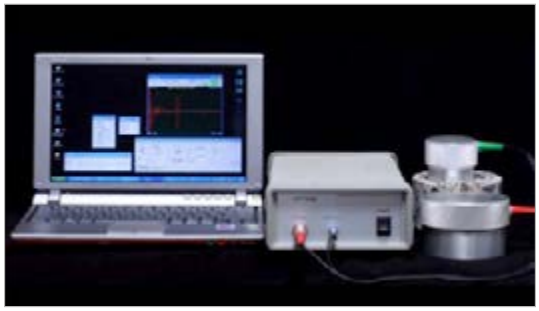
Alternative testing methods available included calibrated hammer tests or using extremely high-power X-rays, but the hammer technique offered limited effectiveness in this situation, and high-power X-rays would pose safety risks. An innovative new solution was needed to detect alkali reactions from one side of a structure, accurately and safely.

The Adaptive Energy Solution

The Customer, a Japanese engineering firm contracted by the government to perform infrastructure testing and repair, sought Adaptive Energy's assistance to solve this testing problem. Adaptive Energy collaborated with the Customer and with Imaging Supersonic Laboratories, where a leading sound engineer had developed an innovative approach for penetrating concrete as well as dense sound-dampening materials like cork or wood. Together the team devised a specialized ultrasonic testing system for large grain and structural materials, the Ultrasonic Composite/Concrete Tester (the UCT12dB).

The UCT12dB system features an ultra-wideband unipole wave generated by a step function pulser incorporated in an active transducer. Ultrasonic (sound) waves are transmitted through a structure from a frequency of DC-5MHz. An ultra-wideband receiver also is incorporated in the transducer with an effective detection range of 10KHz up to 3MHz depending upon the transducer settings.

This unique step function pulser allows the ultrasound waves to penetrate into solid concrete or composite structures that are up to ten meters thick. The system uses a single transducer in concrete for crack detection, thickness measurement, alkali-aggregate reaction and material evaluation. It is able to capture images all the way through the structure from a single surface.



The Ultrasonic Composite/Concrete Tester by data base (UCT12dB) system

There are multiple applications of the UCT12dB technology for assessing not only concrete but other large-grain structures and materials, including:

- Concrete thickness, dual transducer, one side 20 meters
- Concrete thickness, single transducer, one side 10 meters
- Concrete velocity, dual transducers, through transmission, 40 meters
- Concrete velocity, dual transducers, one side, 20 meters
- Damaged Concrete, crack depth, 10 meters depending on concrete condition
- Sealed plate length, 30 meters
- Void inside concrete 5 meter column
- Crack repair by epoxy resin, good or not
- Asphalt Thickness 50cm
- Contact or separate between Concrete base and Asphalt 50cm
- Carbon Brick for furnace 2 meters
- Void in wood
- Thin GFRP 1 meter
- Length of steel plate in dam, 30 meters
- Concrete thickness through steel plate 1 meter
- Clay(wet) frequency analyze 1 meter
- Clay(dry) frequency analyze 5 meters
- Anchor bolt length 5 meters

Results

Using the UCT12dB system, Japanese engineers can make use of a wide variety of methods to test different aspects of their infrastructure. The system is easily able to penetrate through these thick concrete structures and provide critical information about their condition.

As a result, the government can take appropriate steps to repair or replace infrastructure items to mitigate risks to public safety. The life of some structures can be extended through appropriate preventive maintenance, thus avoiding unnecessary replacement costs, while more severely compromised structures can be rebuilt or replaced, averting a potential disaster.

About Adaptive Energy

Adaptive Energy creates customized, non-destructive material evaluation solutions to address mission-critical, time-sensitive testing needs. By combining the latest digital radiography, computed tomography, and ultrasonic imaging technologies with innovative mechanical and robotic assemblies, Adaptive Energy's integrated systems offer rapid deployment, are easy to learn and maintain, and perform reliably under pressure.

Working collaboratively with organizations in the aerospace, automotive, energy, petro-chemical, defense, infrastructure, and materials industries, our experts develop optimized solutions for flaw and crack detection, composite delamination, weld inspection, hardness testing, custom radiation enclosures and overhead gantry systems, and more.

Adaptive Energy is also the exclusive distributor in the U.S. and Canada of FORCE Technology's P-Scan ultrasonic scanners, including the P-Scan Stack with Phased Array, a next generation automated inspection system.

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