Researchers develop non-destructive method to measure the salt content of concrete structures

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Researchers from the RIKEN Center for Advanced Photonics (RAP) have used a method, using the RANS compact neutron source, to non-destructively measure the salt content of structures such as bridges, tunnels, and elevated roadways, which can suffer from degradation due to exposure to salt from seawater and other sources.

The collapse of a bridge in August in Genoa, Italy, leading to the deaths of 37 people, has highlighted the danger posed by aging infrastructure. Japan, like many countries, faces major problems, as many of its bridges and tunnels were constructed during the high economic growth in the 1960s and 1970s and are now suffering degradation. However, inspections are time-consuming. For example, gauging the salt content of cement structures is typically done by boring out a core—an action which is time consuming and can slightly damage the structure.

The research group decided to search for a better way to perform inspections, using a neutron beam—a device that emits high-energy neutrons in a beam—emitted by a compact neutron source that they had developed. Neutrons are an exciting new way to image structures, as they can penetrate quite far into metallic materials thanks to the fact that they do not interact via the electromagnetic force, and thus are not affected by electric charge. They do occasionally interact with nuclei in the materials they penetrate, leading to the release of gamma rays that can be detected.

For this experiment, the group used their compact neutron source, which generates neutrons by bombarding a beryllium target with protons. They used the beam to irradiate a series of concrete blocks with salt squeezed between them, with "prompt" gamma rays—gamma rays that are emitted immediately upon irradiation by neutrons—being measured by high resolution germanium detectors. The prompt gamma rays are emitted from the atoms in the concrete blocks, and different elements can be detected by looking at the energy of the gamma rays. For example, the energies peaks from the prompt gamma rays emitted from chlorine—a component of salt—are 517 kiloelectron volts, 786 kiloelectron volts, 788 kiloelectron volts, 1165 kiloelectron volts, and so on.

By doing this, the researchers were able to demonstrate the presence of salt even when it was surrounded by between 12 and 18 centimeters of concrete. Each measurement took about 10 minutes.

According to Yoshie Otake, who led the study, "This is very exciting, because Japan is suffering from serious infrastructure degradation, and it is impossible to predict when a major accident will happen. Our feasibility study has shown that neutron beams can indeed be used to measure whether the salt content of a concrete structure is within the legal limits set by the government. Our next challenge is to build a compact neutron source that is small enough to be readily transported to various infrastructures to conduct measurements." The results were presented in October at the 18th JSMS Symposium on Concrete Structure Scenarios, held by the Society of Materials Science, Japan.

Provided by RIKEN

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