Sound waves save roads

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Every year roads are built and repaired to the tune of several billions. Intensive efforts are underway all over the world to get 'more road for your money' by developing better methods for both design and quality control of materials. One problem is that today there are no good methods for checking how robustly and safely the roads were built. Therefore they often don't last as long as they were supposed to and more money has to go to road construction.

But now a young Swedish scientist has developed a method where sound waves can reveal what a road looks like underneath and thereby show whether it is being properly built. According to the Swedish Road Administration, the method, which is expected to become the new standard, may entail major quality enhancements and cost savings.

Damage to bridges, tunnels, dams, and nuclear power plants can be uncovered using this technology, and dangerous accidents can thereby be prevented. Today most prognoses are based on educated guesses from previous experience, which often prove to be wrong. Since a road consists of many different materials - gravel, bitumen, air, water - it's difficult to predict how it will respond to future traffic and environmental loads. Because roads, unlike buildings, for instance, are 'built into' the ground, it's hard to inspect them visually.

"But with sound waves, roughly as with x-rays and ultrasound, you can obtain information about the composition and stiffness of the material on a computer screen. This allows you to monitor whether work is being done properly, thus ensuring that the road will last as long and withstand

loads as well as projected. Today inspectors typically have to drill cores and break up asphalt and concrete samples, instead of using this non-destructive type of testing," explains Nils Rydén, a researcher in engineering geology at the Faculty of Engineering, Lund University, who developed the technology.

Some roads only hold up for a couple of years, according to Nils Rydén, either because the materials were not sufficiently compacted, because the road bed was too soft, or because it was raining when the road was built, weaknesses that were then not discovered when the final inspection took place.

Major portions of the country's infrastructure were constructed 40 to 50 years ago and will soon need to be repaired, on the one hand, because they are worn out and, on the other, because they were dimensioned for 40 years, which was the standard back then. That time has now gone by and the question arise if and for how long the structure can be used. The concrete foundations of the Swedish nuclear power stations are in the same situation. Here, too, there have been no methods for inspecting and verifying whether they are in good condition.

"A road can't collapse into the earth and constitute the same safety risk as a bridge or a hydropower facility, which can in fact collapse, as has recently happened in the US and Russia," says Nils Rydén, who for the last couple of years has been busy, alongside his research, helping the Road Administration and various construction companies by tuning his technology so they can use it for their particular needs.

Nils Rydén was inspired to test the possibility of inspecting roads with sound when he wrote his master's thesis in 2000. At that time there were similar projects underway abroad, in the US, for instance, but today the Swedish method is the most advanced technology, according to Nils Rydén. Sound waves have previously been used to inspect material in the

auto and aircraft industry and to find oil and gas deposits underground.

The technology in brief:

Non-destructive testing with sound waves is based on measuring the dispersion of sound waves in constructions in order to 'see,' roughly in the same way as in medical ultrasound examinations, the stiffness and thickness of the materials involved as well as any cracks, etc. The velocity of the sound waves is directly related to the stiffness of the material, and differences in stiffness produce reflections that can be utilized for measuring the thickness of layers and for detecting hidden damage. When sound waves are used for measuring, rather low frequencies are employed, 50-10,000 Hz. Frequencies above 20,000 Hz are usually called ultrasound. The reason available ultrasound technology cannot be used is that ultrasound waves disappear after only a few decimeters in asphalt and concrete. X-rays can also be used for concrete, etc., but this is extremely expensive and complicated compared with sound waves.

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