3D GPR – A MULTITOOL ON THE ROAD

Mapping of layer thicknesses and composition

How GPR works
Ground Penetration Radar (GPR) works by using an antenna to transmit an electromagnetic pulse down through the substrata. Parts of the signal are reflected by layer boundaries between materials with differing polarizations. When the reflected signal returns to the antenna, the amplitude and time delay are registered, and thus the layer boundaries can be determined from the reflections. It is not possible to determine concretely which material the signal has encountered. When discussing street pavement, the reflections are normally established between asphalt and gravel, between gravel and various foundational material, and the boundary between gravel and raw earth. The polarization is largely determined by the density of the material.

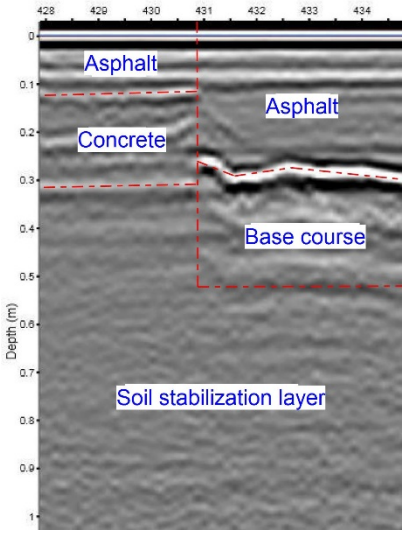
The newest technology
The newest developments in the field of GPR are multifrequency and multichannel 3D GPR.

A system can, for example, be comprised of 20 evenly distributed antennae, so that data is typically collected across a cell size of 7.5 cm square. Multifrequency means that one measures an entire frequency range, as opposed to only a single frequency. By transmitting multiple frequencies, one can map both the surface and objects further down in one go, something that would otherwise require repeated collections with different frequencies.

The resulting data combines the subsurface recordings with the coordinates of the collection, thereby allowing the data to be transferred to GIS or CAD maps.

Example of a radargram
A radargram is a representation of the reflected electromagnetic waves. To the right is shown a radargram for a stretch of 8m motorway.

When one cannot always distinguish the different asphalt layers from each other, it is because their electrical properties and densities are too similar.



CONTACT
Jørgen Ringgaard
Senior Geophysicist
Ph. +45 5161 6807
jri@ramboll.dk

Uffe Nielsen
Project Director
Ph. +45 5161 6782
utn@ramboll.dk

Rambøll Danmark
Hannemanns Allé 53
DK-2300 København S
www.ramboll.com/geophysics

- **Mapping of layer thickness with a 100 % coverage of the surface**
- **Results in GIS format and as contour map**
- **Difference charts, showing deviations from planned asphalt thickness**
- **Volume calculation of asphalt quantities**
- **Mapping of concrete under asphalt**
- **Planning of renovations and pavement breakdown**
- **Mapping of cavities below streets**
- **Mapping of subsurface installations**

Control of new pavement

On a newly completed highway crossing, 3D GPR was used to measure almost 20,000m^2 of asphalt. The high collection speed enabled data from this large area to be collected in just a single work day, and without traffic regulation.

The goal of the GPR measurements was to check the thickness of the completed asphalt coverage. To ensure accuracy, a row of drill core samples were taken to calibrate the GPR.

The correlation between the GPR measurements and the core sample measurements were quite high. The thickness of the collected asphalt layers were measured to an accuracy of ±6 mm. Half of the calibration points were only off my 0-2mm. However, a volume calculation would have likely been even more accurate, as the calibrated measurements would distribute around the true mean value.

Existing pavement

Pavement reinforcement

To reinforce older road pavement, a total scan of the area can be taken in order to get details about the pavement composition, which may vary greatly along different parts of the road.

Below is a map of the asphalt thickness in a roundabout that was to be renovated. During the milling of the surface, the asphalt layer was unexpectedly broken through, and therefore the thickness of the roundabout had to be charted.

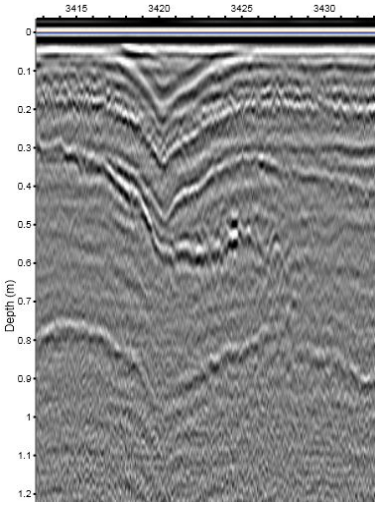
Pavement Breakdown

If the road is to be broken down, rather than reinforced, it's also an advantage to have GPR measurement of the entire area. After the data is processed, one can calculate the amounts of supplies needed.

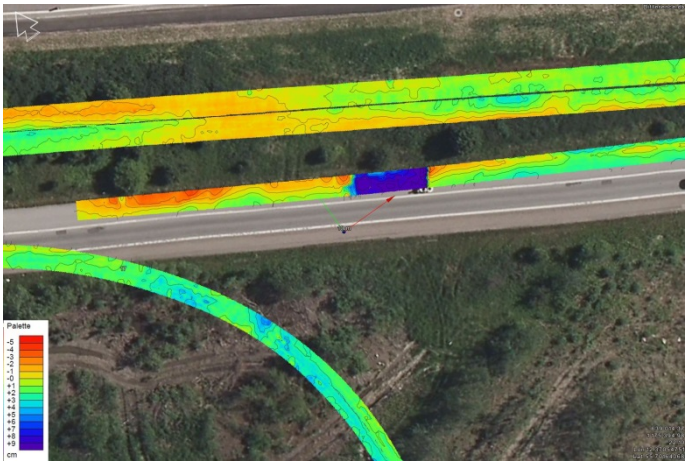
Cavities under roads

The long-term effects of harsh weather can undermine the integrity of a road. Underground sewage infrastructure can also wash away unsecured layers.

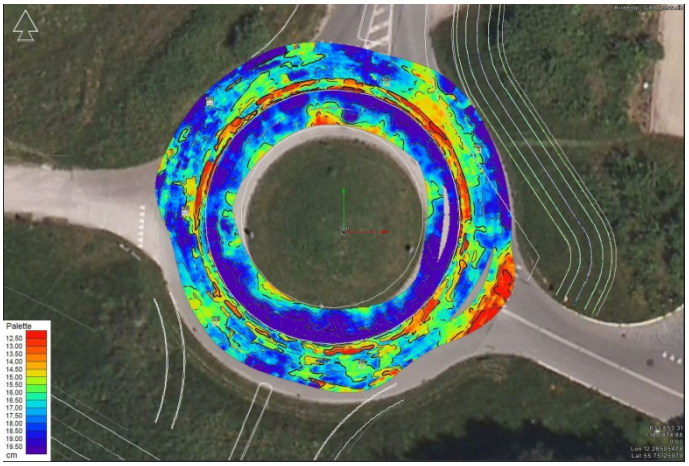
The resulting cavities beneath the road can be mapped with 3D GPR before they become dangerous or cause breaks in the pavement.



Sinking pavement due to undermining



Thickness of asphalt layer on a new street – difference map



Thickness of asphalt layer in a roundabout