Mapping asphalt thickness with high-frequency GPR

Description of problem

When investigating the asphalt thickness along roads it is important to have a small and easily set-up system, which can be used on an ordinary car and in speeds following the traffic rhythm. If the GPR system is mounted on a trailer the maximum survey speed will be lower, and most often some kind of safety arrangement will be needed.

This Application Note gives an example of how to arrange a system, suitable for efficient asphalt investigations, using a high-frequency radar system mounted underneath an ordinary car.

Equipment used

The investigation was carried out with the RAMAC CUII Control unit and the 1.6 GHz shielded antenna, with the RAMAC Monitor XV11 for data acquisition.

The GPR system mounted in a car, with the GPR antenna underneath the rear door and the GPS antenna on the roof.

GPR antenna

Encoder mounted on a wheel.

Investigation method

The GPR antenna is mounted underneath the car, hanging in a strap fixed in one of the doors. An ordinary Malå encoder is used for the trigging and distance measurements. The encoder is attached to one of the car wheels, see photo. To get the absolute position of each profile, the GPR measurement is complemented with a GPS logging with the GPS antenna mounted on the car roof.

The control unit CUII, GPS unit and the Monitor are kept inside the car.

Depending on the type of investigation, one or more lanes can be measured. In cases where both sides of a lane need to be measured, the antenna can be moved between the left and right side of the car.

With measurement settings as follows, the speed can be held at approximately 70 to 80 km/h.

Sampling frequency: 16 000 MHz
Number of samples: 480
Distance between traces: 25 cm
Stacks: Auto

Critical elements

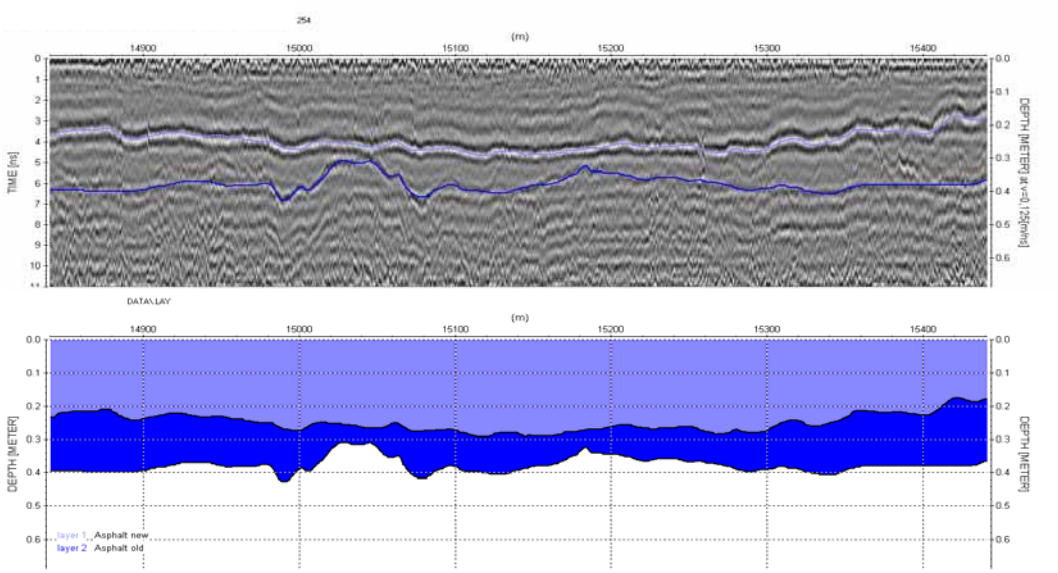
It is important to mount the antenna as close as possible to the asphalt surface in order to get the best possible results. The optimal height above ground will depend both upon speed and on the quality of the road. Most often some 2-3 cm is sufficient. However if the road is bumpy, there is a risk that then antenna will hit the ground, and the height should be increased.

As the encoder is placed on a car wheel it has to be recalibrated for each car type used. This is easily done within the Monitor (or GroundVision). It is good to remember that long calibration distances will result in better distance measurements.

The velocity of the radar waves in asphalt varies most often between 120 to 150 m/μs. It is crucial to have a correct velocity estimation for the interpretation of layer thickness. To overcome this problem it is important to have some geotechnical information, e.g. cores, of the thickness along the investigated road, in order to be able to calibrate the velocity and thereby the depth. Normally one geotechnical checkpoint for each kilometer is quite sufficient.

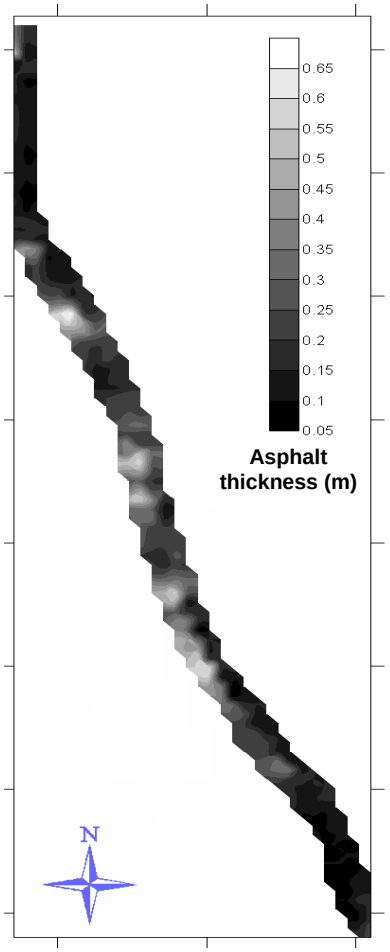
Results

Below an example of result is shown in a 2D section and also presented as a GIS map.



The radargram above shows a section of a road, where the old pavement construction has been reconditioned with new asphalt. Clear layering within the asphalt is seen, indicating several occasions of asphalting.

When measuring several profiles in different lanes and both directions, the interpreted layer thickness can be combined to a map, provided GPS logging is done simultaneously with the GPR measurements. On the right, one example is shown of a 4-lane road, where GPR data was interpreted for all four different lanes.



Conclusions

Mounting the GPR antenna beneath an ordinary car provides a very flexible GPR system for efficient asphalt investigations. The speed can be kept quite high and there is seldom need of any safety arrangement.

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