

DISCUSSION WITH GPR EXPERTS/VENDORS

Summary

Garry Aicken (Principal-Technical Manager, Kessler Soils Engineering Products, Inc.)

- Reached out on January 13, 2021
- Admitted that he is not a GPR expert and can't help with the issue.

George Chang (Director of Research, The Transtec Group, Inc.)

- Reached out on January 13, 2021
- No response has been received.

Ken Maser (Senior Principal, Infrasense)

- Reached out on January 13, 2021
- Meeting scheduled: January 18, 2021 (10:00 – 11:00 am)
- Layer thickness inaccuracy in data from 900 MHz ground-coupled antenna may be due to the resolution issue.
- Signal velocity calibration based on proposed field coring may not improve the thickness prediction if the ground-truth information for signal velocity computation is accurate.
- There is a possibility that the Pressure Cell (PC) location (i.e., elevation) may change during the compaction of asphalt layer and thus, differ from the location as documented in the as-built drawing.
- Some possible solutions proposed: (a) using higher frequency ground-coupled antenna such as 1.6 MHz, (b) common mid-point method to determine signal velocity without coring, and (c) conduct transverse direction full-width survey using 2 GHz air-coupled antenna by placing it on a cart.
- Performing multiple full-length longitudinal survey using 2 GHz air-coupled at regular lateral offset to generate transverse layer thickness profile can be an alternative option; however, it may not provide accurate information due to the difficulty during maintaining the alignment between the air-coupled antenna and the survey line.
- The difference between as-built vs mean predicted layer thickness can be small, such as the case of a CALTRAN project (0.1-inch).

Roger Roberts (Senior Software Engineer at GSSI)

- Reached out on January 13, 2021
- Meeting scheduled: January 18, 2021 (11:00 am – 12:00 pm)
- Layer thickness inaccuracy in data from 900 MHz ground-coupled antenna may be due to: (a) resolution issue, and (b) mismatch between time-zero and pavement surface resulted from antenna separation (i.e., transmitter-receiver offset inside the antenna box).
- Performing multiple full-length longitudinal survey using 2 GHz air-coupled at regular lateral offset to generate transverse layer thickness profile can be considered as an alternative option.
- Field coring may improve the thickness prediction.
- Range of (%) thickness difference: 5 – 10%.

- Regarding mismatch between time-zero and pavement surface, ‘Ground-Truth’ was recommended to minimize the impact based on his experience of a bridge-deck survey using 1.5 MHz ground-coupled antenna.
- Regarding 2.6 GHz ground-coupled antenna, mismatch between time-zero and pavement surface may remain and to minimize, he recommended ‘Ground-Truth’ solution again.

Tom Scullion (Texas Transportation Institute)

- Reached out on January 13, 2021
- Expert opinion was shared through emails
- Clear surface reflection cannot be obtained from the 900 MHz ground-coupled antenna, and thereby, it is very difficult to interpret an accurate 2-way travel time in the asphalt layer, which eventually leads to the lower accuracy.
- Regarding 2 GHz air-coupled antenna, the disadvantage is the limited depth of penetration, i.e., any interfaces deeper than 16 inches may not be detected.
- Regarding the ground-coupled antenna, the signal penetrates deeper, and thus, it can be useful in the test section with separator fabric to monitor moisture build up at the interface.

Timo Saarenketo (CEO & President, Roadscanners Group)

- Reached out on January 13, 2021
- Meeting scheduled: January 21, 2021 (9:00 – 10:00 am)
- Range of expected thickness from 2 GHz antenna is: (a) 5% in case of availability of ‘Ground-Truth’ information, and (b) 10% in case ‘Ground-Truth’ information is not available.
- In case of multiple asphalt lifts, the dielectric constant variation is supposed to be insignificant.
- During the compaction of asphalt layer, location of the instrumentation can be changed (deviate from the coordinates reported in as-built drawing)
- Layer thickness inaccuracy in data from 900 MHz ground-coupled antenna may be due to: (a) resolution issue, and (b) mismatch between time-zero and pavement surface.
- Signal velocity calibration based on field coring may significantly enhance the accuracy of the thickness prediction.
- Based on one of their airfield projects, they monitored the change in pavement layers through the application of LIDAR and GPR. However, they could not quantify change in layer thickness due to the lack of multiple survey data.
- Even though 900 MHz ground-coupled antenna has the earlier mentioned limitations, it can still be useful in case monitoring permanent deformation in unbound layers (granular layer) beneath asphalt layer.
- They recommended frequent (say weekly) GPR survey to monitor permanent deformation.
- Alternative option on multiple longitudinal survey using 2 GHz antenna at regular lateral offset to generate transverse layer thickness was also well-received. Few inches of antenna wandering along the survey line should not adversely affect the accuracy of transverse profile.
- Suggested to re-visit the data to check possible interference of reflections from thin layers, that may affect the accuracy of the thickness prediction. In addition, advanced analysis of GPR was highly recommended for monitoring the change in layer thickness.

- They are willing to deliver a presentation to the FAA on the capability of their RoadDoctor software and experience on GPR application.

Recommendations

- Proceed with the proposed plan for GPR signal calibration using field-cores and assess the accuracy of thickness prediction.
- Re-visit the baseline GPR data for possible improvement in thickness prediction through: (a) signal calibration, and (b) re-examine the layer interface and ‘Ground-Truth’ information.
- If the first two steps are not sufficient to obtain reasonable agreement between predicted and core thickness, an effort shall be made to explore different advanced analysis options such as background noise removal/filtering, migration etc.