**Update on CC9 GPR Data Analysis**

***Cart-Mounted System (900 MHz Ground-Coupled Antenna)***

1. Re-visit of Ground-Truth

* On CC9 as-built, the depth of instrumentation (e.g., PC) was taken from the pavement surface to the middle of the sensor.
* The thickness of sensor was measured at 1-inch for PC and 0.25-inch for LSG/TSG.
* Exact depth of PC (*h*) = as-built Z – 0.5xPC thickness, and the depth of LSG/TSG reported on as-built was correct.

1. *Re-analysis of GPR Data*

* A total of five data sets were considered: (a) LSG/TSG and PC at the bottom of P-403MR in LFS-1N: 2 files; (b) LSG/TSG and PC at the bottom of P-401MR in LFS-3N: 2 files; and (c) LSG/TSG at the bottom of P-401MR in LFS-5N: 1 file.
* LFS-1N: (a) Apply IIR filter (High Pass: 600 MHz and Low Pass: 2500 MHz) on both files to reduce noise level and locate the ‘Ground-Truth’ and layer interfaces; (b) Apply ‘Migration’ technique to locate the apex of the hyperbolic reflection that corresponds to the exact location of ‘Ground-Truth’; (c): Track the pavement surface and exact location of ‘Ground-Truth’ to determine the 2-way travel time (*t*) in asphalt layer, i.e., P-401MR + P-403MR; and (d) Determine the signal velocity: .
* LFC-3N: same as LFS-1N, except this test item does not have P-403MR and thereby, signal velocity only corresponds to P-401MR.
* LFC-5N: same as LFC-3N, except the IIR filter: (a) High Pass: 1500 MHz; and (b) Low Pass: 2500 MHz to enhance the resolution during the data processing.
* The mean signal velocity per test item was then determined from the velocities determined from the two ‘Ground Truth’ instrumentations.

1. *Prediction of Layer Thickness*

* Layer thickness prediction was performed on CC9 baseline full-width GPR survey along: (a) Sta: 0+15 (LFS-1N/1S); (b) Sta: 1+35 (LFC-3N/3S); and (c) Sta: 2+55 (LFC-5N/5S). Note that no GPR data (image) re-processing was needed and the 2-way travel time in asphalt layer was obtained from the baseline processing.
* Predicted asphalt layer thickness incorporating the revised signal velocities are summarized in Table 1. Prediction improvement was evident at some degree, but conclusive observations will depend on the completion of the rest CC9 test items (i.e., LFS-2N, LFS-2S, LFS-4N, and LFC-4S).

***Van-Mounted System (2 GHz Air-Coupled Antenna)***

A metal plate re-calibration test was conducted at higher sampling rate such as 512 and 1024 samples/scan, which will be integrated to the analysis of 2 GHz air-coupled antenna data for thickness prediction. Advanced analysis including filtering may be required.

Table 1. Summary of Layer Thickness

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Test item | Station | Layer | Signal Velocity, in/ns | As-built Thickness, inch | Ground-Truth (PC and LSG/TSG), inch | Predicted Thickness, inch | |
| Re-Analysis | Baseline |
| LFS-1N | 0+15 | P-401MR+P403MR | 4.78 | 10.8 | 11 | 10.9 | 10.8 |
| LFS-1S | 0+15 | P-401MR+P403MR | -- | 8.9 | 9.0 | 8.8 | 9.2 |
| LFC-3N | 1+35 | P-401MR | 4.71 | 5.1 | 5.0 | 4.8 | 6.5 |
| LFC-3S | 1+35 | P-401MR | -- | 5.2 | 5.0 | 4.9 | 6.6 |
| LFC-5N | 2+55 | P-401MR | 3.82 | 3.3 | 3.0 | 3.1 | 5.0 |
| LFC-5S | 2+55 | P-401MR | -- | 3.3 | 3.0 | 3.1 | 5.1 |