**REPORT HIGHLIGHTS**

* **FAA GPR system includes**: (a) Cart-mounted GPR system with 900 MHz ground-coupled antenna; and (b) Van-mounted GPR system with 2 GHz air-coupled and 400 MHz ground-coupled antenna. Antennas and accessories in both systems were functional.
* **The 900 MHz cart-mounted system was selected for**: (a) Full-width GPR survey (transverse direction) to capture the transverse/cross-sectional profile of layer thickness; and (b) Identify as-built thicknesses of asphalt and unbound layers at both shallow and deeper depths.
* **The 2 GHz van-mounted system was selected for**: (a) Full-length GPR survey (longitudinal direction) to capture the longitudinal profile of layer thickness; and (b) Identify thin asphalt layer and as-built thicknesses (i.e., LFC-5N/-5S).
* **The 400 MHz van-mounted system was selected for**: (a) Full-length GPR survey (longitudinal direction) to capture the longitudinal profile of layer thickness; and (b) Identify subgrade at deeper depth, which is required for the determination of subbase thickness (for instance, P-154MR under LFC-3N).
* **GPR survey/testing for determination of signal velocity**: (a) Air-coupled antenna (2 GHz): Metal plate calibration test; and (b) Ground-coupled antenna (400 and 900 MHz): GPR survey on ‘Ground Truth’ locations (i.e., locations of asphalt strain gage and earth pressure cell at known depth).
* **After field-survey, steps for layer thickness interpretation (in RADAN 7) were**: (a) Post-Processing of Baseline GPR Image to determine the 2-way travel time of EM signals in pavement layers, i.e., Eq. (3) – (7), (b) Determination of signal velocity based on metal plate calibration for 2 GHz and ‘Ground Truth’ for 400 and 900 MHz, i.e., Eq. (8) – (16) in the report, and (c) Determination of layer thickness incorporating 2-way travel time and signal velocity, i.e., Eq. (1) in the report.
* **Summary of data processing and analysis**: (a) Transverse profiles of asphalt and underlying layers at shallow depths were generated as ‘Baseline Measurement’ to monitor any possible occurrence of permanent deformation in those layers during CC9 traffic test; (b) Full-length asphalt thickness profiles were generated, which were fairly consistent and close to as-built thickness distribution. This profile can be adopted as an additional ‘Baseline Measurement’ to monitor any possible permanent deformation during CC9 traffic test; and (c) Layer interface atop subgrade was captured leading to generation of full-length subbase thickness profiles, can be adopted as ‘Baseline Measurement’ to monitor any possible permanent deformation during CC9 traffic test.

**PERMANENT DEFORMATION MONITORING & SURVEY RECOMMEDATIONS**

Feasibility of permanent monitoring using GPR during the CC9 traffic test depends on: (a) possible increase in dielectric constant due to densification of pavement layers under repeated loading; (b) capturing the layer interfaces accurately during the interaction between two adjacent layer materials with different dielectric constants along the interfaces; and (c) moisture content variation in pavement layers, which is correlated to dielectric constant of layer material.

If there is no significant change in dielectric constant, it is expected that any change in layer thickness due to permanent deformation during the traffic test can be accomplished.

* Full-width GPR survey using 900 MHz antenna (cart-mounted) is recommended for *weekly-basis (or roughly 2000 vehicle passes)* to: (a) monitor possible occurrence of permanent deformation in asphalt and underlying layers at shallow depth; and (b) monitor any change in dielectric constant and layer interface identification.
* Full-length GPR survey using the 2 GHz antenna (van-mounted) is recommended for *every 0.25-inch of rutting on pavement surface* to monitor possible permanent deformation in asphalt layer.
* Full-length GPR survey using the 400 MHz antenna (van-mounted) is recommended for *every 0.25-inch of rutting on pavement surface, and if, permanent deformation is indicated in coil sensor responses*.

In addition, full-width and -length GPR survey using both cart- and van-mounted systems respectively on pavement surface are recommended prior to post-traffic testing to: (a) compare GPR predicted layer thickness to layer profiles measured from trenching, and (b) obtain data (GPR data and asphalt cores for void determination in laboratory) for possible air void vs dielectric constant correlation development.